Innovative Tools to Understand the Mode of Action of Biostimulants

An online course by New Ag International,
a division of Informa Connect

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Lesson Overview

Part 1: How to investigate the mode of action of biostimulant products

Part 2: New technologies to support the market positioning of biostimulant products

Part 3: The importance of partnerships: the BIOSTIMOLA project and public-private collaboration

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Part 1:
How to investigate the mode of action of biostimulant products

- EU Green Deal
- Function defines the product
- Mechanism and mode of action
- Analytical determinations
- Real Time PCR Gene expression
- Transcriptome analysis (RNA seq)

EU Green Deal

2030 Targets for sustainable food production

PESTICIDES

50%

Reduce the overall use and risk of chemical and hazardous pesticides

NUTRIENT LOSSES

50%

Reduce nutrient losses by 50% whilst retaining soil fertility, resulting in 20% less fertilisers

ANTIMICROBIALS

50%

Reduce sales of antimicrobials for farmed animals and aquaculture

ORGANIC FARMING

25%

Increase the percentage of organically farmed land in the EU

#EUFarm2Fork   #EUGreenDeal

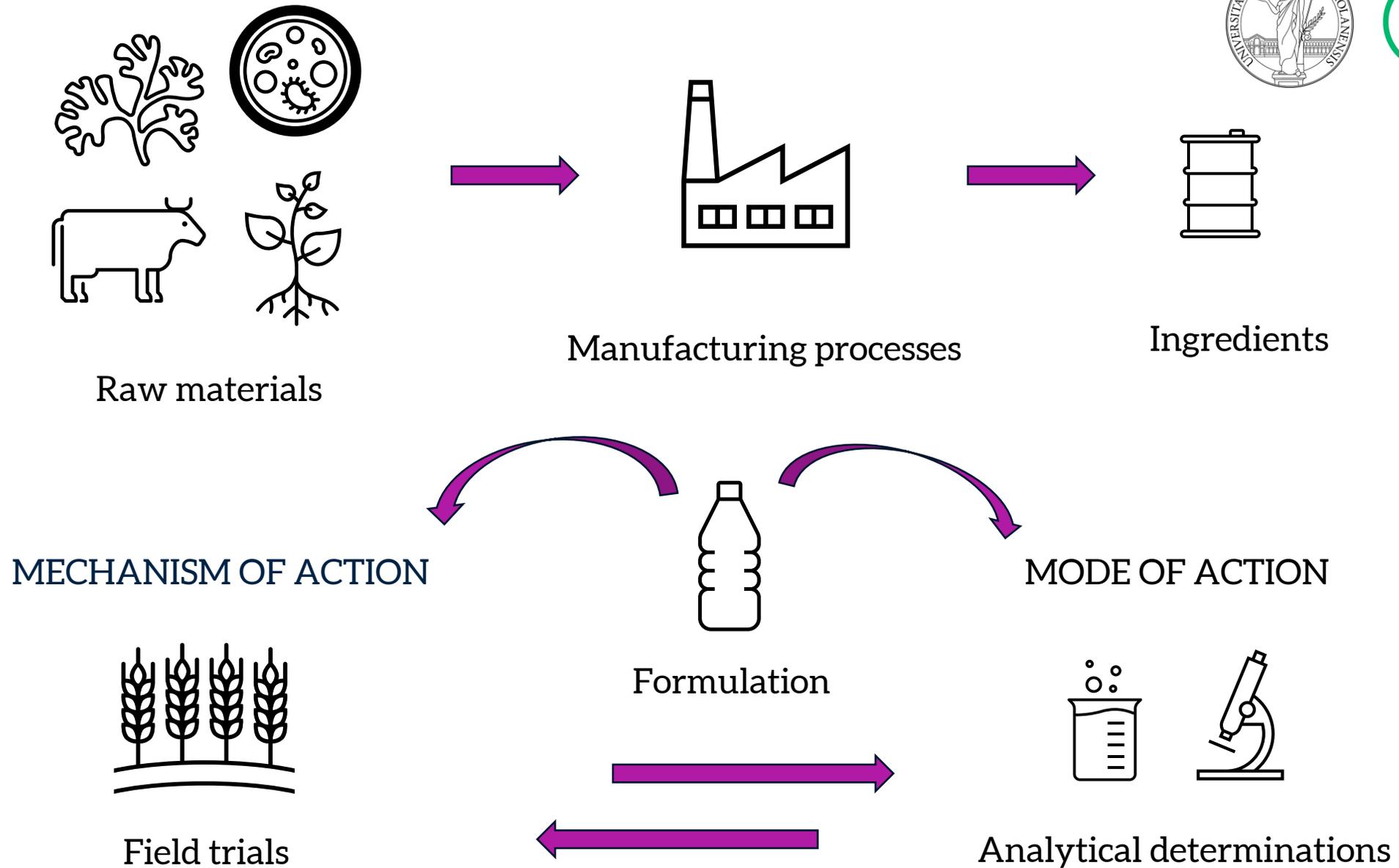European Commission

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Function defines the products

Issues

Function defines the product.

All plant biostimulants need Single Market access.

Plant biostimulants contribute to climate-smart agriculture

Raw materials

Manufacturing processes

Ingredients

MECHANISM OF ACTION

Formulation

MODE OF ACTION

Field trials

Analytical determinations

Mechanism and mode of action

MECHANISM
It consists of identifying a tangible effect of the biostimulant action (e.g., a stimulation of photosynthesis or yield) without an understanding of the explicit biochemical or molecular "mode of action".
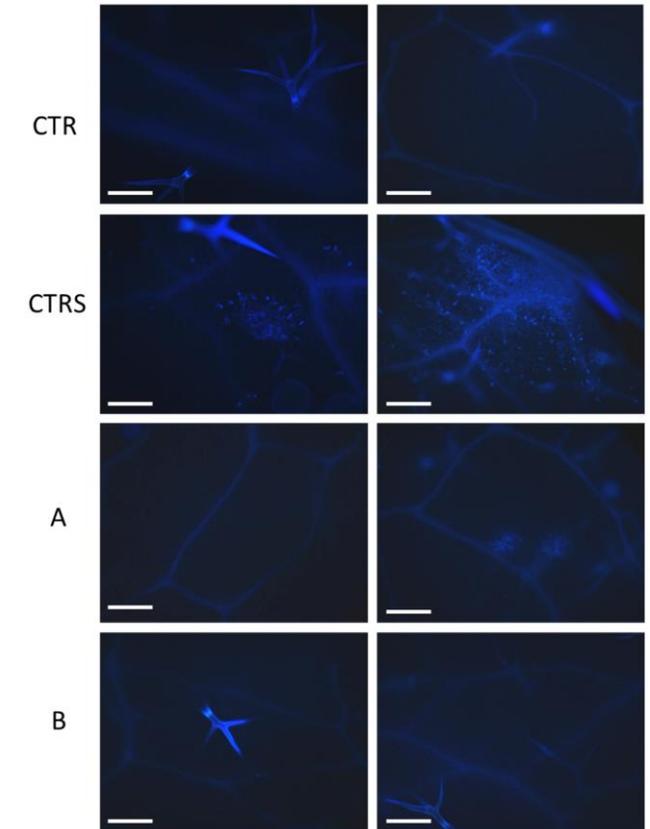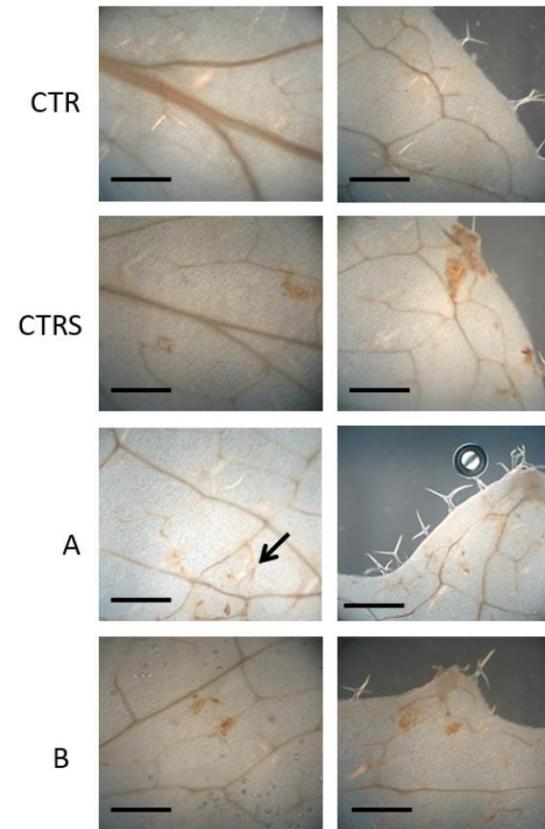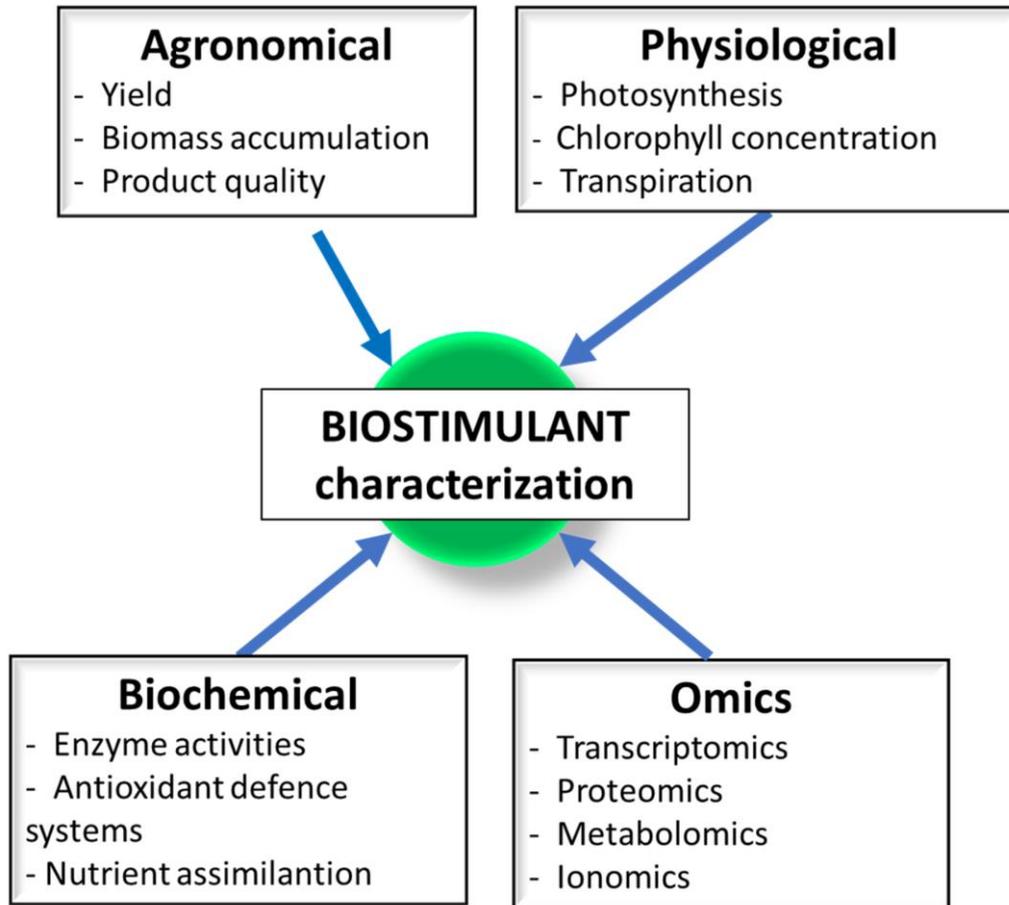
MODE OF ACTION
It involves the identification of a biochemical, molecular or physiological process.
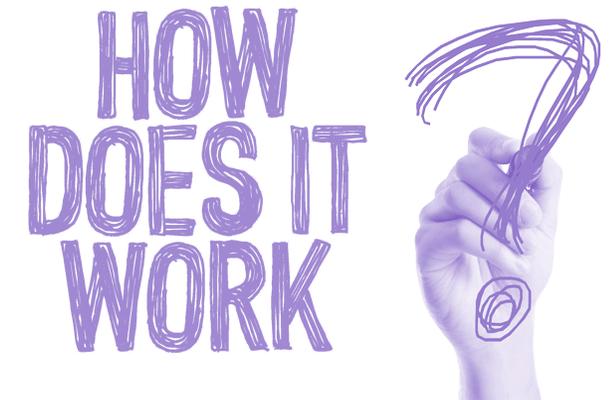
If we accept the concept that a biostimulant is a product of clear benefit but unknown mode of action, then it can only be regulated by its safety and proof of efficacy.

Yakhin, O. I., Lubyanov, A. A., Yakhin, I. A., & Brown, P. H. (2017). Biostimulants in plant science: a global perspective. Frontiers in plant science, 7, 2049

Agronomical
- Yield
- Biomass accumulation
- Product quality

Physiological
- Photosynthesis
- Chlorophyll concentration
- Transpiration

BIOSTIMULANT characterization

Biochemical
- Enzyme activities
- Antioxidant defence systems
- Nutrient assimilantion

Omics
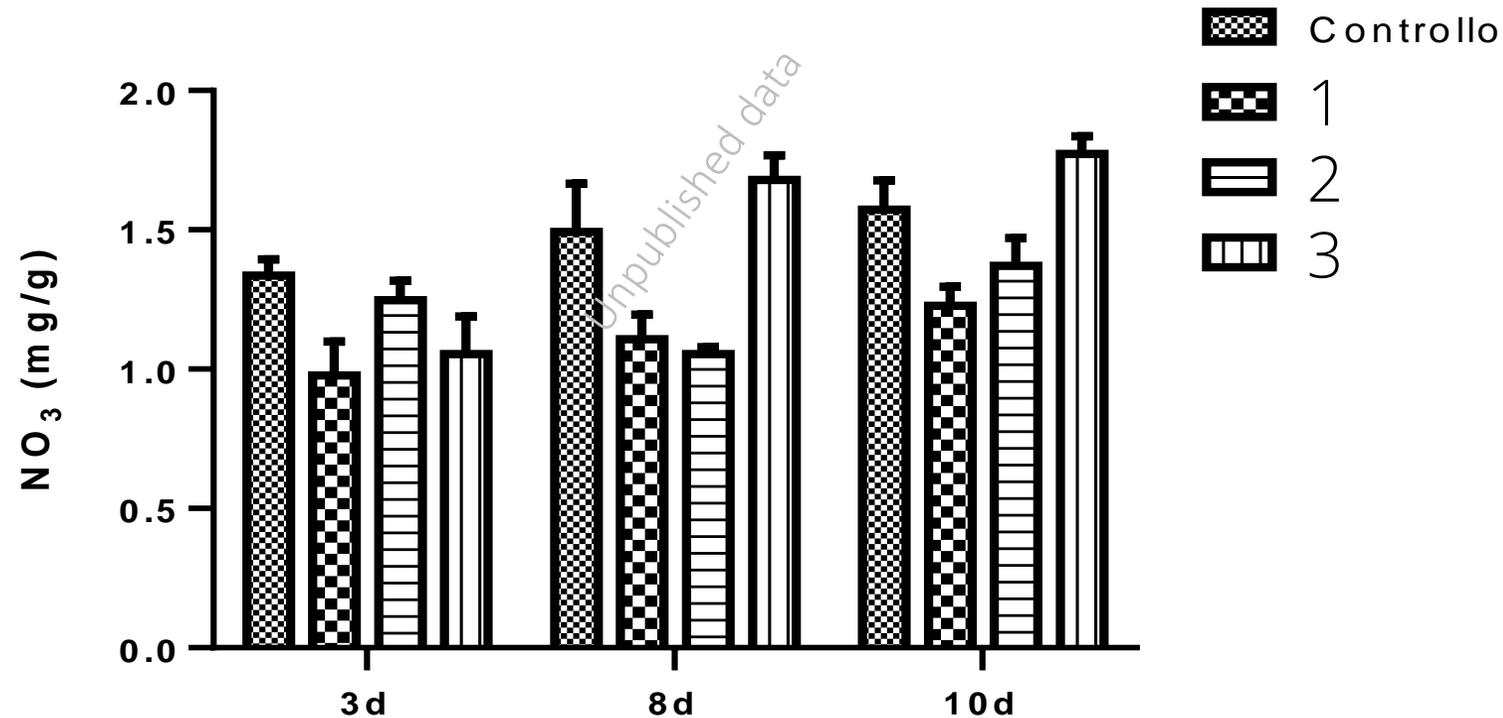- Transcriptomics
- Proteomics
- Metabolomics
- Ionomics

Franzoni, G., Cocetta, G., Prinsi, B., Ferrante, A., & Espen, L. (2022). Biostimulants on Crops: Their Impact under Abiotic Stress Conditions. Horticulturae, 8(3), 189.

Cocetta, G.; Landoni, M.; Pilu, R.; Repiso, C.; Nolasco, J.; Alajarin, M.; Ugena, L.; Levy, C.C.B.; Scatolino, G.; Villa, D.; Ferrante, A. Priming Treatments with Biostimulants to Cope the Short-Term Heat Stress Response: A Transcriptomic Profile Evaluation. Plants 2022, 11, 1130. https://doi.org/10.3390/plants11091130
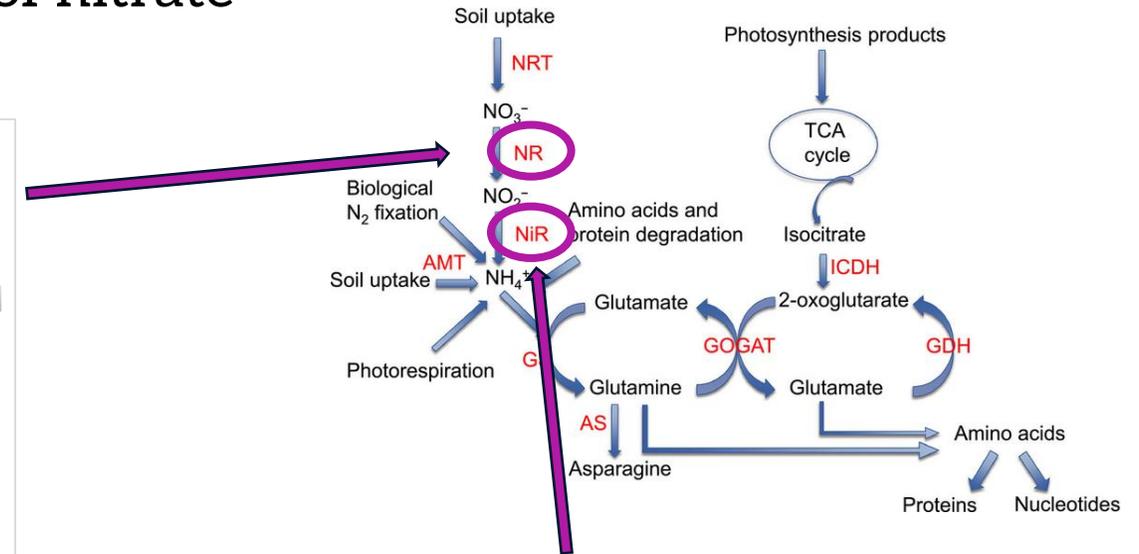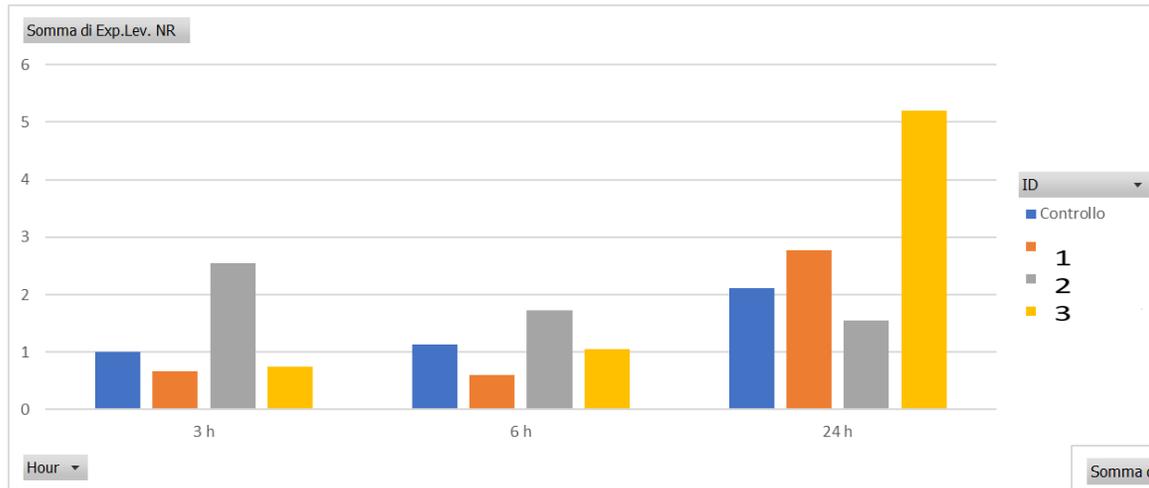
Analytical determinations

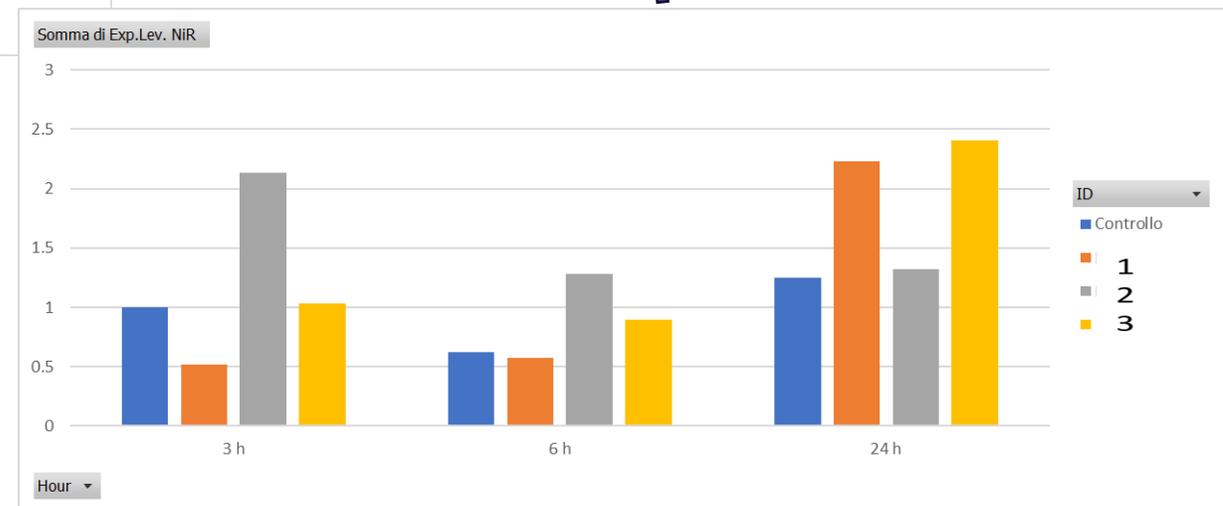Mechanism of action: reduction of leaf nitrate level
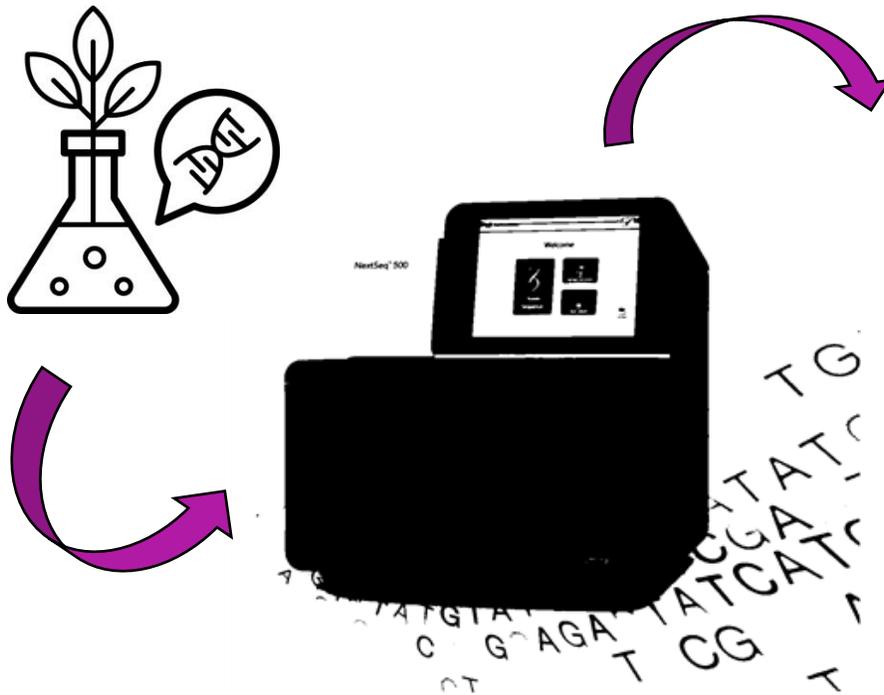
Real Time PCR Gene expression

Mode of action: stimulation of key genes of nitrate metabolism.

Different products show different gene activation times.

Transcriptome analysis (RNA seq)

We got 75,819 Unigenes.

Unigenes have been annotated by aligning with 7 functional databases, finally, 62,207 (NR:82.05%) , 70,218 (NT:92.61%) , 38,831 (Swissprot:51.22%) , 44,971 (KOG:59.31%) , 44,355 (KEGG:58.50%) , 44,311(GO:58.44%) , and 49,501 (InterPro:65.29%).

For functional annotation results, we detected 44,767 CDS. We also detected 2,526 Transcription Factor (TF) coding Unigenes.

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Transcriptome analysis (RNA seq)

Metabolic routes potentially affected by #3

UP-REGULATED
Carbon metabolism and photosynthesis
Cell wall expansion
Nitrate reductase
Hormone-like responses (ethylene, gibberellins and auxins)
DNA damage repair
Aquaporins PIP1 and PIP2, proline and dehydration-sensitive proteins

DOWN-REGULATED
NO_3/Cl transporter suppression

![informa connect]

Part 2:
New technologies to support the market positioning of biostimulant products

- Biostimulants and Nutrition Services: our approach
- Root growth
- Time-laps video
- Images analysis
- Roots and leaves scan
- Seed treatment
- Equipment for precision evaluations

Biostimulants & nutrition services

Services & Research for Agriculture

OUR APPROACH

We carry out experimental tests under different growth conditions, in a protected environment (growth chamber or greenhouse) as well as in the open field.

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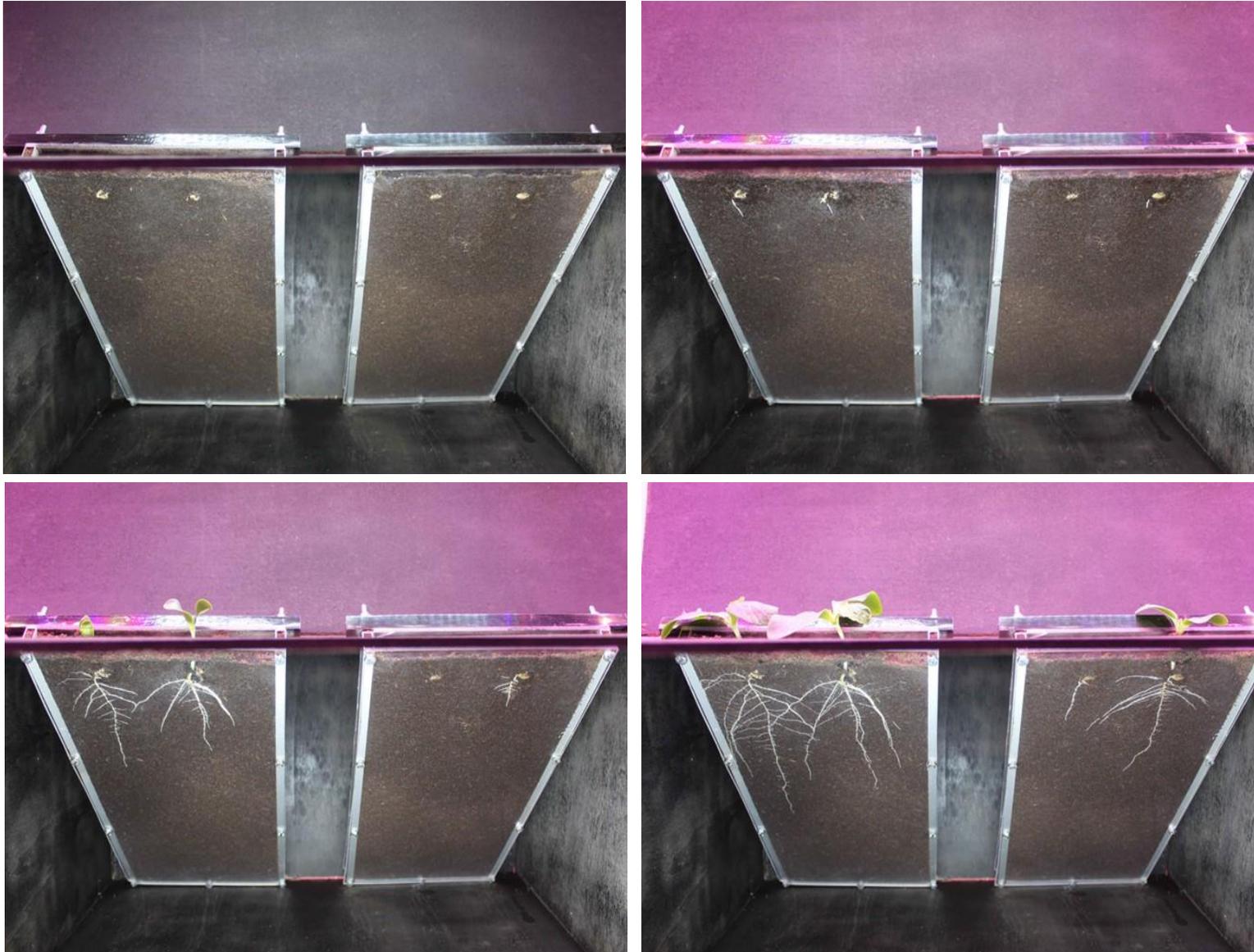# Root growth

Services & Research for Agriculture

Thanks to a particular pot, called rhizobox, it is possible to evaluate the root system of several type of cultivated plants.

Time-laps video

Services & Research for Agriculture

With professional instrumentation, we can process images and realise time-lapse videos to assess and monitor plant growth during the trial

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Images analysis

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1. RGB

- Height
- Crop coverage
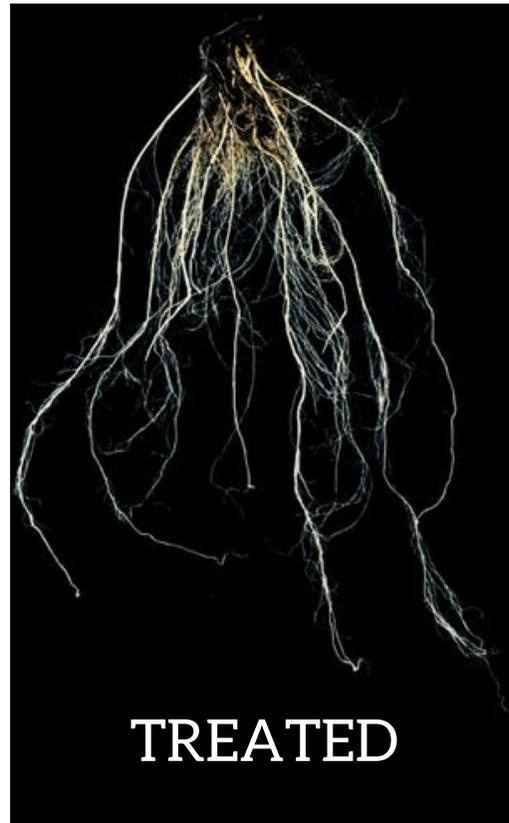- Vigor

2. Multispectral (MSP)

- NDVI
- NDRE
- Thermal camera

Thermal images analysis

With thermal camera analysis it is possible to see stress situations when no symptoms are yet present on the plant
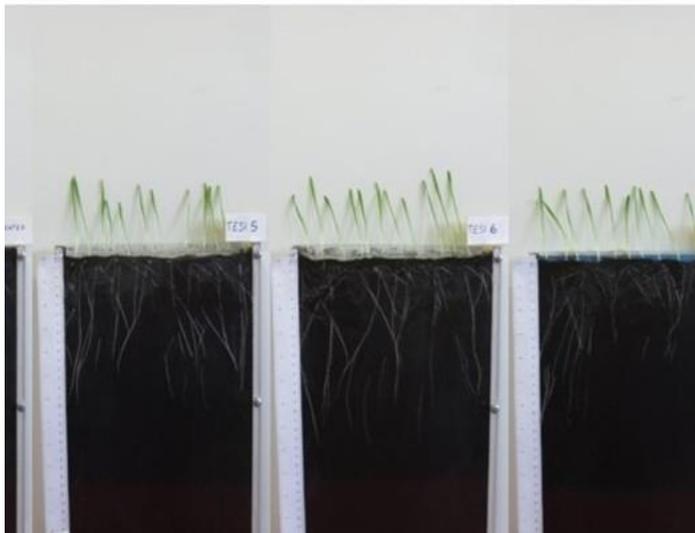

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Roots and leaves

Services & Research for Agriculture

UNTREATED

TREATED

TREATED   UNTREATED

When roots have developed, we can scan the roots and the leaves of each plant and process the images in order to calculate their surface.
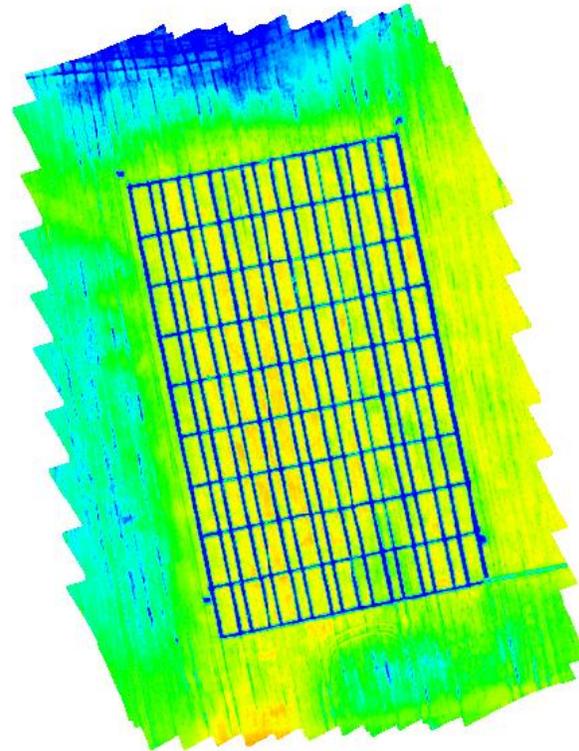
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Seed treatment

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AGRICOLA 2000

We can evaluate the germination of different seeds in Petri dishes, assuring all the growing conditions required, and performing seed treatment.

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Equipment for precision evaluations

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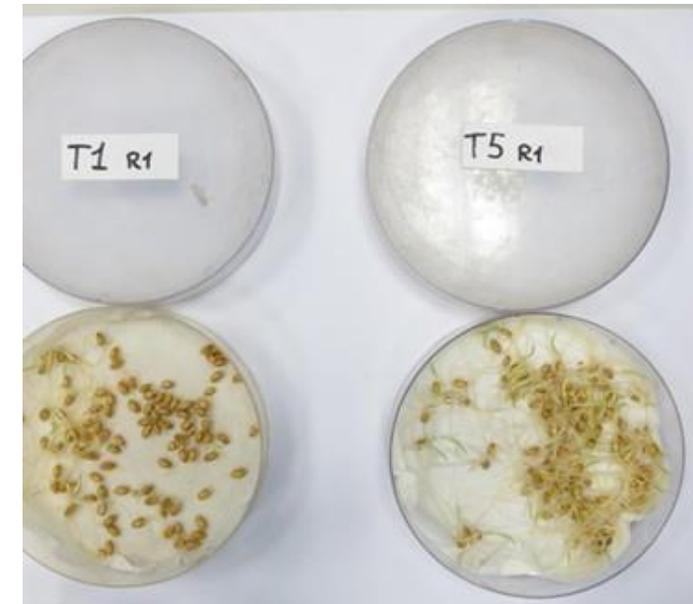
Agricola 2000 have tools for obtaining multispectral maps to evaluate the vegetation status of the crops (non-destructive analysis)

Drone:
- DJI Phantom 4 RTK and Multispectral
- SPAD and NDVI

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Part 3: The importance of partnerships: the BIOSTIMOLA project and public-private collaboration

- Collaboration UNIMI - Agricola 2000
- BIOSTIMOLA project

Collaboration

The collaboration between Agricola 2000 and the Department of Agriculture and Environment Science of the University of Milan, established in 2016, offers a broad knowledge of biostimulant products and the testing and evaluation of their efficacy, from the laboratory to the field.

BIOSTIMOLA project

Regione Lombardia

Serie Ordinaria n. 39 - Mercoledì 28 settembre 2022

D.G. Agricoltura, alimentazione e sistemi verdi

D.d.s. 23 settembre 2022 - n. 13466
Programma di Sviluppo Rurale 2014 – 2020 della Lombardia. operazione 1.2.01 «Progetti dimostrativi e azioni di informazione» d.d.s. 28 dicembre 2021, n. 18769. Approvazione degli esiti istruttori e ammissione a finanziamento delle domande

BIOSTIMOLA: Biostimulants in a nutshell

A project to promote the use of biostimulants in agriculture

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BIOSTIMOLA project

BIOSTIMOLA: Biostimulants in a nutshell

The information generated, collected and disseminated as part of the project will serve as support to those who will benefit from the use of biostimulants and provide them with technical and application knowledge regarding product selection, application methods, timing, dosages and objective assessment of crop responses, treated in different growing contexts.

ACTION AND ACTIVITIES
- The demonstration and study days
- Information activities
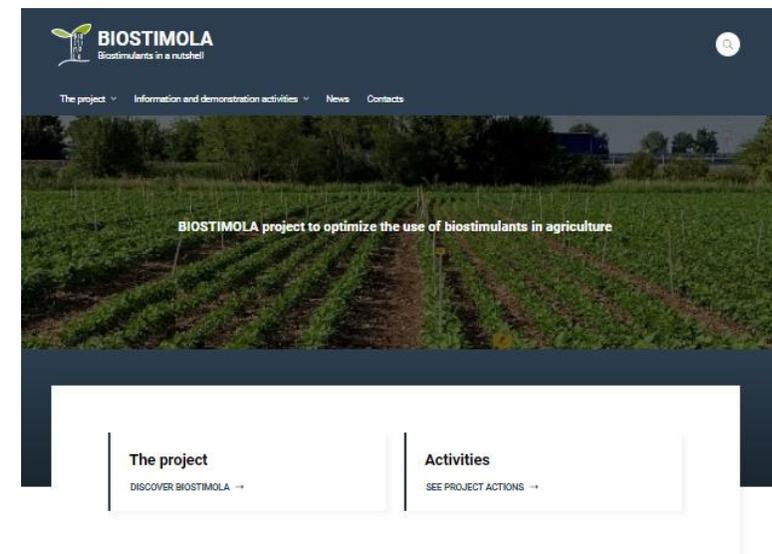
https://biostimola.unimi.it/en/

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Conclusions

We can identify the mode of action of biostimulant products.

Multidisciplinary approaches can be adopted to obtain a complete picture of the effects of the products and to maximize their efficacy (timing, dosage and application methods);

A continuous comparison with field agronomic evaluations and manufacturing process is essential to guide laboratory analyses and to correctly interpret the results obtained, in order to enhance and improve the design and use of new products.

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Thank You!
Questions or Comments?

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