"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”.

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.
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

FIERAGRICOLA Verona, 3-6 Febbraio 2016
I biostimolanti si suddividono:

1. Inoculanti microbici,

2. Sostanze umiche,

3. Idrolizzati proteici ed aminoacidi,

4. Prodotti a base di alghe.
produzione Ha

germinazione

peso fresco

crescita radicale

crescita fogliare

peso secco

SOSTANZE UMICHE
Schmidt et al, Plant Soil (2007)
Fluorescein-labeled interaction with carrot cells in culture compared to indole-3-acetic acid.

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: NO₃⁻)

**NO₃⁻ influx and mRNA synthesis of maize H⁺-ATPase Mha2 and NO₃⁻ transporters**

Pinton et al., 1999

Canellas et al., 2002

Quaggiotti et al., 2004
**NO$_3^-$ ASSIMILATION**

Krebs Cycle

<table>
<thead>
<tr>
<th>Humic samples</th>
<th>Concentration (mg C l⁻¹)</th>
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<tr>
<td></td>
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<td>IDH</td>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
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<td>170a</td>
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<tr>
<td></td>
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<td>0.5</td>
<td>179a</td>
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<td>0.5</td>
<td>149a</td>
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<td></td>
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<tr>
<td>Fraction III</td>
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<td>100c</td>
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<td>0.5</td>
<td>151ab</td>
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<td>163a</td>
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<tr>
<td></td>
<td>5</td>
<td>146b</td>
</tr>
</tbody>
</table>

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

In the presence of TIBA, the leaf explants were without roots.

*INTRODUCTION*

Nardi et al., 1996. Humic substances in terrestrial ecosystems
**Indoleacetic acid into HS**

**Antibodies**


**GC-MS**

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

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.

Gene Ontology Analysis

Identification of the HS biological targets

Bioinformatic analyses

Using 160 primer combinations, the cDNA-AFLP enable to identify 133 genes putatively involved in plants-HS interaction. Real-Time PCR analyses confirmed transcripton levels of 32 HS-regulated genes.
• 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 umiche,

3. Idrolizzati proteici ed aminoacidi,

4. Prodotti a base di alghe.
L'idrolizzato proteico è stato prodotto con un una 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).
II PART

BIOV 5 → from alfalfa plants -EM- ILSACON

12 days plants grown in nutrient solution, treated with the product for 48 hours
Effetto del trattamento con EM sul peso secco di radici e foglie di plantule di mais


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

-\( \text{NH}_4^+ \) → \( \text{GLUTAMMINA} \) → \( \text{GLUTAMMATO} \) → \( \text{GS} \) → \( \text{NH}_4^+ \)

-\( \text{AS} \) → \( \text{ASPARAGINA} \)

-\( \text{\( \alpha \)-KETOGLUTARATO} \) → \( \text{GOGAT} \) → \( \text{GLUTAMMATO} \) → \( \text{AspAT} \) → \( \text{OXALACETATO} \) → \( \text{\( \alpha \)-KETOGLUTARATO} \)

-\( \text{NO}_2^- \) → \( \text{NiR} \) → \( \text{NO}_3^- \)

-\( \text{NR} \) → \( \text{NO}_2^- \) → \( \text{NiR} \) → \( \text{NO}_3^- \)
The oxalacetate required to synthesize Asp is produced from malate in TCA cycle by the activity of malato dehydrogenase (MDH), while α-ketoglutarate can be formed by isocitrate dehydrogenase (IDH) in TCA cycle and by AspAT during Asp production.
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

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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Roots</th>
<th>Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mM NaCl</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>25 mM NaCl + TRIA</td>
<td>138</td>
<td>117</td>
</tr>
<tr>
<td>25 mM NaCl + EM</td>
<td>133</td>
<td>128</td>
</tr>
<tr>
<td>75 mM NaCl</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>75 mM NaCl + TRIA</td>
<td>106</td>
<td>128</td>
</tr>
<tr>
<td>75 mM NaCl + EM</td>
<td>148</td>
<td>122</td>
</tr>
<tr>
<td>150 mM NaCl</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>150 mM NaCl + TRIA</td>
<td>160</td>
<td>137</td>
</tr>
<tr>
<td>150 mM NaCl + EM</td>
<td>157</td>
<td>127</td>
</tr>
</tbody>
</table>

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 (± 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Roots</th>
<th>Leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K(^+) (%)</td>
<td>Na(^+) (%)</td>
</tr>
<tr>
<td>Control</td>
<td>1.238±0.011a</td>
<td>0.408±0.090e</td>
</tr>
<tr>
<td>TRIA</td>
<td>1.130±0.072a</td>
<td>0.472±0.081g</td>
</tr>
<tr>
<td>EM</td>
<td>1.120±0.090a</td>
<td>0.488±0.080g</td>
</tr>
<tr>
<td>25 mM NaCl</td>
<td>0.915±0.008c</td>
<td>0.972±0.015c</td>
</tr>
<tr>
<td>25 mM NaCl+TRIA</td>
<td>0.982±0.017b</td>
<td>0.513±0.034f</td>
</tr>
<tr>
<td>25 mM NaCl +EM</td>
<td>0.990±0.014b</td>
<td>0.502±0.021f</td>
</tr>
<tr>
<td>75 mM NaCl</td>
<td>0.751±0.011e</td>
<td>1.120±0.008b</td>
</tr>
<tr>
<td>75 mM NaCl+TRIA</td>
<td>0.765±0.016de</td>
<td>0.872±0.056d</td>
</tr>
<tr>
<td>75 mM NaCl +EM</td>
<td>0.789±0.020d</td>
<td>0.723±0.090d</td>
</tr>
<tr>
<td>150 mM NaCl</td>
<td>0.432±0.060f</td>
<td>1.209±0.045a</td>
</tr>
<tr>
<td>150 mM NaCl+TRIA</td>
<td>0.480±0.022f</td>
<td>0.891±0.052d</td>
</tr>
<tr>
<td>150 mM NaCl +EM</td>
<td>0.495±0.024f</td>
<td>0.794±0.034d</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>GS</th>
<th>GOGAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.27±0.12b</td>
<td>14.46±0.32c</td>
</tr>
<tr>
<td>EM</td>
<td>6.11±0.32a</td>
<td>16.82±0.18a</td>
</tr>
<tr>
<td>25 mM NaCl</td>
<td>3.13±0.10c</td>
<td>12.50±0.11d</td>
</tr>
<tr>
<td>25 mM NaCl +EM</td>
<td>5.50±0.17a</td>
<td>14.90±0.23c</td>
</tr>
<tr>
<td>75 mM NaCl</td>
<td>3.81±0.11c</td>
<td>11.90±0.20e</td>
</tr>
<tr>
<td>75 mM NaCl +EM</td>
<td>5.00±0.28b</td>
<td>15.52±0.17b</td>
</tr>
<tr>
<td>150 mM NaCl</td>
<td>3.72±0.11c</td>
<td>12.57±0.35d</td>
</tr>
<tr>
<td>150 mM NaCl +EM</td>
<td>4.75±0.30b</td>
<td>14.78±0.33c</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>PAL</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.94± 0.31 f</td>
</tr>
<tr>
<td>EM</td>
<td>3.04± 0.29 f</td>
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<tr>
<td>25 mM NaCl</td>
<td>8.03± 0.20 e</td>
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<td>25 mM NaCl +EM</td>
<td>12.92± 0.15 c</td>
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<tr>
<td>75 mM NaCl</td>
<td>12.34± 0.09 d</td>
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<tr>
<td>75 mM NaCl +EM</td>
<td>15.27±0.22 b</td>
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<tr>
<td>150 mM NaCl</td>
<td>12.69±0.18 d</td>
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<tr>
<td>150 mM NaCl +EM</td>
<td>17.47± 0.33a</td>
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</table>

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).
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.
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
I prodotti sono stati caratterizzati chimicamente:

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<tr>
<th>prodotto</th>
<th>cisteina</th>
<th>a. aspartico</th>
<th>idroxyprolina</th>
<th>metionina</th>
<th>treonina</th>
<th>serina</th>
<th>a. glutam</th>
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<th>lisina</th>
<th>istidina</th>
<th>arginina</th>
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Tab. 1 A e B.

Contenuto di aminoacidi totali negli idrolizzati proteici.

I dati sono la media di tre repliche (s±).
<table>
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<tr>
<th>prodotto</th>
<th>isoleucina</th>
<th>leucina</th>
<th>tirosina</th>
<th>fenilalanina</th>
<th>lisina</th>
<th>istidina</th>
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<th>a. aspartico</th>
<th>metionina</th>
<th>treonina</th>
<th>serina</th>
<th>a. glutammico</th>
<th>glicina</th>
<th>alanina</th>
<th>valina</th>
<th>AA totali</th>
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<td>0,04</td>
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<td>0,74</td>
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<td>0,94</td>
<td>0,93</td>
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<td>6,26</td>
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<td>0,65</td>
<td>0,04</td>
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<td>0,02</td>
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<td>9,16</td>
</tr>
<tr>
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<td>0,08</td>
<td>0,03</td>
<td>0,12</td>
<td>0,77</td>
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<td>0,11</td>
<td>1,93</td>
<td>0,12</td>
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<td>1,66</td>
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</table>

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±).
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<tr>
<td>Cont</td>
<td>3,00</td>
</tr>
<tr>
<td>A</td>
<td>4,10</td>
</tr>
<tr>
<td>B</td>
<td>3,30</td>
</tr>
<tr>
<td>C</td>
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<tr>
<td>D</td>
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<tr>
<td>E</td>
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<table>
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<th>%</th>
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<th>%</th>
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</thead>
<tbody>
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<td>0,90</td>
<td>100</td>
<td>2,10</td>
<td>100</td>
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<td>A</td>
<td>4,10</td>
<td>134*</td>
<td>1,10</td>
<td>118*</td>
<td>2,80</td>
<td>136*</td>
</tr>
<tr>
<td>B</td>
<td>3,30</td>
<td>107</td>
<td>0,70</td>
<td>77</td>
<td>2,70</td>
<td>131*</td>
</tr>
<tr>
<td>C</td>
<td>4,10</td>
<td>136*</td>
<td>0,80</td>
<td>91</td>
<td>3,00</td>
<td>147*</td>
</tr>
<tr>
<td>D</td>
<td>3,00</td>
<td>100</td>
<td>1,20</td>
<td>132*</td>
<td>2,10</td>
<td>100</td>
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<tr>
<td>E</td>
<td>3,70</td>
<td>122*</td>
<td>0,60</td>
<td>68</td>
<td>3,10</td>
<td>149*</td>
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Numero di fiori nelle piante di basilico trattate e non (controllo). L’asterisco indica la significatività del dato per un p ≤0.05.
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<td>152,7 g</td>
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<tr>
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<td>133,3 g</td>
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<tr>
<td>B</td>
<td>131,8 g</td>
<td>150,1 g</td>
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<tr>
<td>C</td>
<td>129,3 g</td>
<td>182,7 g</td>
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<td>D</td>
<td>150,9 g</td>
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<tr>
<td>E</td>
<td>122,4 g</td>
<td>172,1 g</td>
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</table>

Biomassa fogliare delle piante di basilico trattate e non (controllo) con gli idrolizzati proteici. L’asterisco indica la significatività del dato per un p ≤ 0.05.
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<th>Xant + Car</th>
<th></th>
<th>Chl Tot</th>
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</thead>
<tbody>
<tr>
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<td>%</td>
<td>mg/g</td>
<td>%</td>
<td>mg/g</td>
<td>%</td>
<td>mg/g</td>
<td>%</td>
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<tr>
<td>Con</td>
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<td>100</td>
<td>0,84</td>
<td>100</td>
<td>0,71</td>
<td>100</td>
<td>3,49</td>
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</tr>
<tr>
<td>A</td>
<td>2,45</td>
<td>101</td>
<td>0,63</td>
<td>75</td>
<td>0,59</td>
<td>83</td>
<td>3,24</td>
<td>93</td>
</tr>
<tr>
<td>B</td>
<td>2,92</td>
<td>120*</td>
<td>0,71</td>
<td>85</td>
<td>0,8</td>
<td>112</td>
<td>3,99</td>
<td>115*</td>
</tr>
<tr>
<td>C</td>
<td>2,62</td>
<td>108</td>
<td>1,33</td>
<td>160*</td>
<td>0,52</td>
<td>73</td>
<td>3,74</td>
<td>107</td>
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<tr>
<td>D</td>
<td>2,22</td>
<td>92</td>
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<td>0,73</td>
<td>88</td>
<td>0,67</td>
<td>94</td>
<td>3,67</td>
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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 ≤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

<table>
<thead>
<tr>
<th>Foglie</th>
<th>P verdi</th>
<th>P arancio</th>
<th>P rossi</th>
</tr>
</thead>
<tbody>
<tr>
<td>(g p.f.)</td>
<td>%</td>
<td>(g p.f.)</td>
<td>%</td>
</tr>
<tr>
<td>Control</td>
<td>10.08±0.02b</td>
<td>100</td>
<td>14.31±0.04b</td>
</tr>
<tr>
<td>EM•</td>
<td>12.34±0.03b</td>
<td>122</td>
<td>8.17±0.06c</td>
</tr>
<tr>
<td>EM••</td>
<td>26.71±0.12a</td>
<td>265</td>
<td>40.43±0.11a</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Foglie</th>
<th>P verdi</th>
<th>P arancio</th>
<th>P rossi</th>
</tr>
</thead>
<tbody>
<tr>
<td>(g p.f.)</td>
<td>%</td>
<td>(g p.f.)</td>
<td>%</td>
</tr>
<tr>
<td>C</td>
<td>15.51±0.03c</td>
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<td>5.05±0.03</td>
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<tr>
<td>EM•</td>
<td>18.52±0.06a</td>
<td>119</td>
<td>5.26±0.12</td>
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<tr>
<td>EM••</td>
<td>17.36±0.11b</td>
<td>112</td>
<td>3.69±0.08b</td>
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</tbody>
</table>

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••=50 mL/L.
### PRIMO CAMPIONAMENTO

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<th>%</th>
<th>P verdi</th>
<th>%</th>
<th>P arancio</th>
<th>%</th>
<th>P rossi</th>
<th>%</th>
</tr>
</thead>
<tbody>
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<td>(numero)</td>
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<td>(numero)</td>
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<td>(numero)</td>
<td></td>
</tr>
<tr>
<td>C</td>
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<td>18.53±0.12b</td>
<td>100</td>
<td>2.25±0.01b</td>
<td>100</td>
<td>4.00±0.10a</td>
<td>100</td>
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<tr>
<td>EM•</td>
<td>23.60±0.22b</td>
<td>103</td>
<td>20.00±0.12c</td>
<td>108</td>
<td>1.83±0.12c</td>
<td>81</td>
<td>4.23±0.08a</td>
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</tr>
<tr>
<td>EM••</td>
<td>55.65±0.21a</td>
<td>242</td>
<td>50.50±0.32a</td>
<td>273</td>
<td>2.58±0.10a</td>
<td>115</td>
<td>4.20±0.12a</td>
<td>105</td>
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</table>

Tabella 3. Effetto del primo tettamento 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 ±). 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

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<tr>
<th></th>
<th>P totali</th>
<th>P verdi</th>
<th>P arancio</th>
<th>P rossi</th>
</tr>
</thead>
<tbody>
<tr>
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<td>(numero)</td>
<td></td>
<td>(numero)</td>
<td></td>
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<tr>
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<td>4.13±0.012</td>
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<tr>
<td>EM••</td>
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<td>4.13±0.008</td>
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Tabella 4. Effetto del secondo tettamento 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 ±). 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.
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.

<table>
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<td>(%)</td>
<td>mg Fe²⁺E kg⁻¹ p.f.</td>
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<td>Pep rossi</td>
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<tr>
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<td>1317.083±0.32a</td>
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<td>3135.63±0.11b</td>
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<td>EM ••</td>
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<td>3280.62±0.12a</td>
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<td>Pep verdi</td>
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<td></td>
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<td>3621.172±0.18b</td>
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<tr>
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<td>5439.012±0.13a</td>
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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.

<table>
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<th>Acido ascorbico</th>
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<td></td>
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<td>mg Fe2+E kg⁻¹ p.f. (%)</td>
<td>mg kg⁻¹ p.f. (%)</td>
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<tr>
<td>Foglie</td>
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<td></td>
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</tr>
<tr>
<td>C</td>
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<td>672.034±14.12a 159</td>
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<tr>
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<td>14539.345±22.14b 121</td>
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FIERAGRICOLA Verona, 3-6 Febbraio 2016
## PRIMO CAMPIONAMENTO

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<th>(%)</th>
<th>diidrocapsiciana (mg/L)</th>
<th>(%)</th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>nd</td>
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<td>0.913±0.03b</td>
<td>100</td>
</tr>
<tr>
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<td>nd</td>
<td>-</td>
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<tr>
<td>EM••</td>
<td>nd</td>
<td>-</td>
<td>0.767±0.02c</td>
<td>84</td>
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<tr>
<td><strong>Pep rossi</strong></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Pep verdi</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td>179.820±3.21a</td>
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<td>46.358±0.12a</td>
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</tr>
<tr>
<td>EM•</td>
<td>153.949±13.12b</td>
<td>86</td>
<td>38.749±0.21b</td>
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<tr>
<td>EM••</td>
<td>160.723±8.77b</td>
<td>89</td>
<td>47.279±0.08a</td>
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**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

<table>
<thead>
<tr>
<th></th>
<th>capsicina (mg/L)</th>
<th>capsicina (%)</th>
<th>diidrocapsicina (mg/L)</th>
<th>diidrocapsicina (%)</th>
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<tbody>
<tr>
<td><strong>Foglie</strong></td>
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<tr>
<td>C</td>
<td>nd</td>
<td>-</td>
<td>nd</td>
<td>-</td>
</tr>
<tr>
<td>EM•</td>
<td>nd</td>
<td>-</td>
<td>nd</td>
<td>-</td>
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<tr>
<td>EM••</td>
<td>nd</td>
<td>-</td>
<td>nd</td>
<td>-</td>
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<tr>
<td><strong>Pep rossi</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td>48.109±0.90c</td>
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<td>17.795±0.16c</td>
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<tr>
<td>EM•</td>
<td>220.947±0.32b</td>
<td>459</td>
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<td>EM••</td>
<td>335.069±0.28a</td>
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<td>78.423±0.10a</td>
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<td><strong>Pep verdi</strong></td>
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<tr>
<td>C</td>
<td>89.333±0.13c</td>
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<td>27.268±2.15c</td>
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<tr>
<td>EM•</td>
<td>98.912±0.14b</td>
<td>111</td>
<td>29.365±2.11b</td>
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<tr>
<td>EM••</td>
<td>117.559±0.32a</td>
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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 ±). 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
Quinto Vicentino (Vicenza)
<table>
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<th>Radici</th>
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<tr>
<td></td>
<td>(g)</td>
<td>(%)</td>
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![Diagram](image-url)
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<th>TRATTAMENTO</th>
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<th>% stimolaz</th>
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</thead>
<tbody>
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<td>100</td>
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<tr>
<td>FC</td>
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<tr>
<td>EM</td>
<td>1,238</td>
<td>119</td>
</tr>
</tbody>
</table>

**Questo Vicentino (Vicenza)**

FIERAGRICOLA Verona, 3-6 Febbraio 2016
biostimolante: 1 ml/pianta
0,1 ml/pianta

2 tempi di applicazione: al trapianto
dopo 1 settimana
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

serenella.nardi@unipd.it