



University of Padova, Department of Agronomy, Food,
Natural Resources, Animal and Environment

FIERAGRICOLA

112th International Agricultural Technologies Show

Verona, MER 3 - SAB 6 Febbraio 2016

" Biostimolanti: come agiscono ed effetti sulle
colture" .

Prof.ssa Serenella Nardi



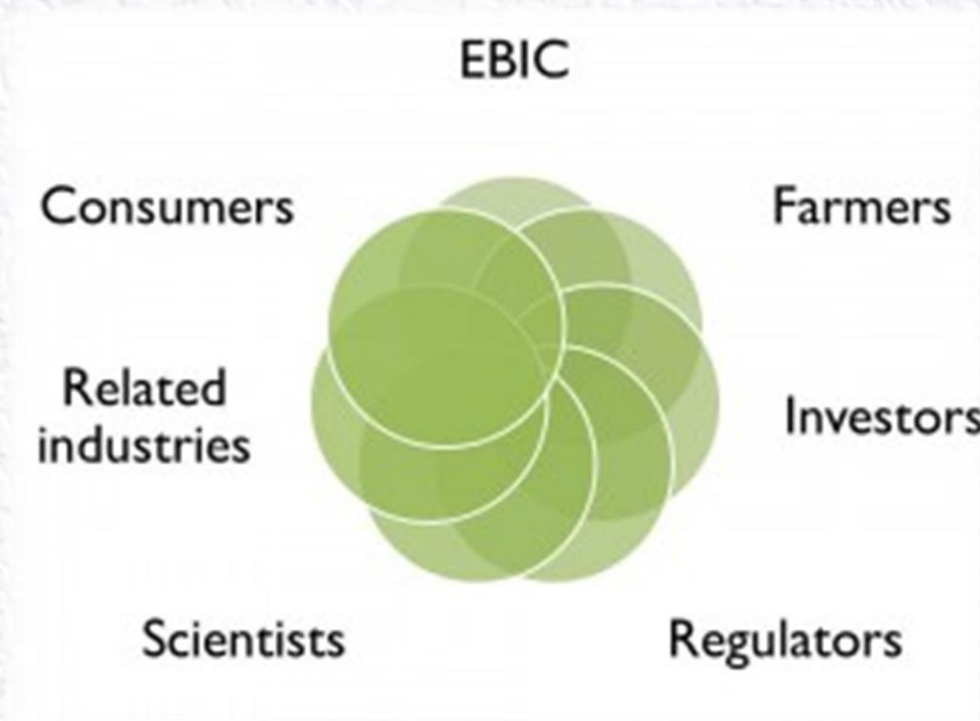
“Per biostimolante si intende qualsiasi prodotto naturale o sintetico, minerale od organico caratterizzato da diverse azioni e modalità d’uso in grado di contribuire positivamente al miglioramento della nutrizione e allo sviluppo delle specie vegetali”.

Decreto Legislativo 29 aprile 2006 n. 217 (D.Lgs. 217/06) “Revisione della disciplina in materia di fertilizzanti”, pubblicato sulla G.U. n. 141 del 20 giugno 2006 – Suppl. Ordinario n. 152.



in Europe >6.2 million hectares were treated with biostimulants in 2012

EBIC è stata fondata nel giugno 2011 come Consorzio europeo industriale sui biostimolanti e raggruppa 50 aziende attive in Europa.



The European Biostimulants Industry Council describes:

“Plant biostimulants contain substance(s) and/or micro-organisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to enhance/benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and crop quality. Biostimulants have no direct action against pests, and therefore **do not fall within the regulatory framework of pesticides**” .

Finally, the EBIC concept of biostimulants includes products with some nutrients, provided that the effect on plant growth is not through direct fertilization: “**Biostimulants operate through different mechanisms than fertilisers, regardless of the presence of nutrients in the products**” (EBIC 2012).



The First World Congress on Biostimulants in Agriculture
26-29 November, 2012, Strasbourg Congress Center, France

The First World Congress on the use of Biostimulants in Agriculture was an international scientific and technical conference to review the latest knowledge on these products, which are increasingly used in crop production around the world. A panel of prestigious international speakers discussed the impact of Biostimulants on Plant Nutrition, Abiotic Stresses, Plant Disease Responses, Plant Growth and Development, as well as the various aspects of legislation on these products in the main markets, with a special focus on Europe.

NEWAG INTERNATIONAL

Welcome to

**The 1st World Congress
on the use of Biostimulants
in Agriculture**

26-29 November, 2012



**THE 2ND WORLD CONGRESS
ON THE USE OF BIOSTIMULANTS
IN AGRICULTURE**

 **Monday 16th - Thursday 19th November, 2015**
Florence Convention Centre, Italy

ORGANISED BY
NEWAG INTERNATIONAL
Science-based solutions for plant growth



PLATINUM SPONSOR
EBIC
European Biostimulants Industry Council

FIERAGRICOLA Verona, 3-6 Febbraio
2016

dal LABORATORIO

al CAMPO:

Il cammino è lungo



PROVE CAMPO



PROVE PRE CAMPO

DET. ANIONI ANALISI FOGL.

RILIEVI MORFOMETRICI

**ALLEVAMENTO DI PIANTE IN
CONDIZIONI CONTROLLATE**

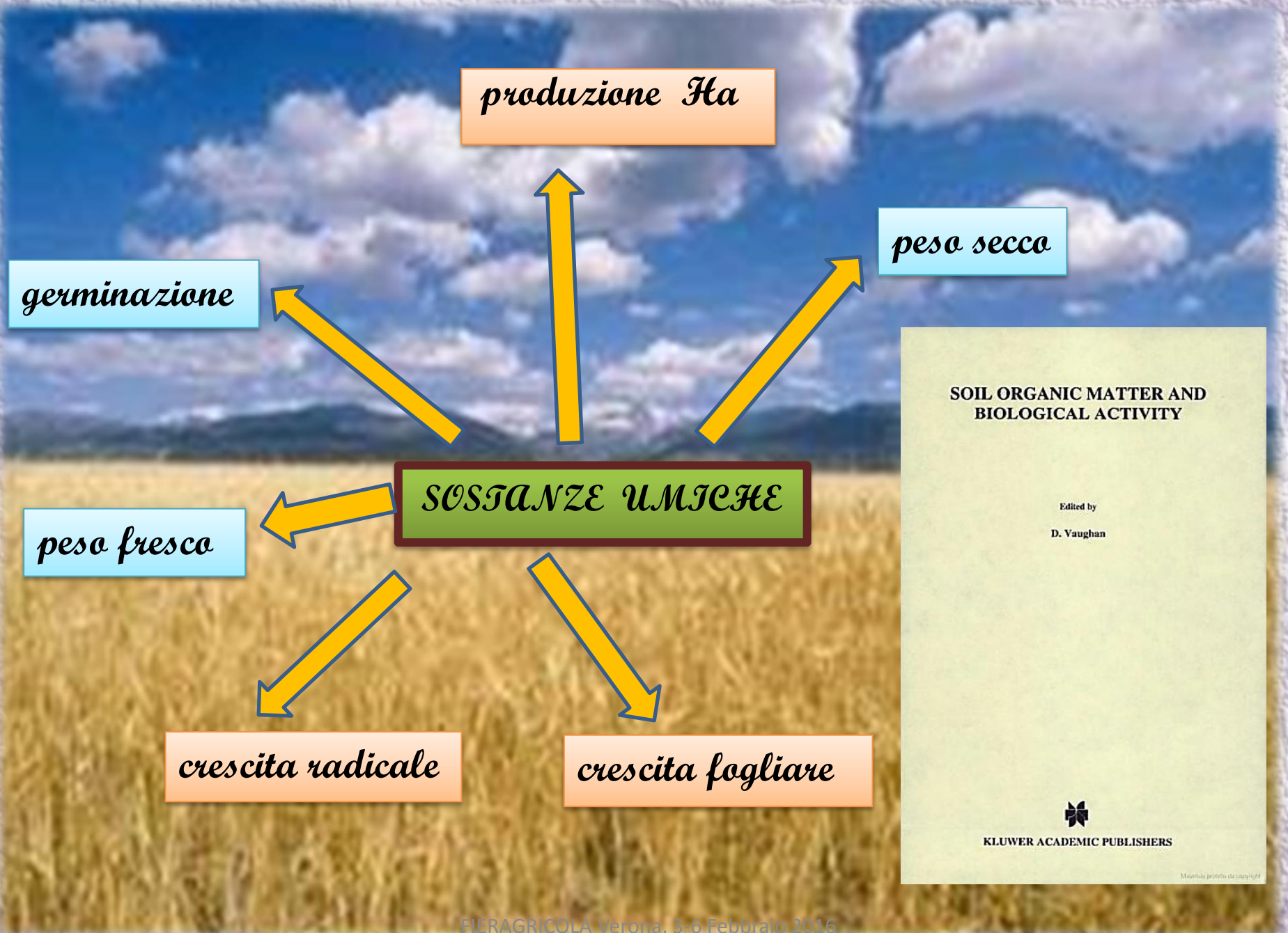


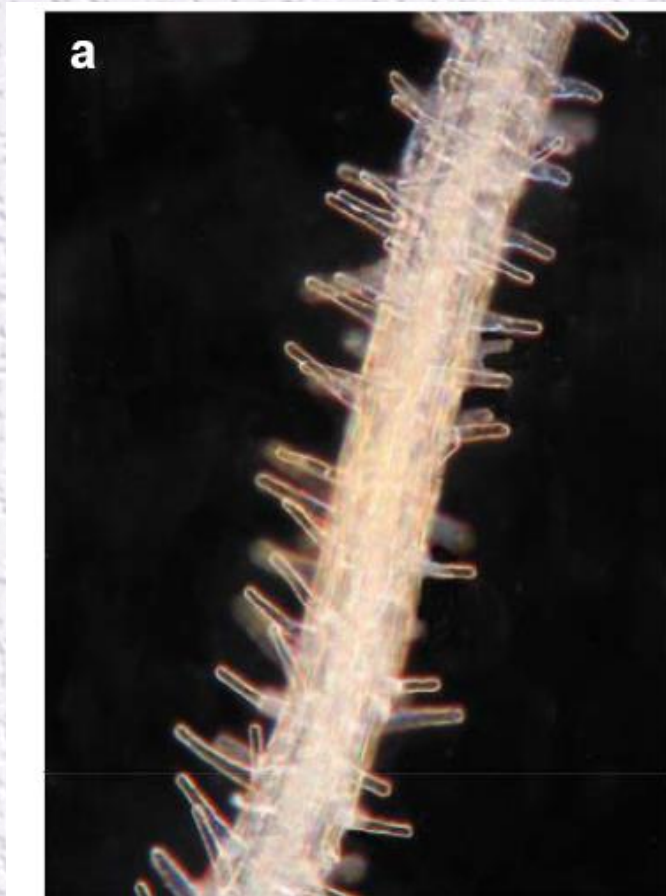
TEST AUDUS



I biostimolanti si suddividono:

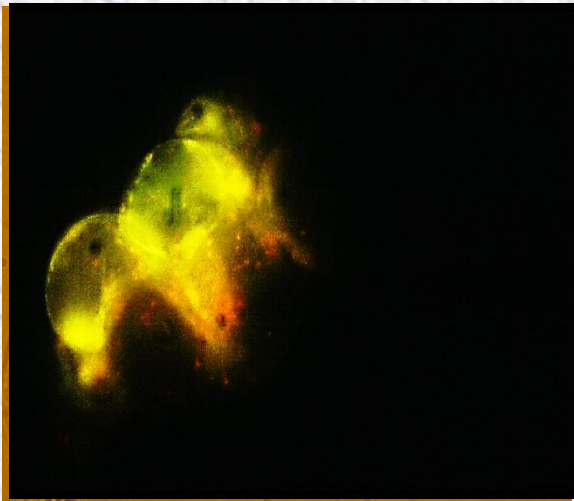
1. Inoculanti microbici,
2. Sostanze uniche,
3. Idrolizzati proteici ed aminoacidi,
4. Prodotti a base di alghe.





Schmidt et al, Plant Soil (2007)

Fluorescein-labeled interaction with carrot cells in culture compared to indole-3-acetic acid.



Fluorescence labeling of bound FA in carrot cell culture after 72 hr of incubation.



Fluorescence labeling of bound IAA in carrot cell culture after 72 hr of incubation.

Muscolo, et al., 2007. Journal of Chem Ecol 33, 115-129.



Effetti di stimolazione.....

Trasporto dei nutrienti

- sintesi proteica

- Cinetica di trasporto

- attività-ATPasica microsomiale

- attività H^+ -ATPasica del plasmalemma e del tonoplasto

- Dell'Agnola and Ferrari, 1971

- Vaughan et al., 1985

- Nardi et al., 2000

- Cacco et al., 2000

- Maggioni et al., 1987;

- Nardi et al., 1991;

- Pinton et al., 1992

- Varanini et al., 1993

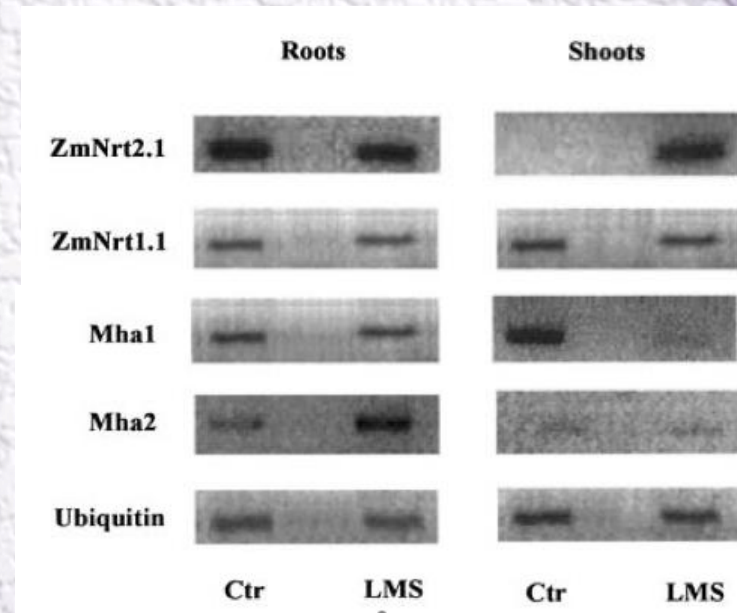
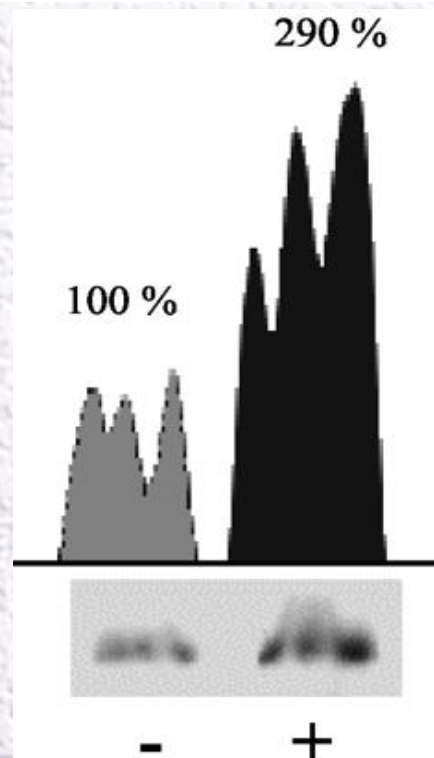
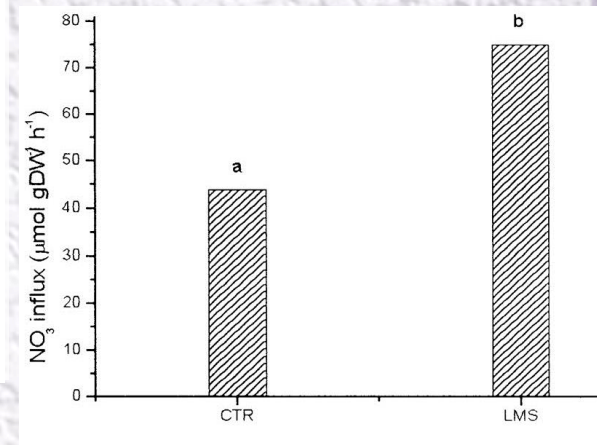
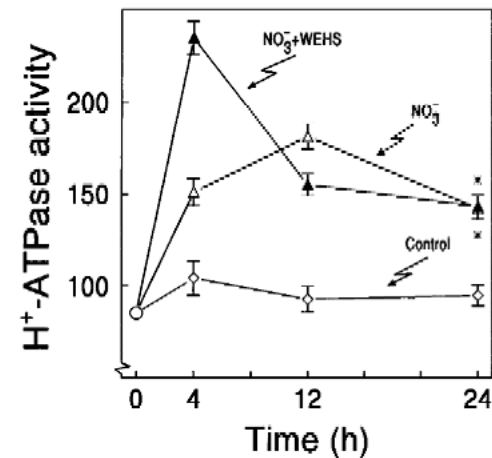
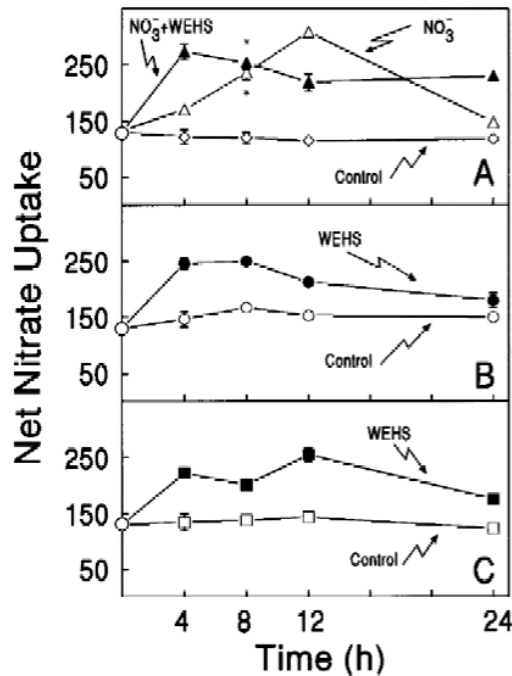
- Pinton et al., 1997

- Pinton et al., 1999

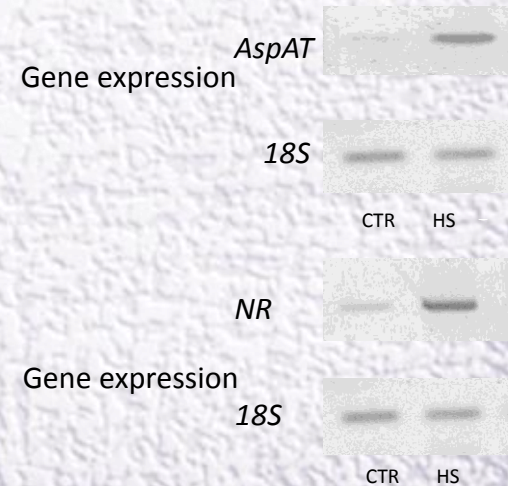
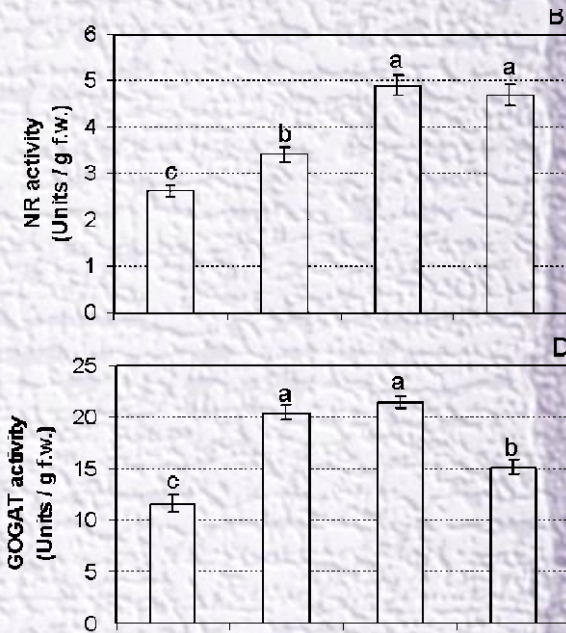
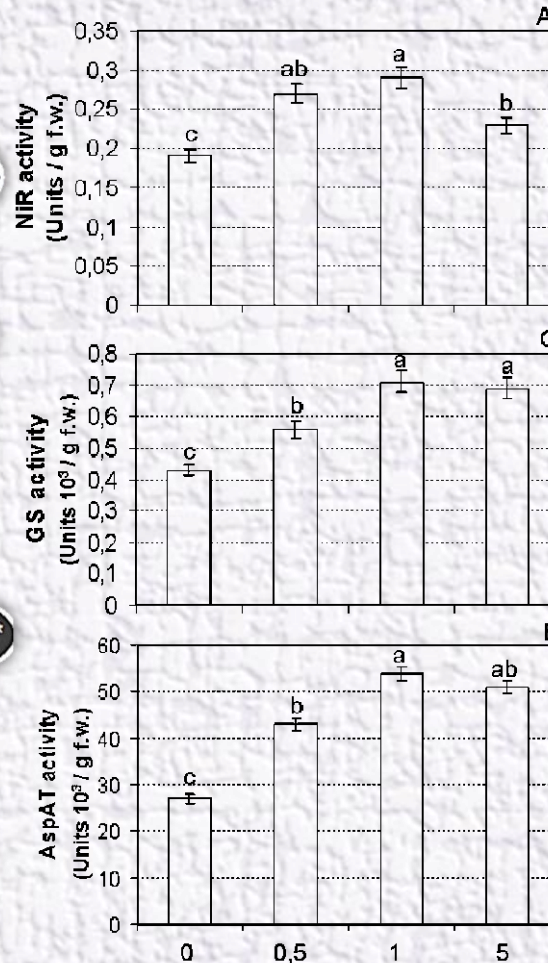
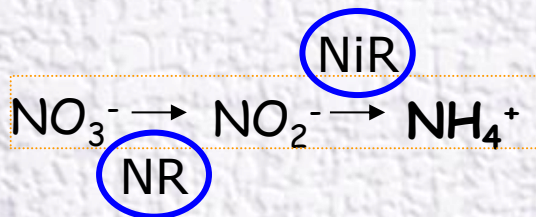
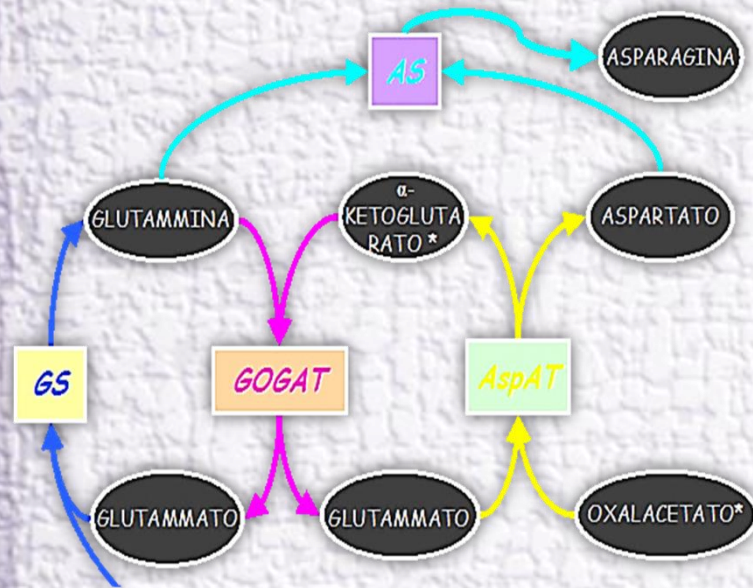
- Canellas et al., 2002

HS Biological Activity (Ion uptake : NO_3^-)

NO_3^- influx and mRNA
synthesis of maize H^+ -ATPase
Mha2 and NO_3^- transporters

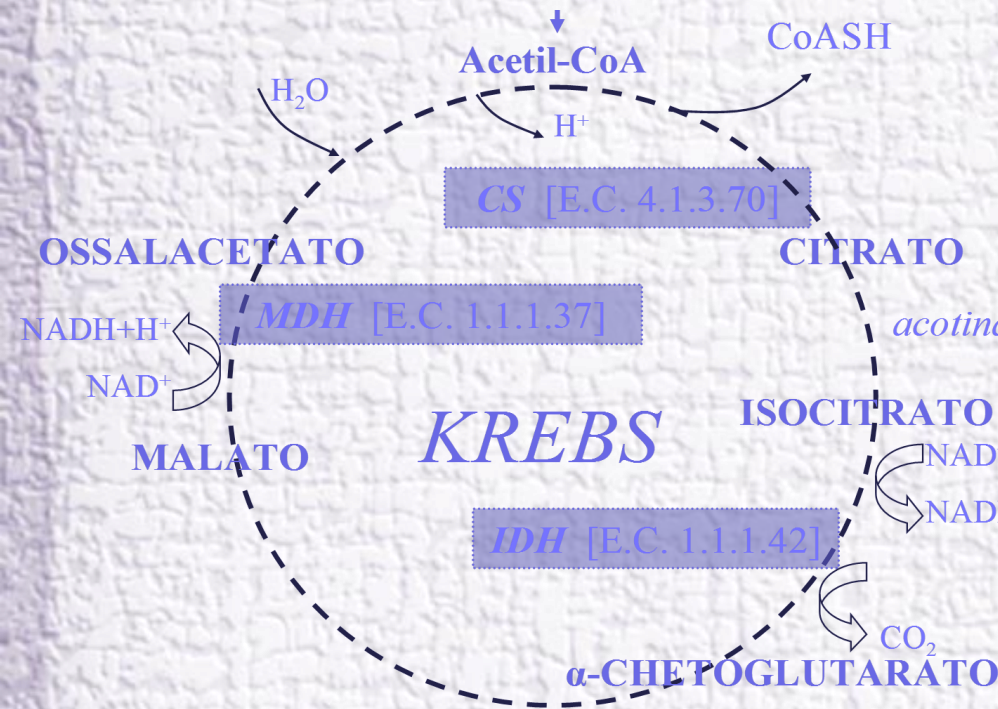


NO₃⁻ ASSIMILATION



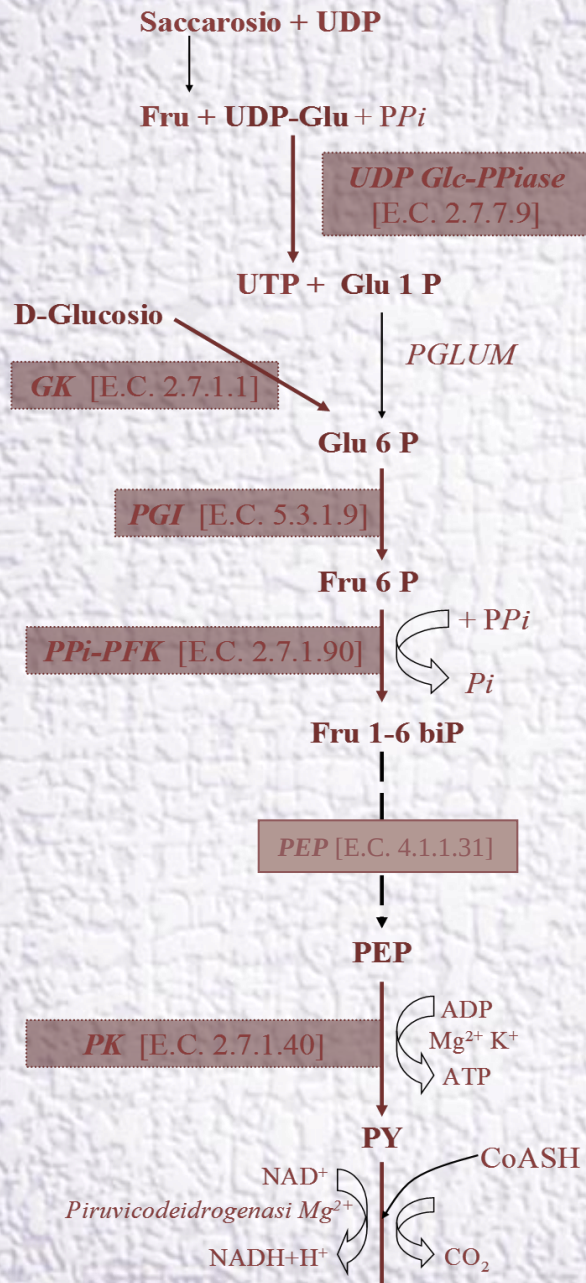
Vaccaro, S., Muscolo, A., Pizzeghello, D., Spaccini, R., Piccolo, A., Nardi, S., 2009. Effect of a Compost and Its Water-Soluble Fractions on Key Enzymes of Nitrogen Metabolism in Maize Seedlings. Journal of Agricultural and Food Chemistry 57, 11267-11276.

Krebs Cycle



Humic samples	Concentration (mg Cl ⁻¹)	Enzyme activities ^a		
		CS	IDH	MDH
HA	0	100c	100c	100c
	0.5	116b	126b	101c
	1	170a	131ab	124b
	5	157a	144a	153a
Fraction I	0	100c	100c	100c
	0.5	179a	122b	152a
	1	158b	148a	123b
	5	103c	105c	103c
Fraction II	0	100c	100b	100c
	0.5	149a	155a	121b
	1	127b	166a	135a
	5	55d	60c	61d
Fraction III	0	100c	100d	100d
	0.5	151ab	139b	155b
	1	163a	119c	129c
	5	146b	175a	210a

Nardi, S., Muscolo, A., Vaccaro, S., Baiano, S., Spaccini, R., Piccolo, A., 2007. Relationship between molecular characteristics of soil humic fractions and glycolytic pathway and krebs cycle in maize seedlings. *Soil Biology & Biochemistry* 39, 3138-3146.



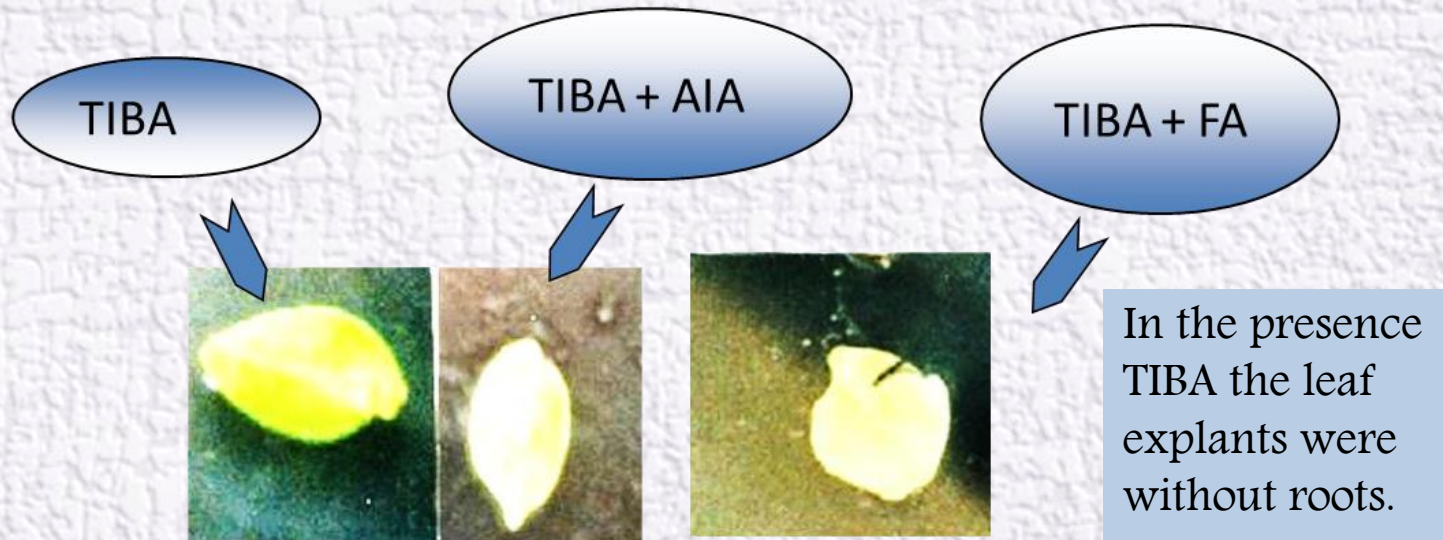
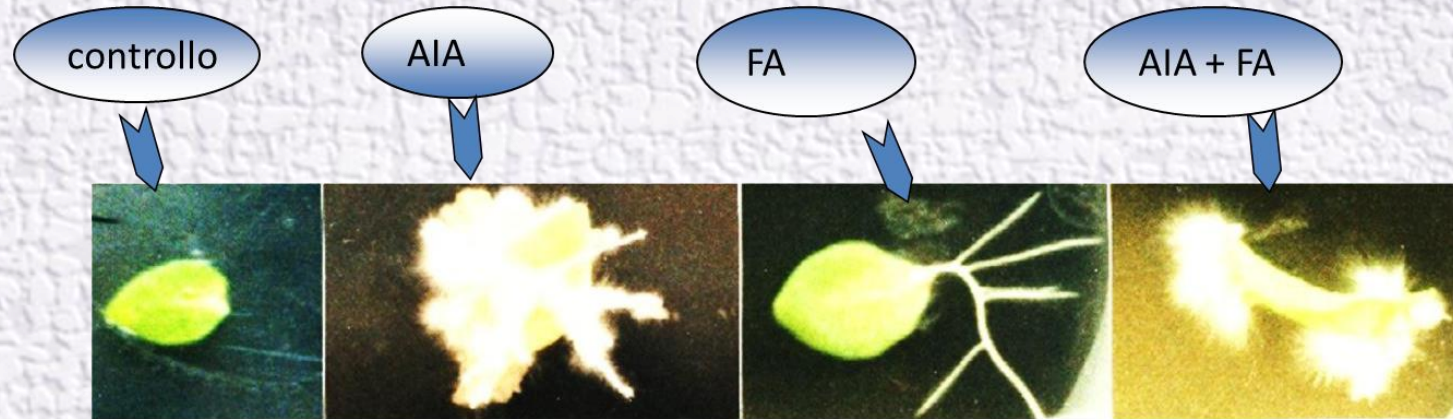
**G
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Humic samples	Concentration (mg C l ⁻¹)	Enzyme activities ^a			
		GK	PGI	PFK	PK
HA	0	100d	100c	100b	100c
	0.5	109c	108bc	101b	129ab
	1	125b	114b	106b	121b
	5	194a	218a	219a	135a
Fraction I	0	100c	100c	100c	100c
	0.5	180a	179a	165a	180a
	1	122b	110b	113b	122b
	5	89d	89d	102c	101c
Fraction II	0	100c	100c	100b	100b
	0.5	166a	138b	166a	169a
	1	146b	184a	181a	164a
	5	69d	58d	69c	52c
Fraction III	0	100c	100b	100c	100c
	0.5	148a	166a	149ab	171a
	1	150a	159a	137b	165ab
	5	120b	151a	163a	152b

Nardi, S., Muscolo, A., Vaccaro, S., Baiano, S., Spaccini, R., Piccolo, A., 2007. Relationship between molecular characteristics of soil humic fractions and glycolytic pathway and krebs cycle in maize seedlings. Soil Biology & Biochemistry 39, 3138-3146.

INTRODUCTION

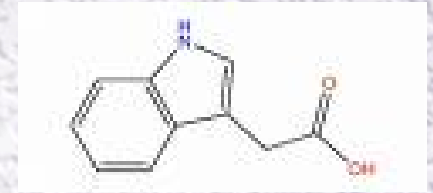
Nardi et al., 1996. Humic substances in terrestrial ecosystems



Photographs of leaf explants of *Nicotiana plumbaginifolia* treated with HS and hormones

FloraGRIKOLA Verona, 3-8 Febbraio 2016

HS HORMONE-LIKE ACTIVITY



ELISA immuno-enzimatic test by
monoclonal antibodies
Radio-immunoassay (RIA) in fluid phase
by polyclonal antibodies

Indoleacetic acid into HS

Antibodies

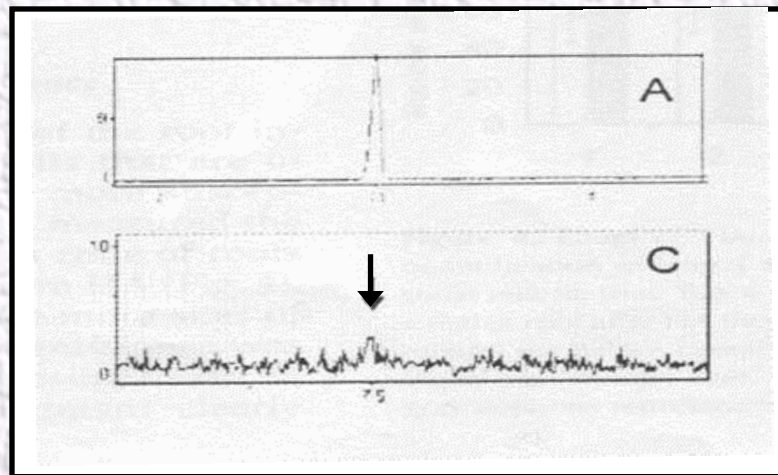
Muscolo, A., Cutrupi, S., Nardi, S., 1998. IAA detection in humic substances. *Soil Biology & Biochemistry* 30, 1199-1201.

Pizzeghello, D., Nicolini, G., Nardi, S., 2001. Hormone-like activity of humic substances in *Fagus sylvatica* forests. *New Phytologist* 151, 647-657.

HS from earthworm faeces 0.3 – 0.5%

HS from forest soils 0.0045 – 0.0363%

GC-MS



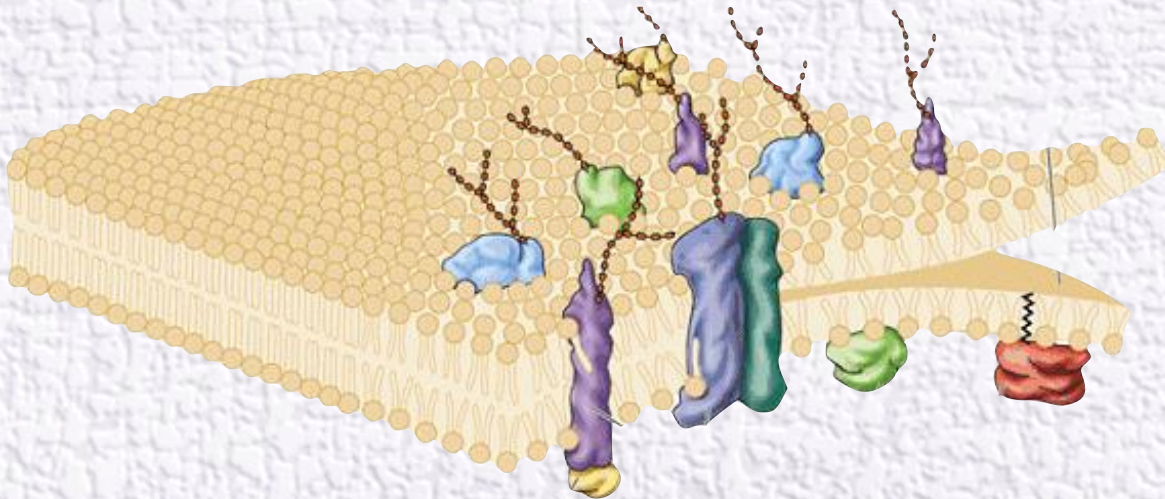
**GAS
CHROMATOGRAM** of the
standard methylated IAA (A) and
the gas chromatogram of the
methylated HA isolated from
earthworm compost

Canellas, L.P., Olivares, F.L., Okorokova-Facanha, A.L., Facanha, A.R., 2002. Humic acids isolated from earthworm compost enhance root elongation, lateral root emergence, and plasma membrane H⁺-ATPase activity in maize roots. *Plant Physiol.* 130, 1951-1957.

Humic Substances biological activity: a proteomic approach

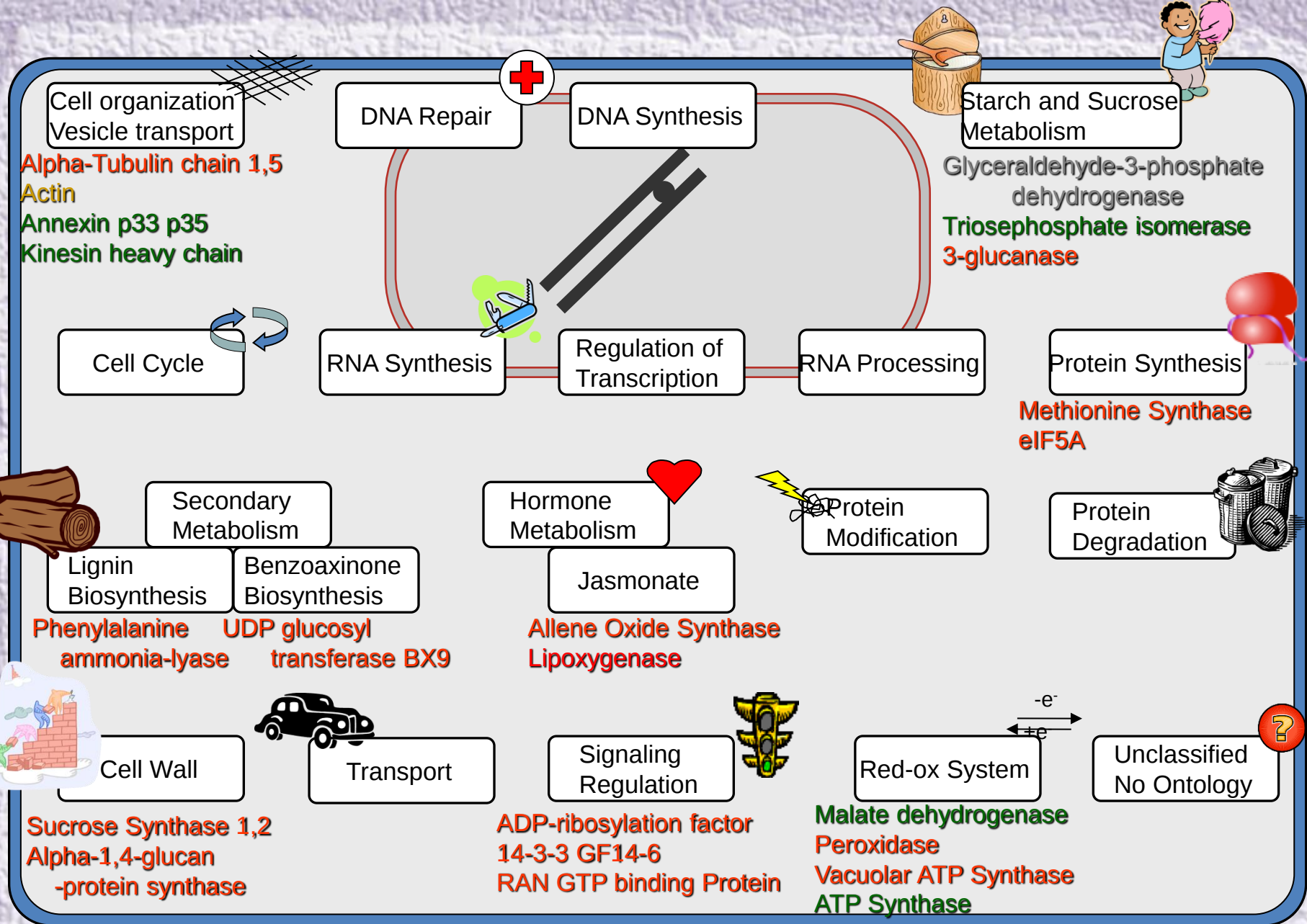
The plasma membrane represents the site for the exchange of information and substances between the cell and its environment.

The aim of study was to establish which proteins were differentially expressed after exposure to HS in PM-enriched root extracts.



Buchanan B.B., Gruissem W., Jones R.L. (2001).
Biochemistry & Molecular Biology of Plants. American
Society of Plant Physiologists

Carletti, P., Masi, A., Spolaore, B., De Laureto, P.P., De Zorzi, M., Turetta, L., Ferretti, M., Nardi, S., 2008. Protein expression changes in maize roots in response to humic substances. *Journal of Chemical Ecology* 34, 804-818.

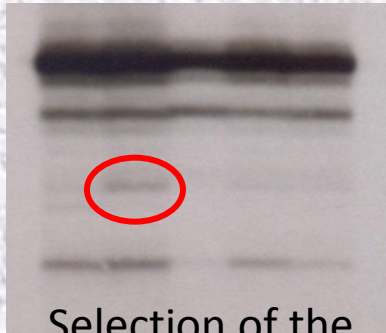


TRANSCRIPTOMICS

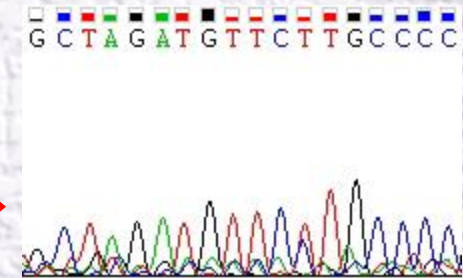
cDNA-AFLP

Sequencing

T₀ C₃₀ HS₃₀ C_{2h} HS_{2h}



Isolation and purification



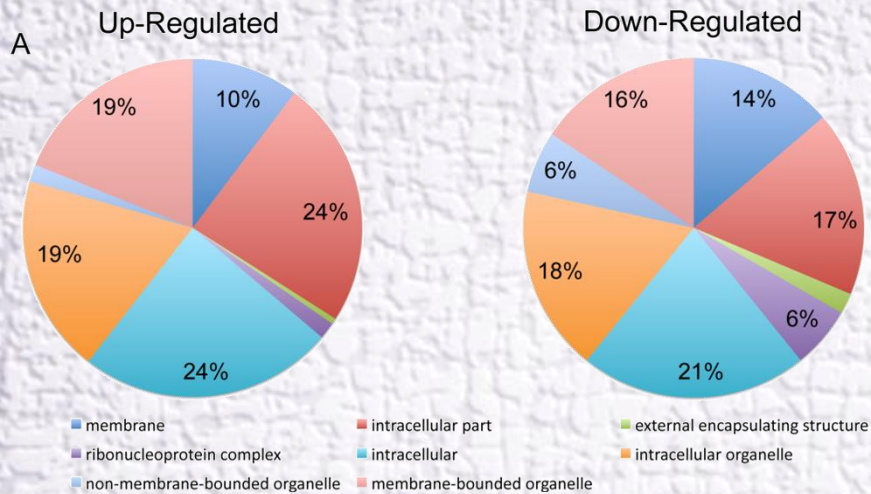
Using 160 primer combinations, the cDNA-AFLP enable to identify 133 genes putatevely involved in plants-HS interaction.

Real- Time PCR analyses confirmed transcripton levels of 32 HS-regulated genes

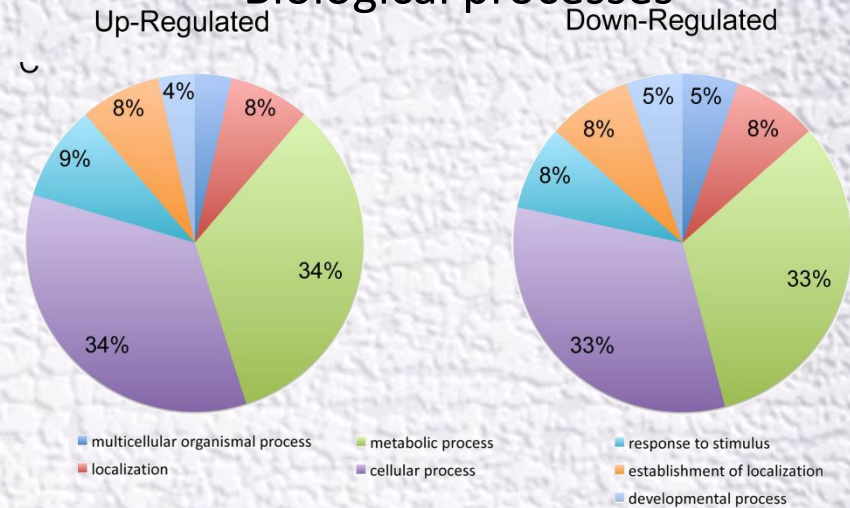
Identification of the HS biological targets

Gene Ontology Analysis

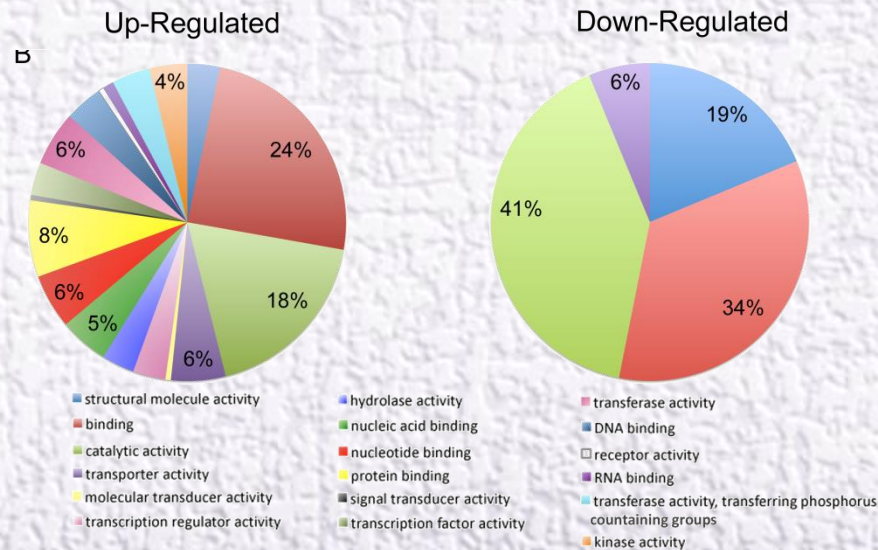
Cellular Components



Biological processes



Molecular Functions



Concluding.....

- HS are the result of a plant-soil cross-talking
- HS action is extremely complex due to its structural characteristics and due to the bioactive substances entrapped in its matrix





I biostimolanti si suddividono:

1. Inoculanti microbici,
2. Sostanze uniche,
3. Idrolizzati proteici ed aminoacidi,
4. Prodotti a base di alghe.

EM= **ILSACON**

L'idrolizzato proteico è stato prodotto con un'idrolisi enzimatica (FCEH®) usando materiale vegetale.

Protein hydrolysates are produced through enzymatic, chemical or thermal hydrolysis of a variety of animal and plant residues, including animal epithelial or connective tissues (Cavani et al., 2006; Ertani et al., 2009, 2013a), animal collagen and elastine (Cavani et al., 2006), carobgerm protein (Parrado et al., 2008) and alfalfa plants (Schiavon et al., 2008; Ertani et al., 2009, 2013b).



Scientia Agricola

<http://dx.doi.org/10.1590/0103-9016-2015-0006>

Review

Plant biostimulants: physiological responses induced by protein hydrolyzed-based products and humic substances in plant metabolism

Serenella Nardi*, Diego Pizzeghello, Michela Schiavon, Andrea Ertani

ILIRAGRICOLA Verona, 3-6 febbraio 2016



II PART

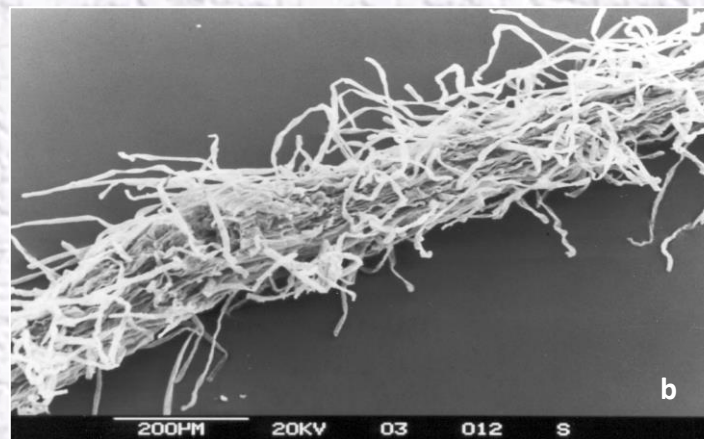
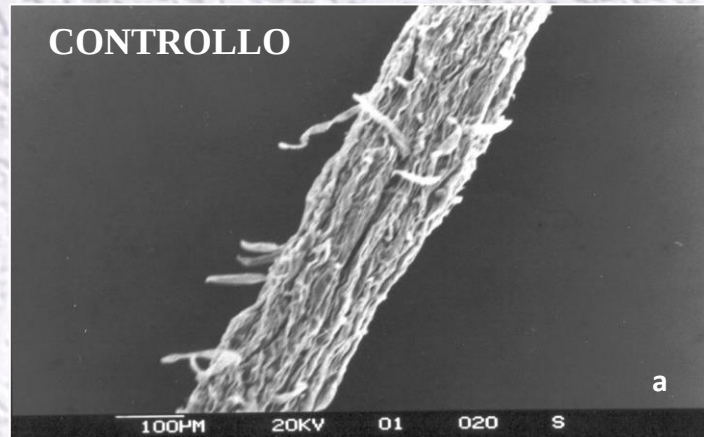
BIOV 5 → from alfalfa plants =EM= *ILSACON*



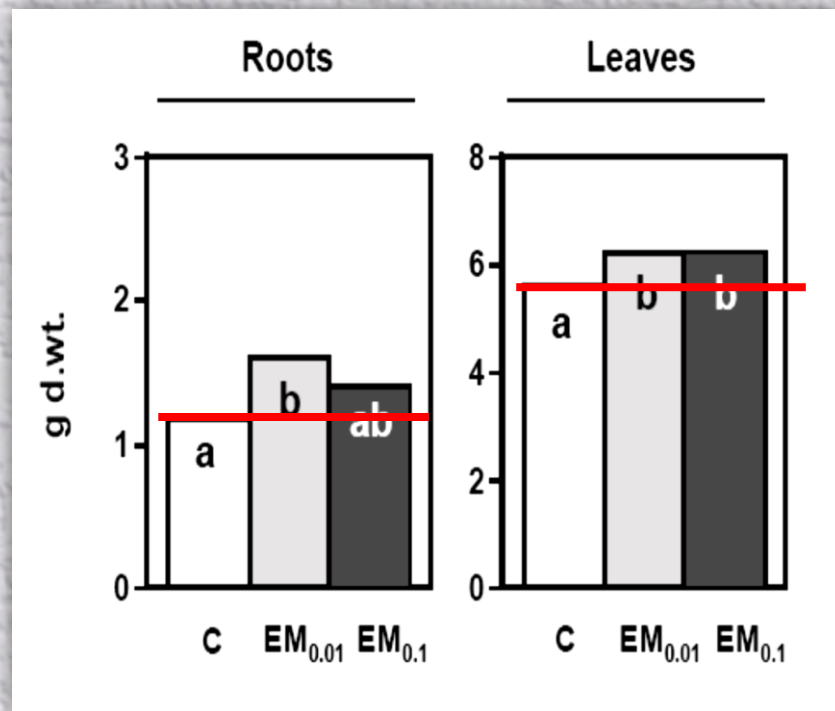
12 days plants grown in nutrient solution, treated with the product for 48 hours



CONTROLLO

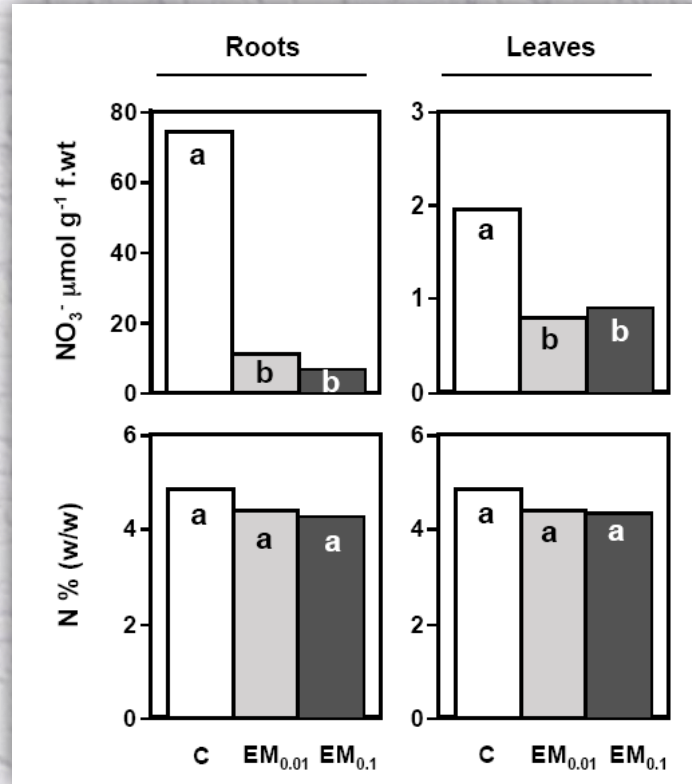
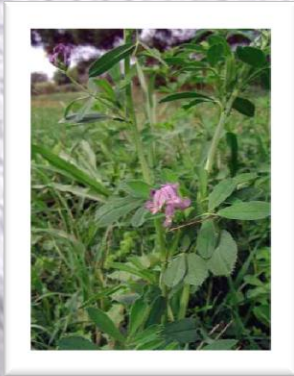


Schiavon et al., (2008) J. Agric. Food Chem. 56, 11800-11808.

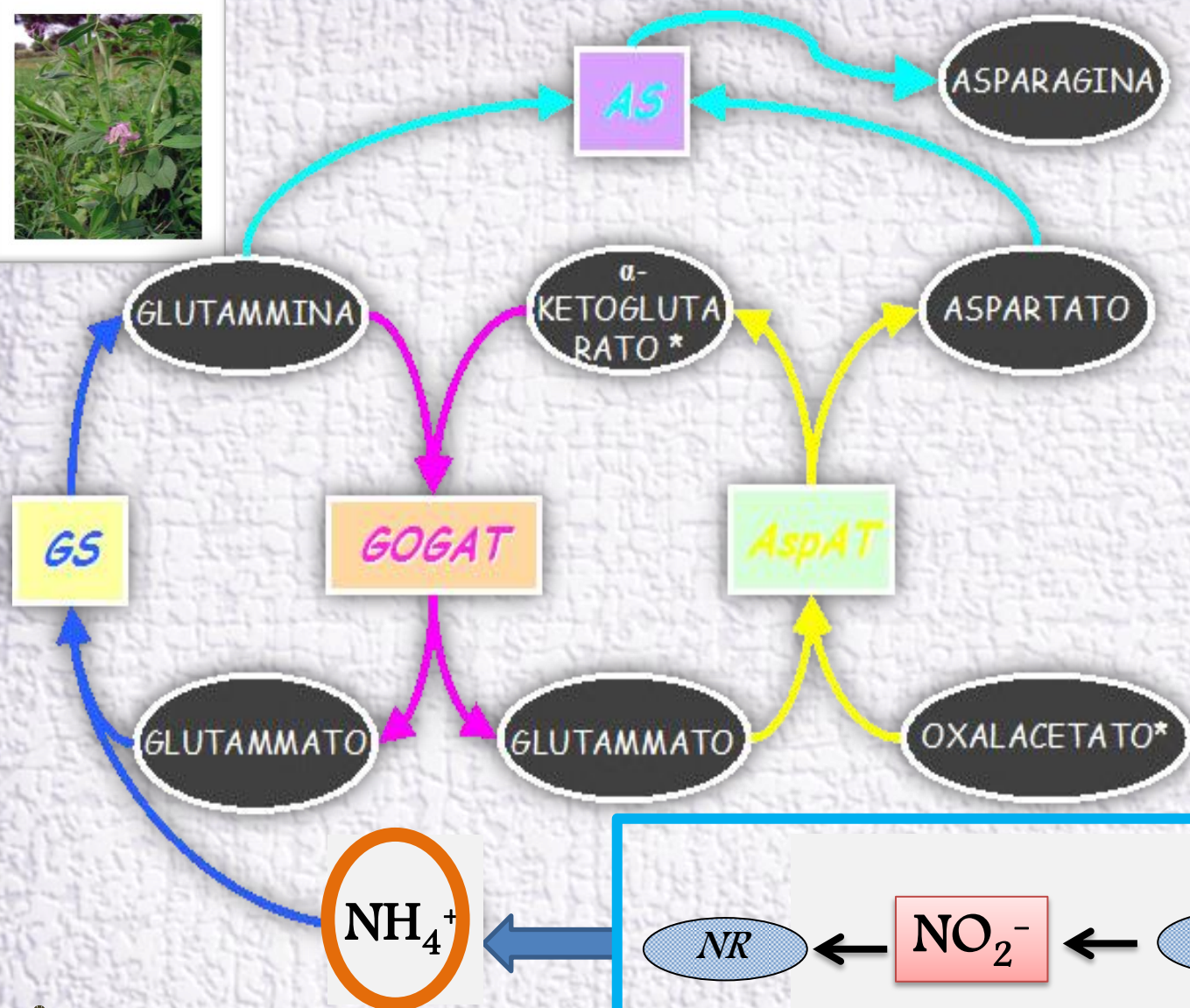


Effetto del trattamento con EM sul peso secco di radici e foglie di plantule di mais

Schiavon et al., (2008) J. Agric. Food Chem. 56 , 11800–11808.



Effetto del trattamento con EM sul contenuto di nitrato ed azoto in radici e foglie di plantule di mais.

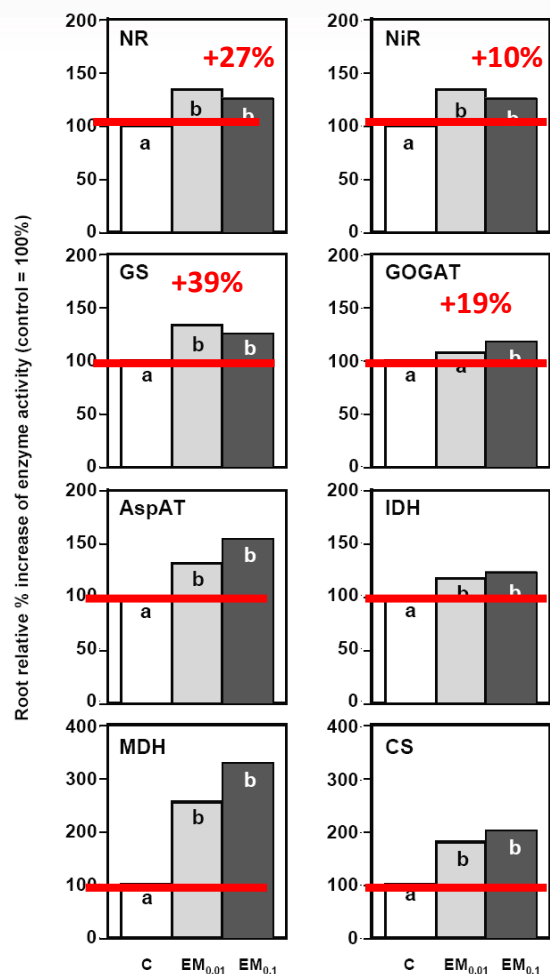


*FROM KREBS CYCLE





ROOT



Schiavon et al., (2008) *J. Agric. Food Chem.* 56, 11800-11808.

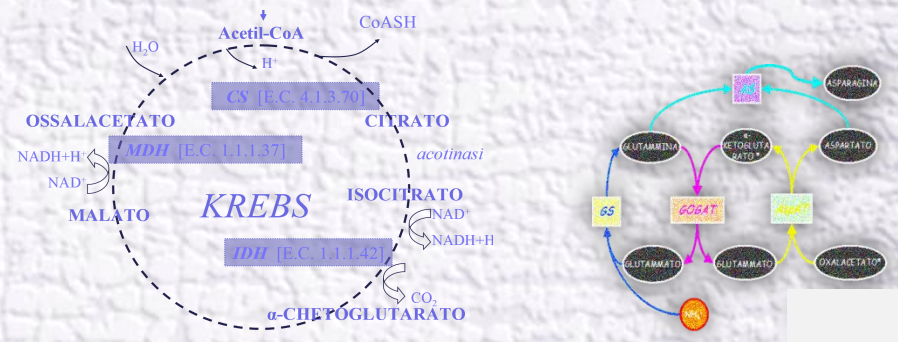


The protein hydrolysate increased the activities of the enzymes involved in the nitrogen assimilation and TCA cycle pathways compared to the control

Root enzyme activity of nitrate reductase (NR), nitrite reductase (NiR), glutamine synthetase (GS), glutamate synthase (GOGAT), malate dehydrogenase (MDH), isocitrate dehydrogenase (IDH), citrate synthase (CS), aspartate aminotransferase (AspAT) in *Z. mays* plants grown for 12 d in Hoagland modified complete nutrient solution and treated for 2 d with EM at 0.01 or 0.1 mg L⁻¹. Data are the means of 5 values each from three independent experiments (±SE). Different letters on bars indicate significant differences between treatments (P<0.05). C = control



Schiavon et al., (2008) J. Agric. Food Chem. 56, 11800-11808.



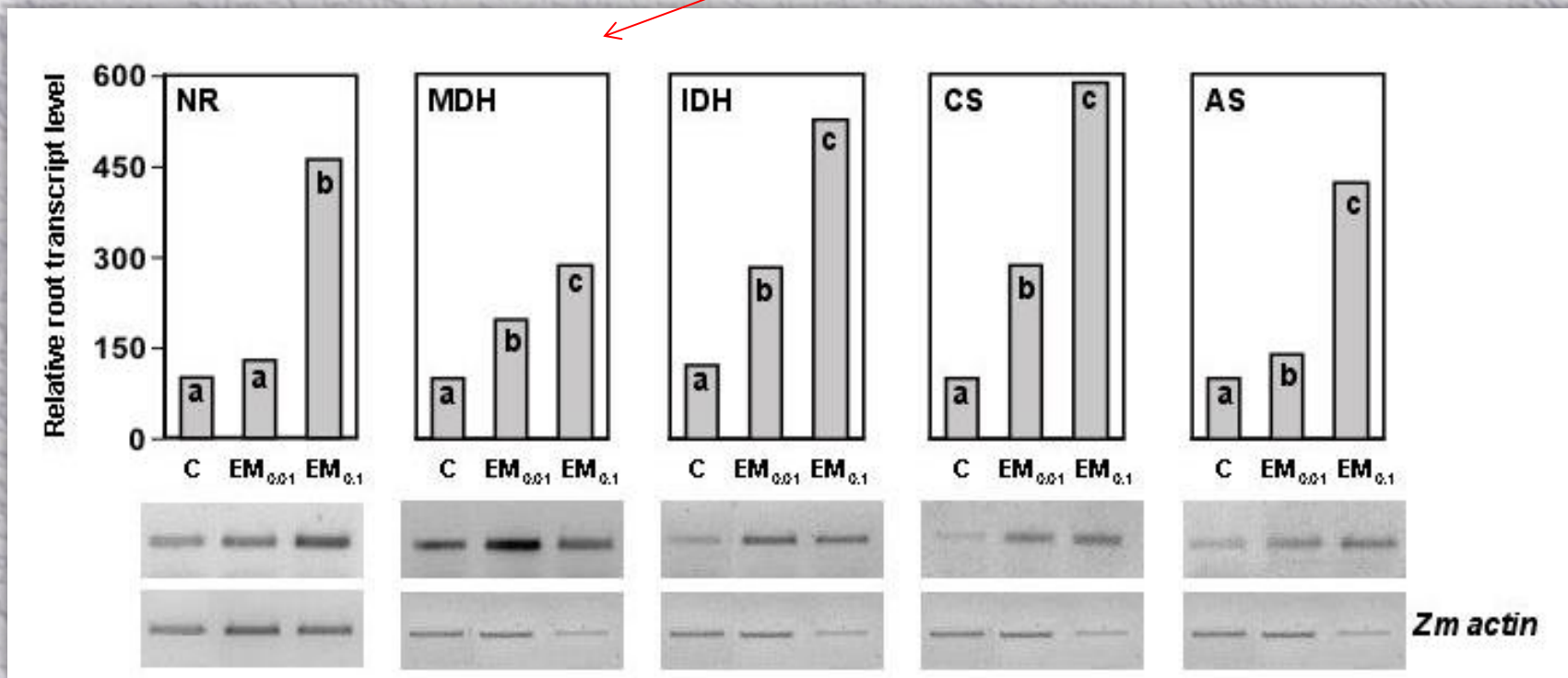
Leaf enzyme activity of nitrate reductase (NR), nitrite reductase (NiR), glutamine synthetase (GS), glutamate synthase (GOGAT), malate dehydrogenase (MDH), isocitrate dehydrogenase (IDH), citrate synthase (CS), aspartate aminotransferase (AspAT) in *Z. mays* plants grown for 12 d in Hoagland modified complete nutrient solution and treated for 2 d with EM at 0.01 or 0.1 mg L⁻¹.



II PART

Schiavon et al., (2008) J. Agric. Food Chem. 56 , 11800–11808.

increase of the mRNA abundance



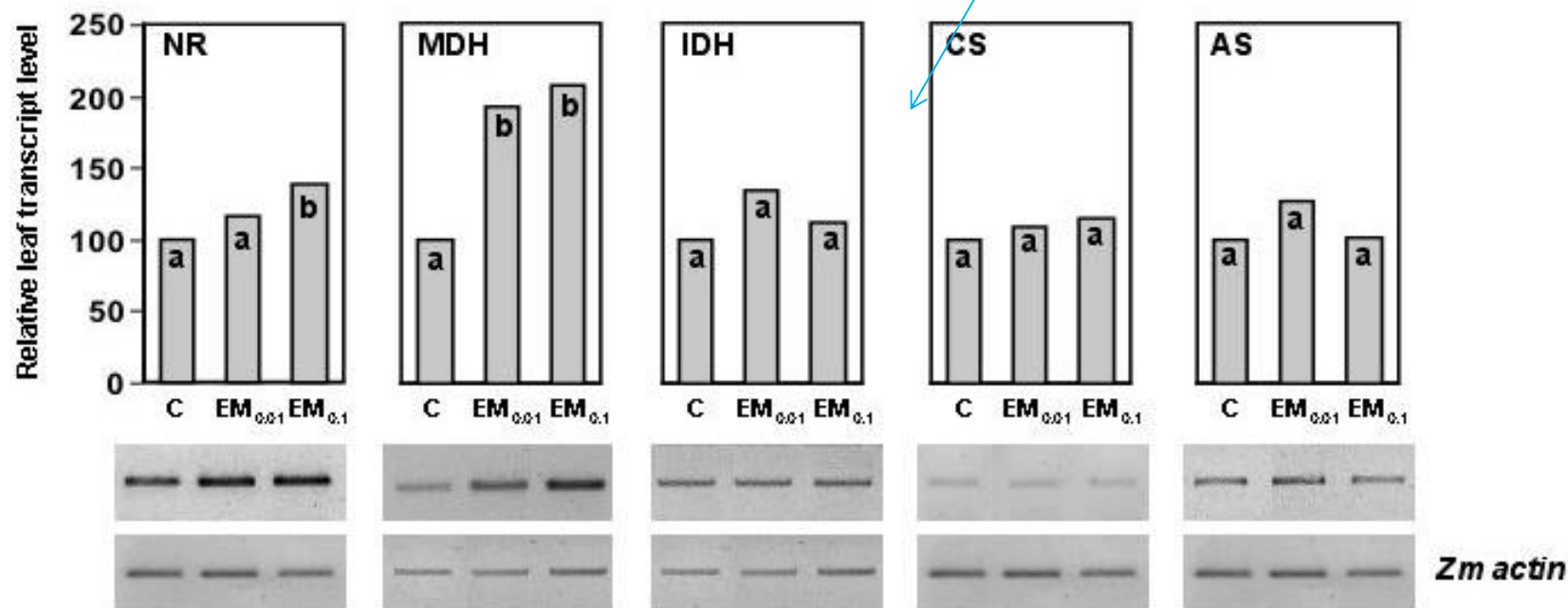
Gene expression (mRNA level) and relative transcript accumulation of nitrate reductase (NR), malate dehydrogenase (MDH), isocitrate dehydrogenase (IDH), citrate synthase (CS), asparagine synthetase (AS) in roots of *Z. mays* plants grown for 12 d in Hoagland modified complete nutrient solution and treated for 2 d with EM at 0.01 or 0.1 mg L⁻¹.



II PART

Schiavon et al., (2008) J. Agric. Food Chem. 56 , 11800–11808.

EM did not influence the transcript level of genes coding for IDH, CS and AS



Gene expression (mRNA level) and relative transcript accumulation of nitrate reductase (NR), malate dehydrogenase (MDH), isocitrate dehydrogenase (IDH), citrate synthase (CS), asparagine synthetase (AS) transcript accumulation in leaves of *Z. mays* plants grown for 12 d in Hoagland modified complete nutrient solution and treated for 2 d with EM at 0.01 or 0.1 mg L⁻¹.

Plants were grown for 12 days in the absence of NaCl or in the presence (25, 75 and 150 mM). On the 12th day, plants were supplied for 48 h with 1.0 mg L⁻¹ EM or 11.2 mM TRIA.

Control

TRIA

EM

25 mM NaCl

25 mM NaCl+TRIA

25 mM NaCl +EM

75 mM NaCl

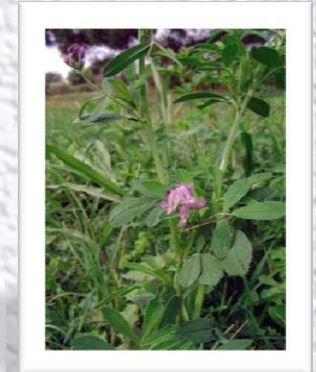
75 mM NaCl+TRIA

75 mM NaCl +EM

150 mM NaCl

150 mM NaCl+TRIA

150 mM NaCl +EM



III PART

Ertani et al., 2012 Plant and Soil

The root and leaf fresh weight of plants supplied NaCl was significantly increased by EM and TRIA, respect to the plants grown in the presence of NaCl



Treatment	Roots	Leaves
	%	%
25 mM NaCl	100	100
25 mM NaCl+TRIA	138	117
25 mM NaCl +EM	133	128
75 mM NaCl	100	100
75 mM NaCl+TRIA	106	128
75 mM NaCl +EM	148	122
150 mM NaCl	100	100
150 mM NaCl+TRIA	160	137
150 mM NaCl +EM	157	127

Root and leaf fresh weight of *Z. mays* plants grown for 14 days in a complete culture solution with 0 (control), 25, 75 and 150 mM NaCl. A sub-sample of 12 d-old plants was additionally treated for 48 h with 1 mg L⁻¹ EM or 11.2 mM TRIA. Data represent the means of three measurements per treatment with ten plants in each ($\pm$ *std*).



III PART The application of EM or TRIA to salt-stressed plants determined a reduction of Na^+ in roots and leaves and, on the other hand, an increase of K^+ concentration.

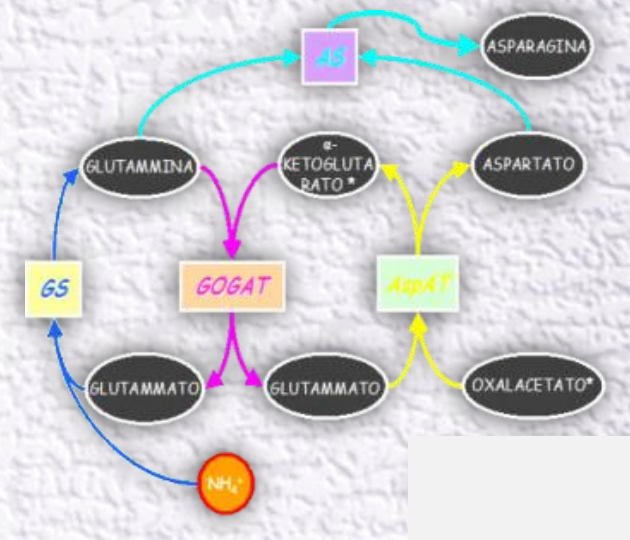
Treatment	Roots			Leaf		
	K^+ (%)	Na^+ (%)	K^+/Na^+	K^+ (%)	Na^+ (%)	K^+/Na^+
Control	1.238±0.011a	0.408±0.090e	3.03±0.141a	2.501±0.051c	0.040±0.001g	62.52±3.210c
TRIA	1.130±0.072a	0.472±0.081g	2.11±0.10b2	3.722±0.030ab	0.048±0.005g	77.54±2.181b
EM	1.120±0.090a	0.488±0.080g	2.29±0.060b	4.203±0.062a	0.051±0.004g	82.41±2.810a
25 mM NaCl	0.915±0.008c	0.972±0.015c	0.94±0.044e	2.320±0.150c	1.102±0.070e	0.210±0.012h
25 mM NaCl+TRIA	0.982±0.017b	0.513±0.034f	1.91±0.012c	3.302±0.210b	0.914±0.070f	3.61±0.018d
25 mM NaCl +EM	0.990±0.014b	0.502±0.021f	1.97±0.011c	3.312±0.121b	0.921±0.038f	3.58±0.022d
75 mM NaCl	0.751±0.011e	1.120±0.008b	0.67±0.023g	2.002±0.110cd	2.652±0.034c	0.754±0.022f
75 mM NaCl+TRIA	0.765±0.016de	0.872±0.056d	0.87±0.020f	2.340±0.100c	2.041±0.070d	1.14±0.072e
75 mM NaCl +EM	0.789±0.020d	0.723±0.090d	1.09±0.011d	2.357±0.101c	2.018±0.143d	1.16±0.033e
150 mM NaCl	0.432±0.060f	1.209±0.045a	0.35±0.012i	1.791±0.122d	3.702±0.121a	0.483±0.021g
150 mM NaCl+TRIA	0.480±0.022f	0.891±0.052d	0.53±0.015h	1.918±0.131d	2.987±0.132b	0.64±0.042f
150 mM NaCl +EM	0.495±0.024f	0.794±0.034d	0.62±0.030g	1.926±0.091d	2.970±0.109b	0.64±0.021g

Table 3. K^+ , Na^+ concentration and K^+/Na^+ in roots and leaves of *Z. mays* plants grown for 14 days in a complete culture solution with 0 (control), 25, 75 and 150 mM NaCl. A sub-sample of 12 d-old plants was additionally treated for 48 h 1 mg L⁻¹ EM or 11.2 mM TRIA. Data of K^+ and Na^+



III PART

Treatment	GS	GOGAT
	$(\mu\text{mol}^{-1} \text{g}^{-1} \text{fw})$	
Control	4.27±0.12b	14.46±0.32c
EM	6.11±0.32a	16.82±0.18a
25 mM NaCl	3.13±0.10c	12.50±0.11d
25 mM NaCl +EM	5.50±0.17a	14.90±0.23c
75 mM NaCl	3.81±0.11c	11.90±0.20e
75 mM NaCl +EM	5.00±0.28b	15.52±0.17b
150 mM NaCl	3.72±0.11c	12.57±0.35d
150 mM NaCl +EM	4.75±0.30b	14.78±0.33c

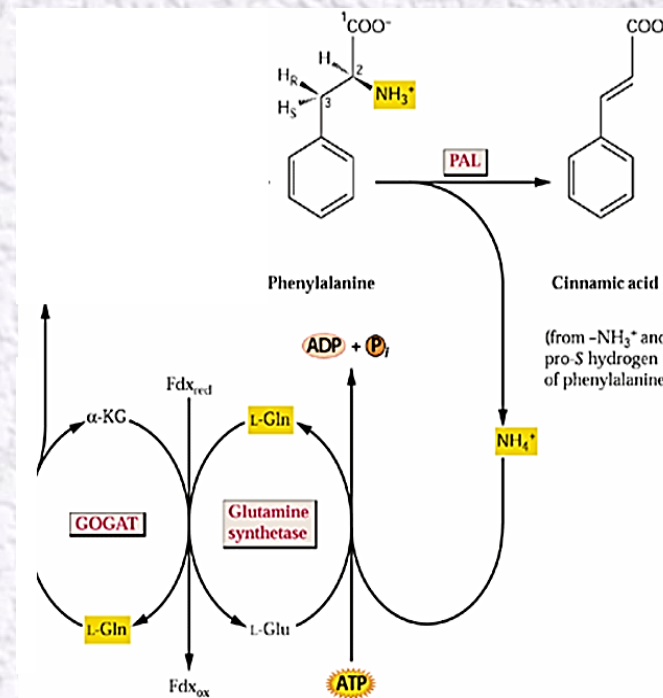


Glutamine synthetase (GS), glutamate synthase (GOGAT) activities in leaves of *Z. mays* grown for 14 days in a complete culture solution with 0 (control), 25, 75 and 150 mM NaCl.



PAL activity

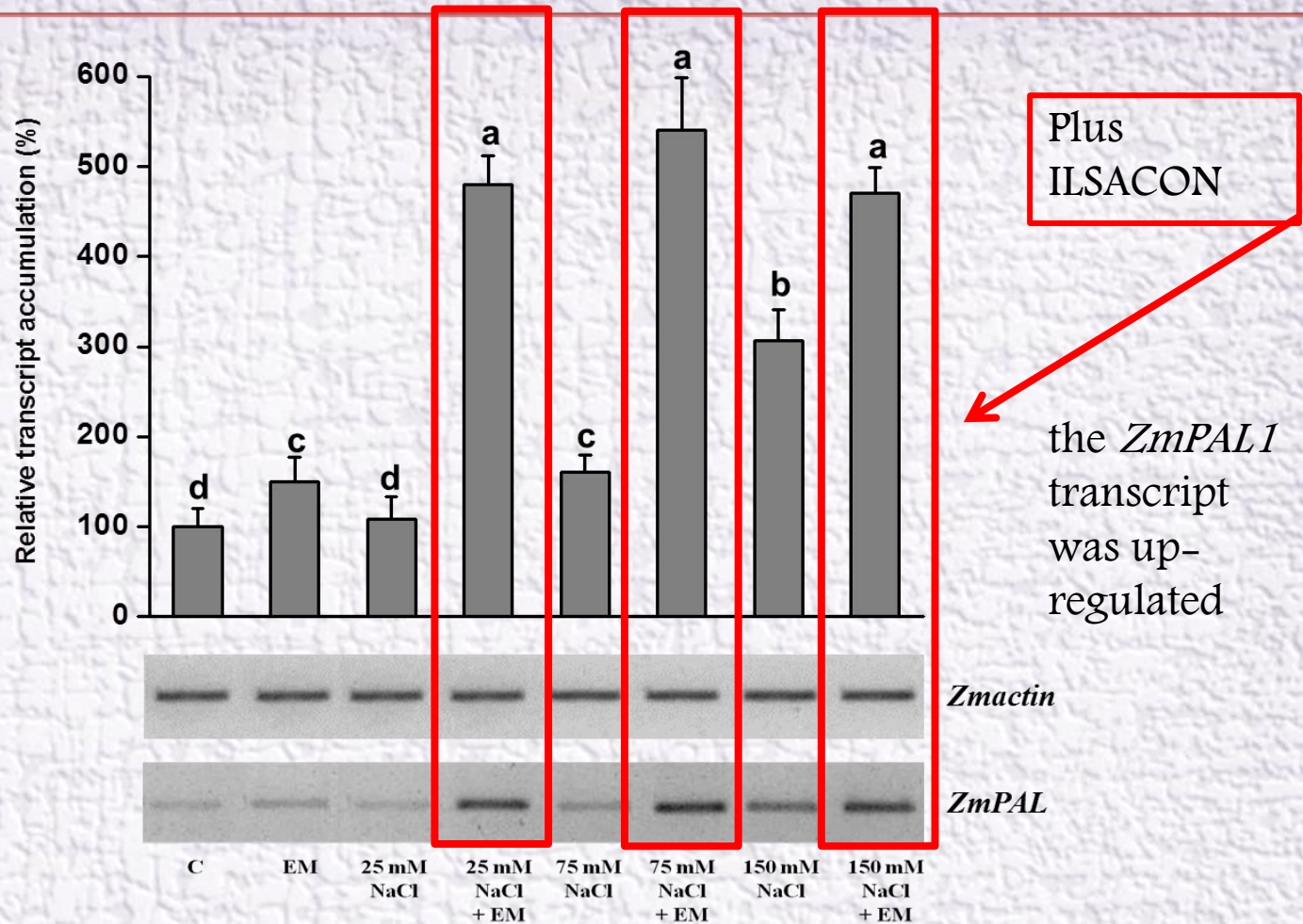
Treatment	PAL (nmol cinn acid mg ⁻¹ prot min ⁻¹)
Control	3.94± 0.31 f
EM	3.04± 0.29 f
25 mM NaCl	8.03± 0.20 e
25 mM NaCl +EM	12.92± 0.15 c
75 mM NaCl	12.34± 0.09 d
75 mM NaCl +EM	15.27±0.22 b
150 mM NaCl	12.69±0.18 d
150 mM NaCl +EM	17.47± 0.33a



Phenylalanine ammonia-lyase (PAL) catalyzed the first step in the biosynthesis of phenolics. Plants may cope with salt stress also through stimulation of the secondary metabolism that leads to the synthesis of phenolic compounds (phenylpropanoids).



III PART



Relative transcript accumulation of the gene encoding phenylalanine ammonia-lyase (*ZmPAL*) in leaves of *Z. mays* plants grown for 12 days in a complete culture solution and/or NaCl and treated for 2 days with 1 mg L⁻¹ EM or 11.2 mM TRIA.

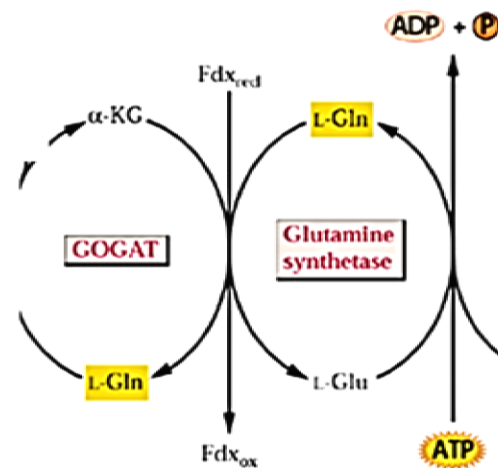
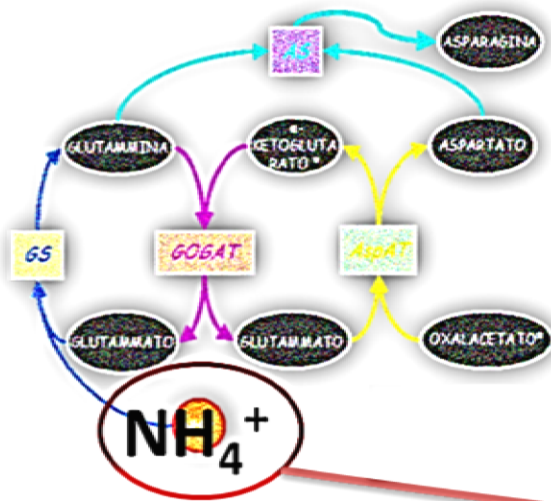


PHENOLS PRODUCTION

Phenylalanine

Cinnamic acid

(from -NH_3^+ and pro-S hydrogen of phenylalanine)



The enhancement of N assimilation was concomitant with the stimulation of the secondary metabolism associated with the PAL enzyme activity and synthesis of phenolic compounds.

Higher activity of PAL results in a greater production of NH_4^+ ions that could be recycled in the glutamine synthase/glutamate synthase (GS/GOGAT) cycle to synthesize new amino acids



dal campo al lab



**Studio
dei formulati**



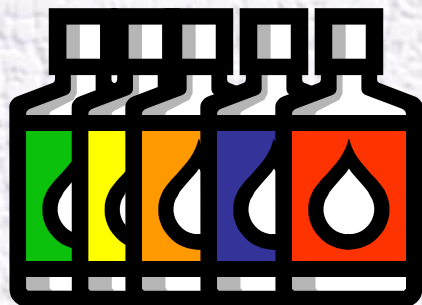
**PROVE
CAMPO**

**prove in
PRE-CAMPO**

**prove in cella
CLIMATICA**

**test
AUDUS**

prodotti





 **LANDLAB** Quinto Vicentino (Vicenza)

FIERAGRICOLA Verona, 3-6 Febbraio 2016

I prodotti sono stati caratterizzati chimicamente:

AMMINOACIDI TOTALI g/100g										
prodotto	cisteina	a. aspartico	idrossiprolina	metionina	treonina	serina	a. glutam	glicina	alanina	valina
A	0,32	2,73	3,10	0,34	0,55	1,02	5,11	7,52	4,02	1,62
B	0,21	3,19	5,03	0,39	0,77	1,51	5,82	11,61	5,05	1,80
C	0,06	2,93	6,19	0,49	0,09	0,20	7,35	16,33	7,97	1,70
D	0,06	2,28	4,15	0,46	0,09	0,19	6,05	11,04	6,24	1,57
E	0,68	3,15	1,75	0,26	1,47	3,27	5,22	6,06	3,30	2,62

AMMINOACIDI TOTALI g/100g										
prodotto	isoleucina	leucina	tirosina	fenilalanina	idrossilisina	lisina	istidina	arginina	prolina	tot amminoacidi
A	0,92	1,98	0,68	1,18	0,30	1,48	0,36	2,09	4,76	40,06
B	1,00	2,05	0,42	1,34	0,47	1,77	0,34	3,15	7,19	53,12
C	0,71	2,17	0,45	1,45	0,64	2,00	0,35	0,83	10,31	62,18
D	0,61	2,03	0,58	1,26	0,73	1,81	0,29	0,38	6,99	46,80
E	1,46	2,66	0,52	1,68	0,15	1,22	0,35	2,60	5,12	43,53

Tab. 1 A e B.

Contenuto di aminoacidi totali negli idrolizzati proteici.

I dati sono la media di tre repliche ($\pm$).

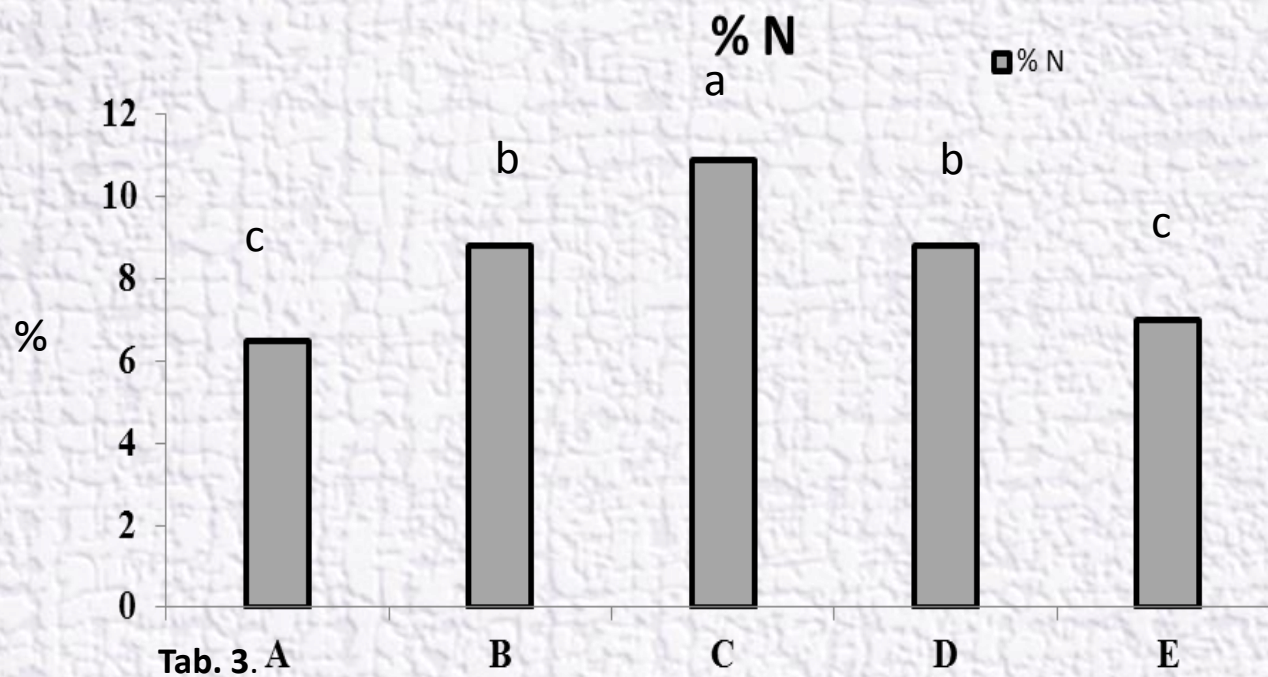
AMINOACIDI LIBERI g/100g								
prodotto	isoleucina	leucina	tirosina	fenilalanina	lisina	istidina	arginina	prolina
A	0,18	0,40	0,10	0,28	0,11	0,03	0,35	0,72
B	0,28	0,55	0,09	0,37	0,16	0,04	0,51	1,08
C	<0,02	0,16	0,07	0,10	0,01	0,02	<0,02	1,52
D	0,03	0,30	0,19	0,10	0,24	<0,02	0,15	1,60
E	0,93	1,83	0,23	1,17	0,47	0,15	1,48	2,83

AMINOACIDI LIBERI g/100g										
prodotto	cisteina	a. aspartico	metionina	treonina	serina	a. glutammico	glicina	alanina	valina	AA totali
A	0,02	0,49	0,04	0,26	0,74	0,32	0,94	0,93	0,35	6,26
B	0,03	0,65	0,04	0,39	1,06	0,47	1,33	0,82	0,48	8,35
C	0,07	0,37	0,03	0,02	0,11	0,38	3,89	2,02	0,25	9,16
D	0,08	0,54	0,08	0,03	0,12	0,77	5,47	2,54	0,34	12,68
E	0,11	1,93	0,12	1,22	3,23	2,69	2,40	1,66	1,43	23,88

Tab. 2 A e B.

Contenuto di aminoacidi liberi negli idrolizzati proteici.

I dati sono la media di tre repliche (s±).



Contenuto percentuale di azoto negli idrolizzati analizzati.

I dati sono la media di tre repliche ($s \pm$).

	numero fiori					
	08.08.12		23.08.12		18.09.12	
	n°	%	n°	%	n°	%
Cont	3,00	100	0,90	100	2,10	100
A	4,10	134*	1,10	118*	2,80	136*
B	3,30	107	0,70	77	2,70	131*
C	4,10	136*	0,80	91	3,00	147*
D	3,00	100	1,20	132*	2,10	100
E	3,70	122*	0,60	68	3,10	149*

Numero di fiori nelle piante di basilico trattate e non (controllo).
L'asterisco indica la significatività del dato per un $p \leq 0.05$.

	23.08.12		19.09.12	
prodotto	g	%	g	%
Cont	132,4	100	152,7	100
A	133,3	101	185,9	122*
B	131,8	100	150,1	98
C	129,3	98	182,7	120*
D	150,9	114*	158	103
E	122,4	92	172,1	113

Biomassa fogliare delle piante di basilico trattate e non (controllo) con gli idrolizzati proteici. L'asterisco indica la significatività del dato per un $p \leq 0.05$.

	Chl A		Chl B		Xant + Car		Chl Tot	
	mg/g	%	mg/g	%	mg/g	%	mg/g	%
Con	2,43	100	0,84	100	0,71	100	3,49	100
A	2,45	101	0,63	75	0,59	83	3,24	93
B	2,92	120*	0,71	85	0,8	112	3,99	115*
C	2,62	108	1,33	160*	0,52	73	3,74	107
D	2,22	92	0,7	84	0,57	79	3,01	86
E	2,63	108	0,73	88	0,67	94	3,67	105

Tab. 7.

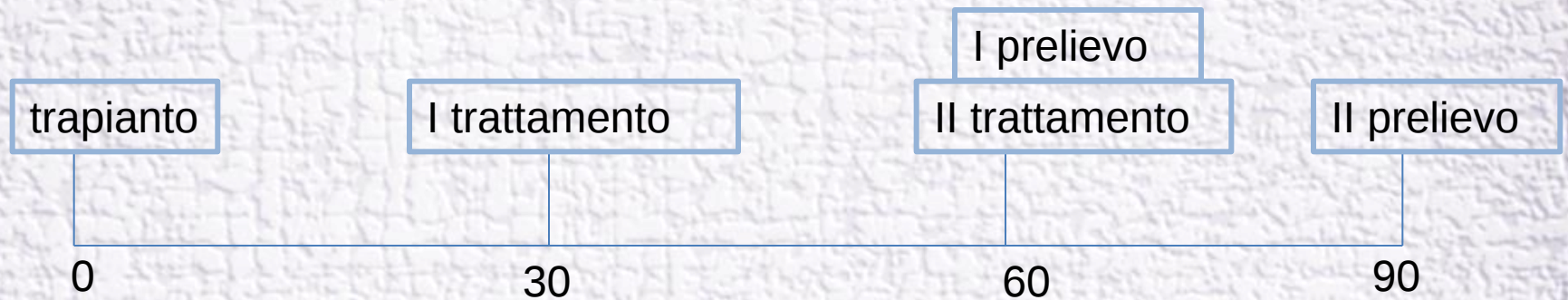
Contenuto di clorofille delle piante di basilico trattate e non (controllo) con gli idrolizzati proteici. L'asterisco indica la significatività del dato per un $p \leq 0.05$.



Saggiare l'azione di un biostimolante sul
metabolismo di piante di peperoncino
(*Capsicum chinensis*).

- Morfometrici (biomassa fogliare, numero e peso di peperoncini verdi, arancio e rossi);
- Contenuto di fenoli totali;
- Capacità Antiossidasica Totale (CAT);
- Acido ascorbico;
- Capsaicina e diidrocapsaicina.

Piante di peperoncino sono state coltivate in tunnel per 90 giorni all'interno di vasi con un substrato formato da torba.



Trascorsi 30 giorni dal primo trattamento è stato effettuato il secondo alle stesse concentrazioni. Un mese dopo il trapianto una parte delle piante è stata spruzzata con EM alle concentrazioni di **25 * e 50 **ml/L.**

PRIMO CAMPIONAMENTO

	Foglie		P verdi		P arancio		P rossi	
	(g p.f.)	%	(g p.f.)	%	(g p.f.)	%	(g p.f.)	%
Control	10.08±0.02b	100	14.31±0.04b	100	2.42±0.03b	100	4.59±0.010a	100
EM•	12.34±0.03b	122	8.17±0.06c	57	2.20±0.01b	91	3.40±0.03b	74
EM••	26.71±0.12a	265	40.43±0.11a	283	2.82±0.03a	117	3.36±0.2b	73

Tabella 1. Effetto del primo trattamento con il biostimolante EM sul peso fresco delle foglie, dei peperoncini verdi, arancioni e rossi. I dati sono la media di tre repliche (s ±). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti P<5% secondo il test di Student-Newman-Keuls test. EM •=25 mL/L; EM••=50 mL/L.

SECONDO CAMPIONAMENTO

	Foglie		P verdi		P arancio		P rossi	
	(g p.f.)	%	(g p.f.)	%	(g p.f.)	%	(g p.f.)	%
C	15.51±0.03c	100	5.05±0.03	100	0.78±0.05c	100	16.33±0.13c	100
EM•	18.52±0.06a	119	5.26±0.12	104	0.95±0.002c	121	29.88±0.21ab	183
EM••	17.36±0.11b	112	3.69±0.08b	73	2.36±0.06b	303	32.77±0.21a	201

Tabella 2. Effetto del secondo trattamento con il biostimolante EM sul peso fresco delle foglie, dei peperoncini verdi, arancioni e rossi. I dati sono la media di tre repliche (s ±). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti P<5% secondo il test di Student-Newman-Keuls test. EM •=25 mL/L; EM••=50mL/L.

CONTROLLO

ilsacon



PRIMO CAMPIONAMENTO

	P totali	%	P verdi	%	P arancio	%	P rossi	%
	(numero)		(numero)		(numero)		(numero)	
C	23.00±0.13b	100	18.53±0.12b	100	2.25±0.01b	100	4.00±0.10a	100
EM•	23.60±0.22b	103	20.00±0.12c	108	1.83±0.12c	81	4.23±0.08a	106
EM••	55.65±0.21a	242	50.50±0.32a	273	2.58±0.10a	115	4.20±0.12a	105

Tabella 3. Effetto del primo trattamento con il biostimolante EM, sul numero totale dei peperoncini e nei diversi stadi di maturazione: verdi, arancio e rossi. I dati sono la media di tre repliche ($s \pm$). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti $P < 5\%$ secondo il test di Student-Newman-Keuls test. EM •25 mL/L; EM••50mL/L.

SECONDO CAMPIONAMENTO

	P totali		P verdi		P arancio		P rossi	
	(numero)	%	(numero)	%	(numero)	%	(numero)	%
C	23.90±0.13	100	4.13±0.012	100	1.00±0.03	100	18.00±0.12	100
EM•	44.20±0.07	185	6.13±0.023	148	1.83±0.05	183	36.08±0.12	200
EM••	41.10±0.12	172	4.13±0.008	100	2.50±0.02	250	37.18±0.13	207

Tabella 4. Effetto del secondo trattamento con il biostimolante EM, sul numero totale dei peperoncini e nei diversi stadi di maturazione: verdi, arancio e rossi. I dati sono la media di tre repliche ($s \pm$). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti $P < 5\%$ secondo il test di Student-Newman-Keuls test. EM •25mL/L; EM••50mL/L.

EM *

EM **

CONTROLLO



PRIMO CAMPIONAMENTO

	Fenoli totali		CAT		Acido ascorbico	
	mg GAE kg ⁻¹ p.f.	(%)	mg Fe ²⁺ E kg ⁻¹ p.f.	(%)	mg kg ⁻¹ p.f.	(%)
Foglie						
C	1102.869±0.19c	100	3042.96±0.14b	100	1857.722±12.31c	100
EM •	1686.318±0.32a	153	3697.87±0.23a	122	2190.342±21.12a	118
EM••	1745.964±0.33b	158	3781.06±0.18a	124	1906.966±13.81b	103
Pep rossi						
C	1081.954±0.19c	100	3090.25±0.21c	100	1740.995±12.22c	100
EM •	1317.083±0.32a	122	3135.63±0.11b	101	1905.722±12.01a	109
EM ••	1138.002±0.16b	105	3280.62±0.12a	106	1877.675±13.26b	108
Pep verdi						
C	3621.172±0.18b	100	1078.83±0.31c	100	1502.340±11.02c	100
EM•	5559.484±0.12a	154	1733.17±0.15a	161	1806.806±12.10a	120
EM••	5439.012±0.13a	150	1432.95±0.12b	133	1697.402±10.08b	112

Tabella 5. Effetto del primo trattamento biostimolante sul quantitativo fenoli totali, CAT e acido ascorbico, in foglie e peperoncini verdi e rossi. I dati sono la media di tre repliche (s ±). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti P<5% secondo il test di Student-Newman-Keuls test. EM •25mL/L; EM••50mL/L.

SECONDO CAMPIONAMENTO

	Fenoli totali		CAT		Acido ascorbico	
	mg GAE kg ⁻¹ p.f.	(%)	mg Fe ²⁺ +E kg ⁻¹ p.f.	(%)	mg kg ⁻¹ p.f.	(%)
Foglie						
C	1318.001±11.10b	100	3620.94±11.10c	100	528.007±11.10b	100
EM •	1906.321±13.22a	145	3890.47±13.21b	107	723.746±11.00a	137
EM ••	1894.573±12.20a	144	3990.43±14.12a	110	525.468±12.54b	100
Pep rossi						
C	1196.122±11.20c	100	4218.39±11.34c	100	538.120±13.02c	100
EM •	1732.343±13.23a	145	5770.43±13.54b	136	715.736±13.44b	133
EM ••	1667.034±23.15b	139	672.034±14.12a	159	1185.312±23.17a	220
Pep verdi						
C	2364.506±11.05b	100	12010.78±12.31c	100	498.741±22.02c	100
EM•	5670.328±3.28a	240	15260.34±16.18a	127	1263.245±14.21a	253
EM••	5678.302±3.14a	240	14539.345±22.14b	121	1021.546±14.17b	205

Tabella 6. Effetto del secondo trattamento biostimolante sul quantitativo fenoli totali, CAT e acido ascorbico, in foglie e peperoncini verdi e rossi. I dati sono la media di tre repliche (s ±). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti P<5% secondo il test di Student-Newman-Keuls test. EM •25mL/L; EM••50 mL/L.

PRIMO CAMPIONAMENTO

	capsicina		diidrocapsaicina	
	(mg/L)	(%)	(mg/L)	(%)
Foglie				
C	nd	-	0.913±0.03b	100
EM•	nd	-	1.805±0.03a	198
EM ••	nd	-	0.767±0.02c	84
Pep rossi				
C	155.119±12.11c	100	42.880±0.10c	100
EM•	201.144±2.19b	130	38.814±0.11b	91
EM••	211.831±2.11a	137	62.476±0.10a	146
Pep verdi				
C	179.820±3.21a	100	46.358±0.12a	100
EM •	153.949±13.12b	86	38.749±0.21b	84
EM••	160.723±8.77b	89	47.279±0.08a	102

Tabella 7. Effetto del primo trattamento biostimolante sulla quantità di capsicina e diidrocapsicina in foglie e peperoncini rossi e verdi. I dati sono la media di tre repliche (s ±). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti P<5% secondo il test di Student-Newman-Keuls test. EM •25mL/L; EM••50mL/L.

SECONDO CAMPIONAMENTO

	capsicina		diidrocapsicina	
	(mg/L)	(%)	(mg/L)	(%)
Foglie				
C	nd	-	nd	-
EM•	nd	-	nd	-
EM ••	nd	-	nd	-
Pep rossi				
C	48.109±0.90c	100	17.795±0.16c	100
EM •	220.947±0.32b	459	46.596±0.11b	262
EM ••	335.069±0.28a	696	78.423±0.10a	441
Pep verdi				
C	89.333±0.13c	100	27.268±2.15c	100
EM •	98.912±0.14b	111	29.365±2.11b	107
EM ••	117.559±0.32a	132	43.949±2.10a	161

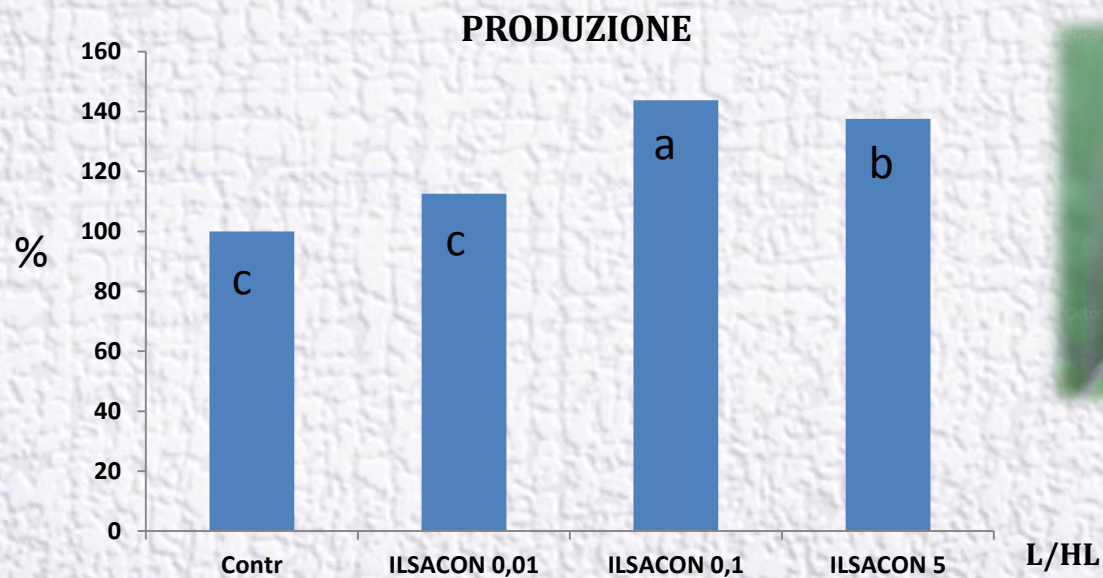
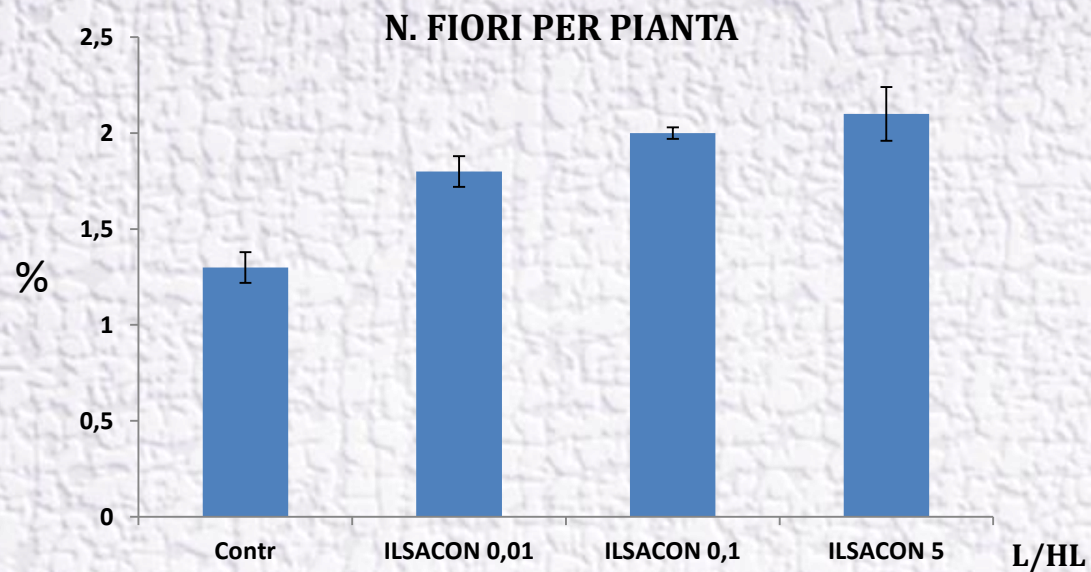
Tabella 8. Effetto del secondo trattamento biostimolante sulla quantità di capsicina e diidrocapsicina in foglie e peperoncini rossi e verdi. I dati sono la media di tre repliche ($s \pm$). I valori nella stessa colonna seguiti dalla stessa lettera non sono statisticamente differenti $P < 5\%$ secondo il test di Student-Newman-Keuls test. EM •25mL/L; EM••50mL/L.

- Aumento della biomassa fogliare;
- Aumento del numero di peperoncini;
- Miglioramento delle caratteristiche nutrizionali.
- Incremento del contenuto di acido ascorbico

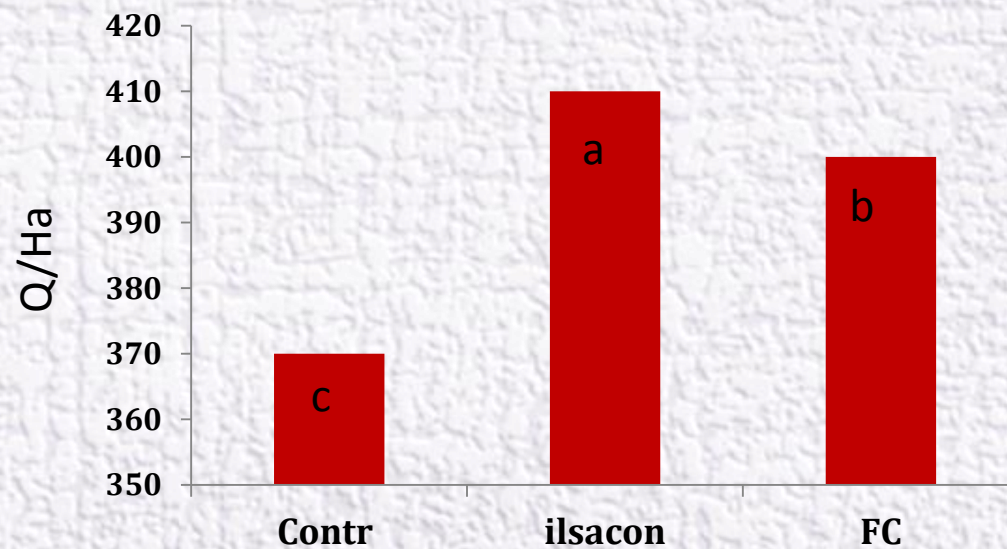


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FIERAGRICOLA Verona, 3-6 Febbraio 2016



Trattamento	Peso fresco				SPAD	
	Foglie		Radici		Media	(%)
	(g)	(%)	(g)	(%)		
Controllo	2.75b	100	1.39b	100	34b	100
EM0,1	3.01a	109	1.70a	123	40a	117
EM1	3.34a	121	1.73a	125	43a	125





 **LANDLAB** Quinto Vicentino (Vicenza)

FIERAGRICOLA Verona, 3-6 Febbraio 2016

TRATTATO

TRATTAMENTO	Kg/pianta	% stimolaz
Controllo	1,044	100
FC	1,226	117
EM	1,238	119

CONTROLLO



CONTROLLO



biostimolante: 1 ml/pianta
0,1 ml/pianta

2 tempi di applicazione: al trapianto
dopo 1 settimana

 **LANDLAB** Quinto Vicentino (Vicenza)



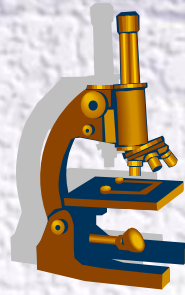
FIERAGRICOLA Verona, 3-6 Febbraio 2016

TRATTATO

trattamento	numero di frutti in 10 piante	% stimolazione rispetto al controllo
controllo	6	100
EM 0,1 ml/l	14,7	245
EM 1 ml/l	16,7	278
FC 0,1 ml/l	12,3	205
FC 1 ml/l	13,7	228

Percentuali di stimolazione del numero di frutti di fragola trattata con EM ed FC, rispetto al controllo non trattato.





WORK IN PROGRESS.....

II.L.S.A. (S.P.A.), Arzignano - VI - Concimi e fertilizzanti



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