Plant Protection and Plant Health in Europe: Efficacy and risks of „biorationals“ in organic and integrated pest management - acceptable?
8th International Symposium, 13 - 14 December 2017, Braunschweig, Germany

Bio-rational or bio-logical: different concepts, different impact

Markus Weinmann, M. Nkebiwe, K. Bradáčová, H. Bremer, I. Mpanga, N. Weber, N. Morad-Talab, A.S. Florea, G. Fora, Gh. Poşta, K.F. Lauer, M. Raupp, T. Müller, U. Ludewig, V. Römheld (posthum), and G. Neumann

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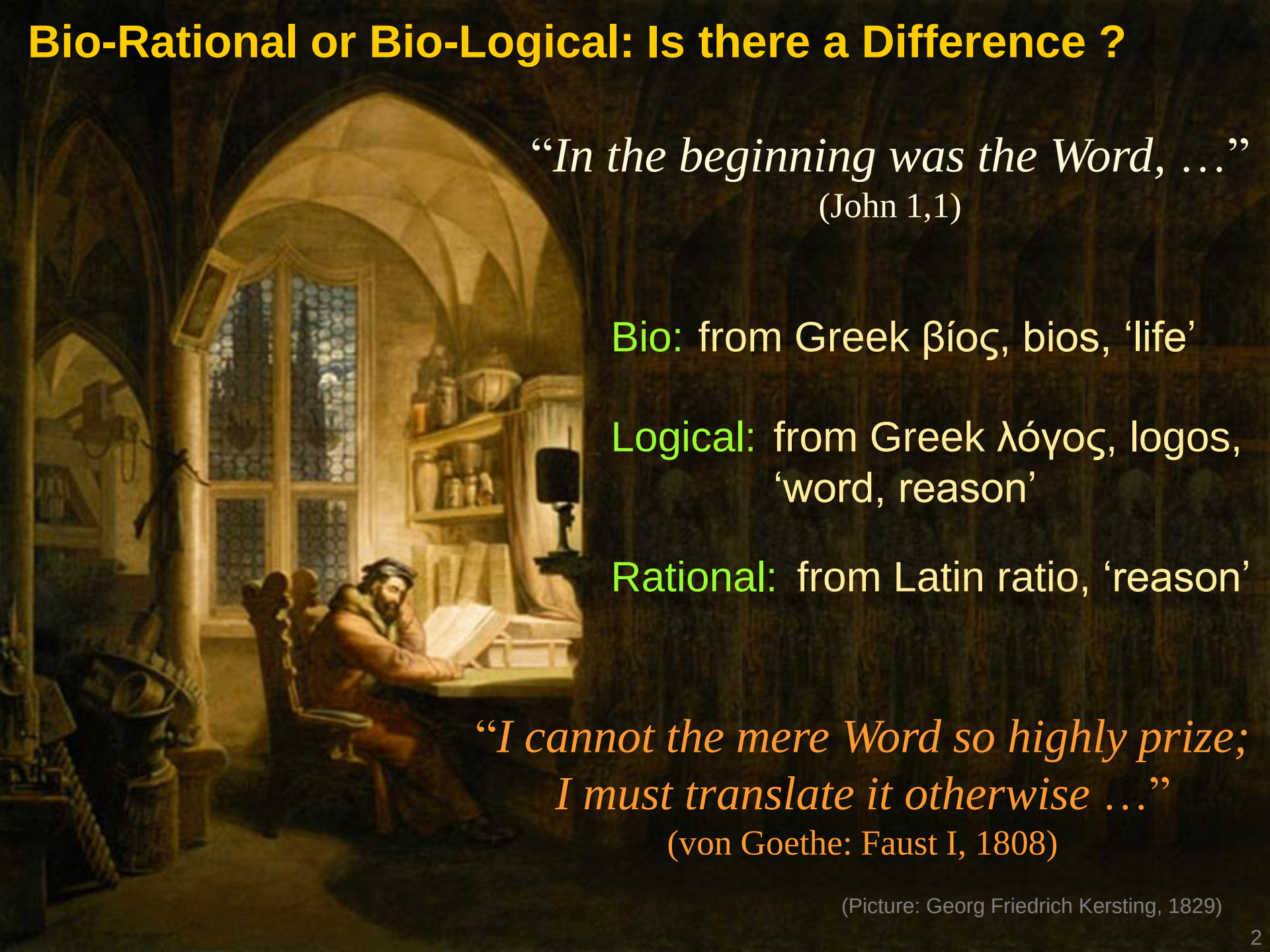
Bio-Rational or Bio-Logical: Is there a Difference ?



"In the beginning was the Word, …"
(John 1,1)

Bio: from Greek βίος, bios, 'life'

Logical: from Greek λόγος, logos, 'word, reason'

Rational: from Latin ratio, 'reason'

"I cannot the mere Word so highly prize;
I must translate it otherwise …"
(von Goethe: Faust I, 1808)

(Picture: Georg Friedrich Kersting, 1829)

What is Reasoning ?

(Picture: www.google.com)

"*reckoning of consequences*"

(Hobbes, 1660: The Leviathan, V)

Rational → calculation

"*inner dialogue of the soul with itself*"

(Plato, ca. 360 BC: Sophist, 263e3-5)

Rational → soul inherent logic

What are Bio-Rationals ?

(Bio-) agents or processes with specific action against harmful organisms, but limited or no effect on non-target organisms

(e.g. Horowitz et al., 2009, in the text book “Biorational Control of Athropod Pests”, Springer)

Rationality is the purposeful calculation of the most efficient means and procedures to realize goals.

(e.g. Max Weber, 1922)

“*The use of the word ‘biorational’ should be avoided to prevent confusion because of the diversity of the definitions applied to the term*.”

“*The term ‘biorational’ is inherently defective, in that it implies that chemical pesticides are irrational.*”

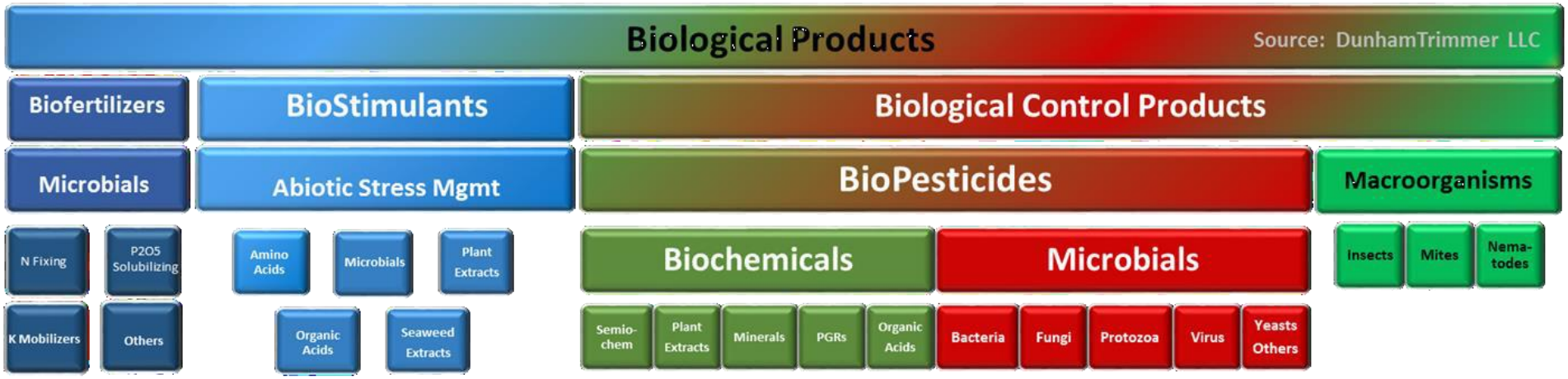
(Hall & Barry, 1995; cited in Crump et al., 1999)

Global Relevance of Bio-Logicals

ABIM Annual Biocontrol Industry Meeting®

Market Overview by DunhamTrimmer

IBMA INTERNATIONAL BIOCONTROL MANUFACTURERS ASSOCIATION



Biofertilizers

- Microbials used to enhance plant nutrient uptake from soil
- Nitrogen fixing bacteria make up largest group
- Others include mobilizers of specific nutrients (zinc, sulfur) and mycorrhizal fungi
- Biofertilizers regulated under country/state fertilizer regulations

Biostimulants

- Seaweed Extracts make up the largest segment in this group
- Organic acids are humic and fulvic acids used as soil amendments, formed by the microbial degradation of plant matter.
- Microbials, primarily bacteria, often used as seed or soil treatment to aid in nutrient assimilation
- Definition and regulation of biostimulants is still under development in most parts of the world

BioPesticides

- Biopesticides are derived from natural materials, such as plants, bacteria and certain minerals. Biopesticides target specific pests and are inherently less toxic than synthetic pesticides.

Biochemicals

- Plant Extracts; Minerals & Others; PGRs; Semiochemicals; Organic Acids
- Plant Extracts make up the largest segment in this group
- Semiochemicals (pheromones) has the largest actual number of products
- Largest challenge for Plant Extracts is manufacturing and consistent quality in the active ingredient(s)

Microbials

- Bacteria; Fungi; Virus; Protozoan; Yeasts
- Bacteria, followed by Fungi make up the largest groups commercially (>90%)
- Microbials are the largest market of biopesticides at US$1.3 Bn.
- Biggest challenges for microbials are formulation related: 1) Shelf-life; 2) Stability; 3) Performance enhancement

Macroorganisms

- Insects; Mites; Nematodes
- Insects followed by mites makeup the largest groups
- Unique in that the live organism in the form of eggs, larvae, pupae or adult is used.
- Most important challenge for Macros is logistics—shipping live organisms that have to have special care to survive
- Normally not classified as a Biopesticide—only as Biological Control Products

Presented by Willem Ravensberg, IBMA at the MiCROPE conference in Vienna, 07. December 2017

What are Bio-Logicals ?

Utilization Groups / Intension

Bio-stimulants

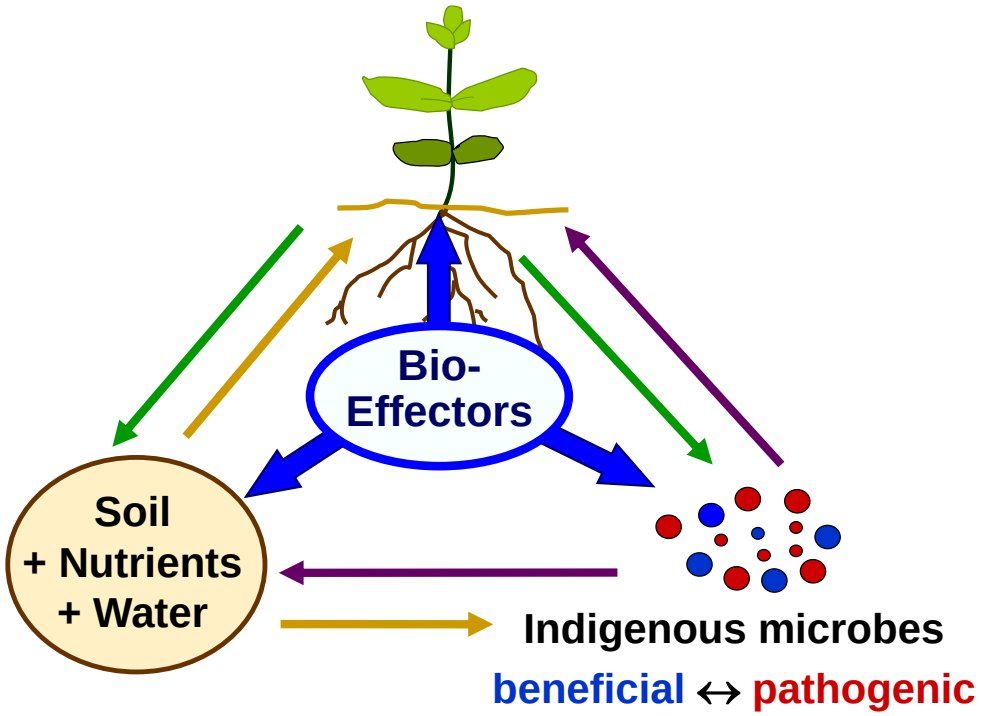
Bio-fertilizers

Bio-pesticides

Bio-control agents

Bio-logicals

Active Ingredients / Mode of Action



Functional implementation or activation of biological mechanisms, especially those interfering with soil-plant-microbial interactions.

No direct input of mineral nutrients or toxins in the sense of fertilizers or pesticides.

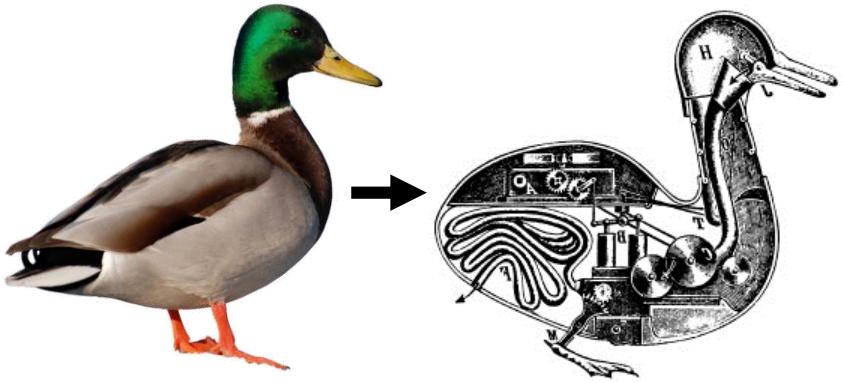
Is it Time for a Paradigm Shift in Natural Science?

Reductionism/positivism

- Systems / living things are fully determined by their components
  - → Genetics
  - → Physico/chemical factors
- Only empiric knowledge is valid

Holistic view

- Reality is complex and creative
  - → Feedback loops
  - → Synergistic interactions
  - → Spontaneity and active learning
- Organisms are organized life forms

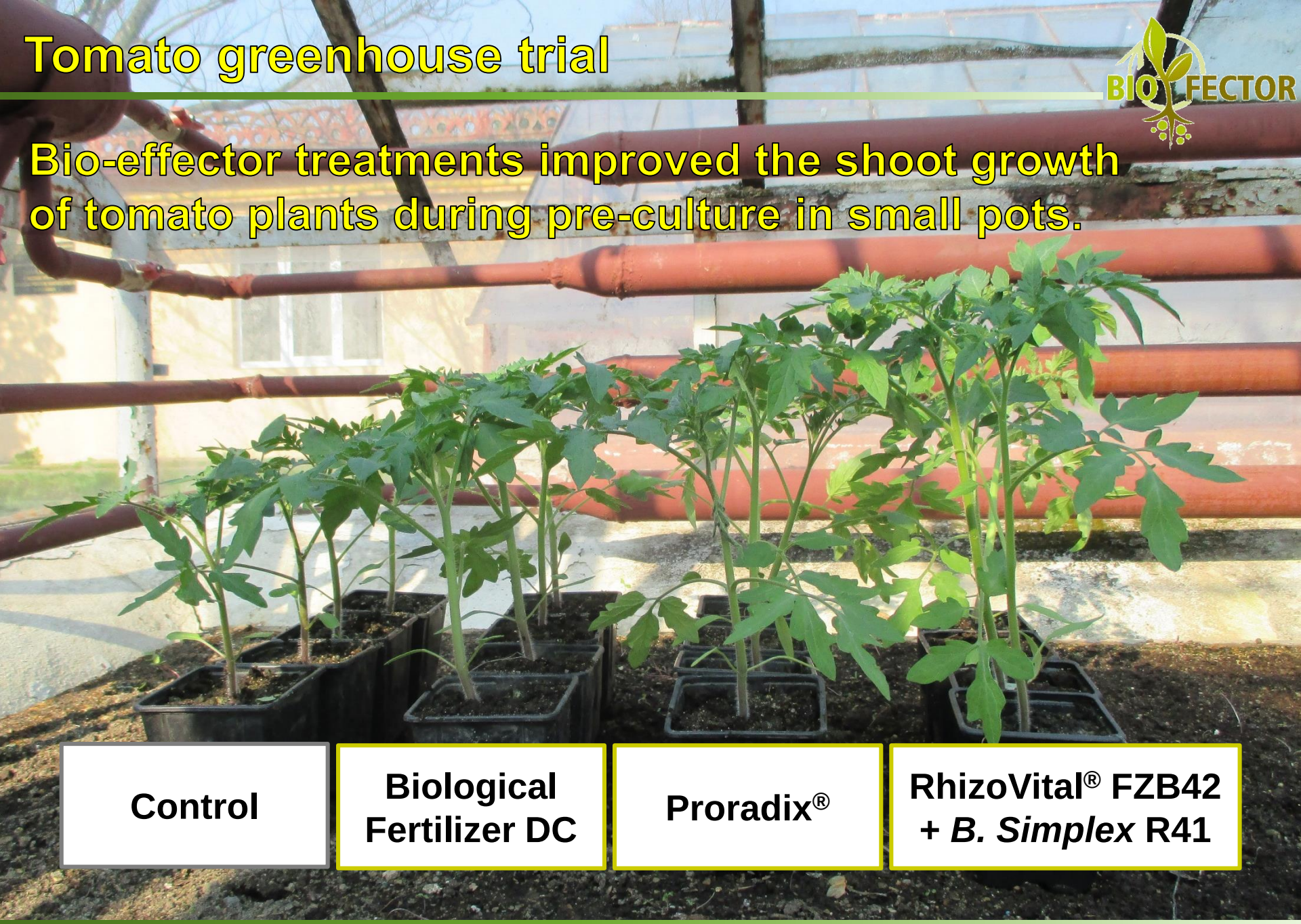


(Pictures: www.publicdomainpictures.net; Jacques de Vaucanson, 1738)

The ordered whole is other than the sum of its parts !

Tomato greenhouse trial

Bio-effector treatments improved the shoot growth of tomato plants during pre-culture in small pots.



Control	Biological Fertilizer DC	Proradix®	RhizoVital® FZB42 + *B. Simplex* R41

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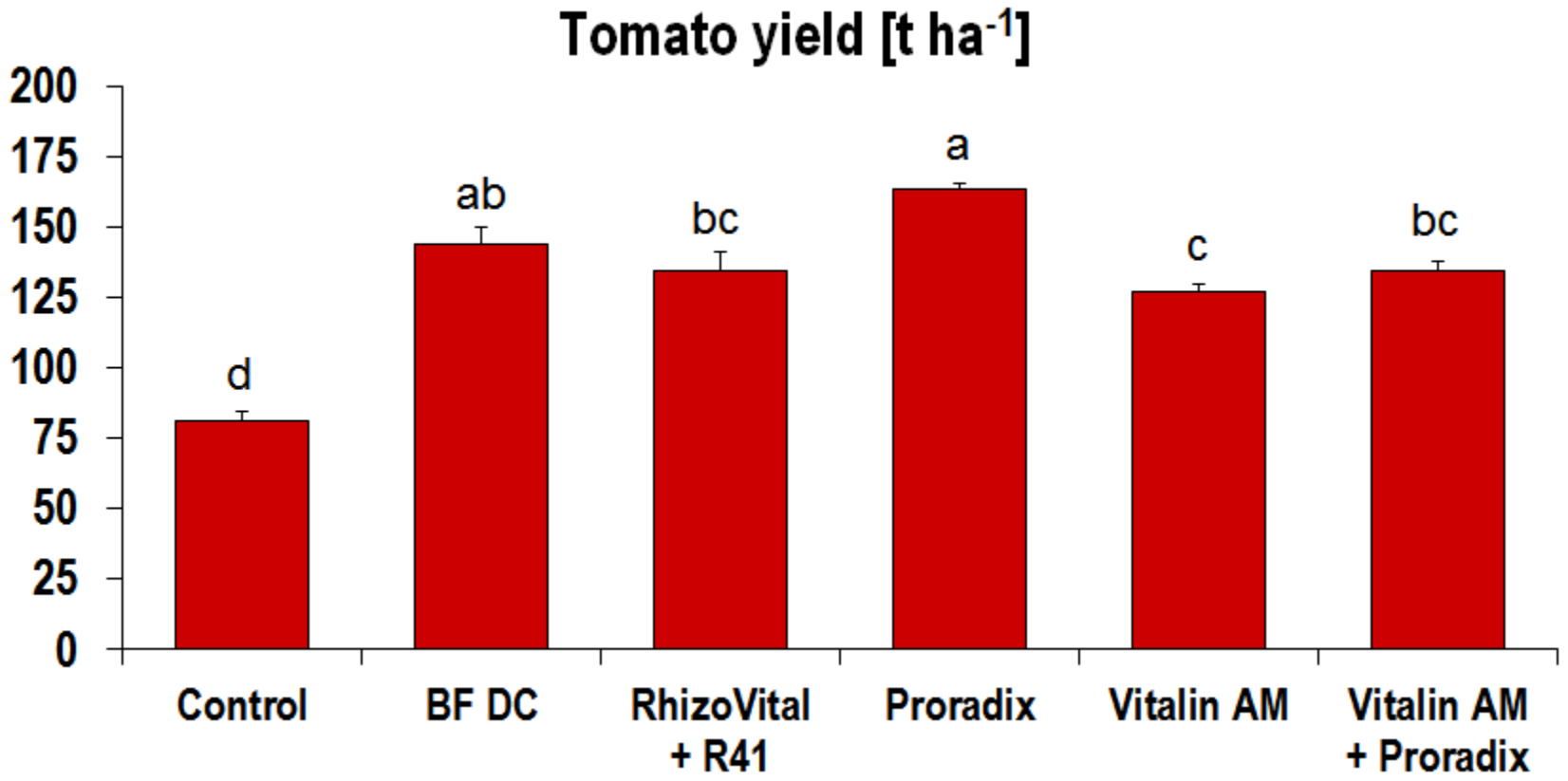
Tomato greenhouse trial

Results from the production phase



Poşta et al. (in preparation)

Bio-effector treatments induced strong yield increased in tomato production (Tukey test, $p < 0.05$, data not normally distributed)

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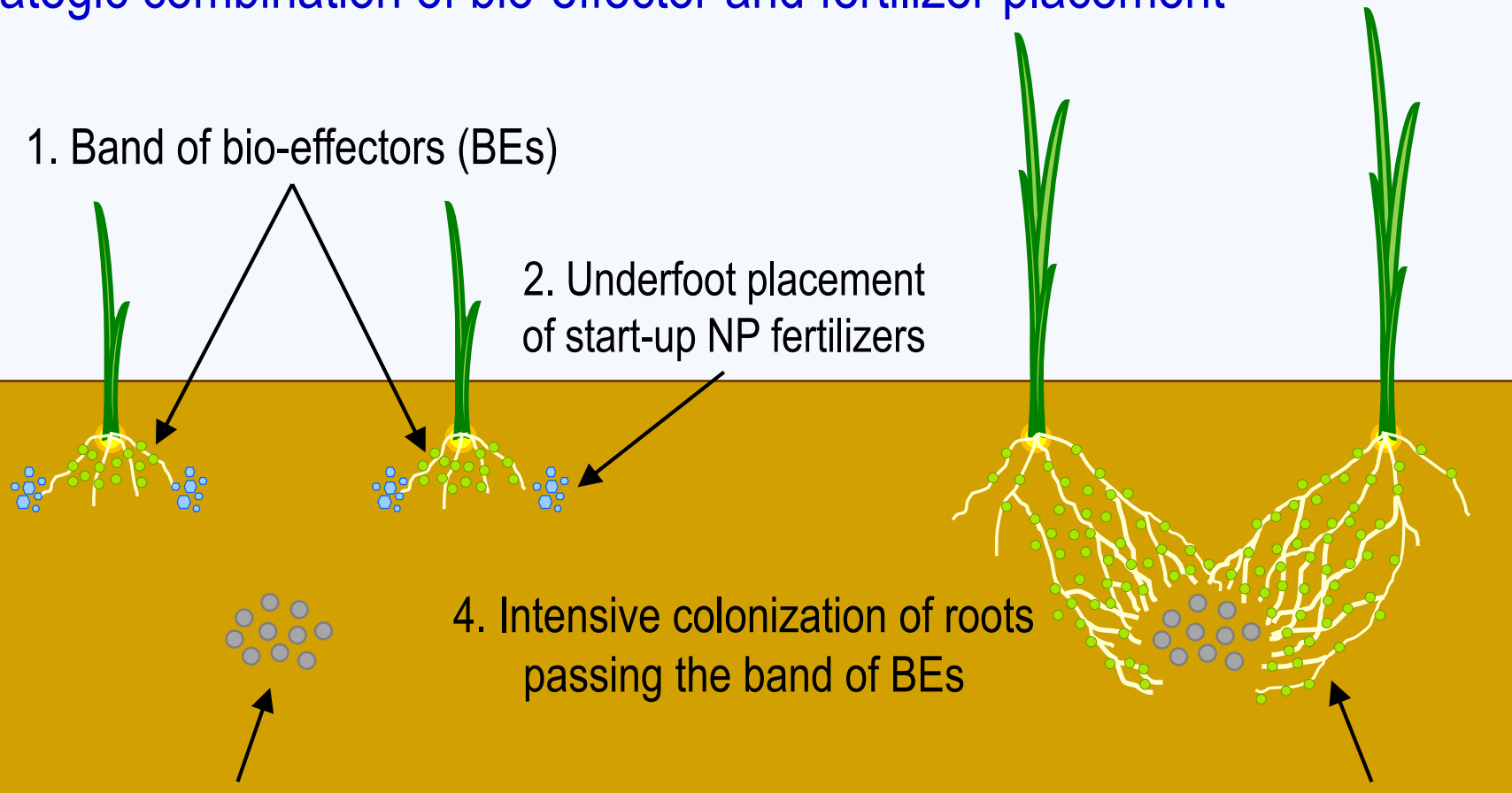
Placement strategies in Maize

Strategic combination of bio-effector and fertilizer placement



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Placement strategies in Maize

Rooting density

CULTAN depots induced the formation of dense rooting zones

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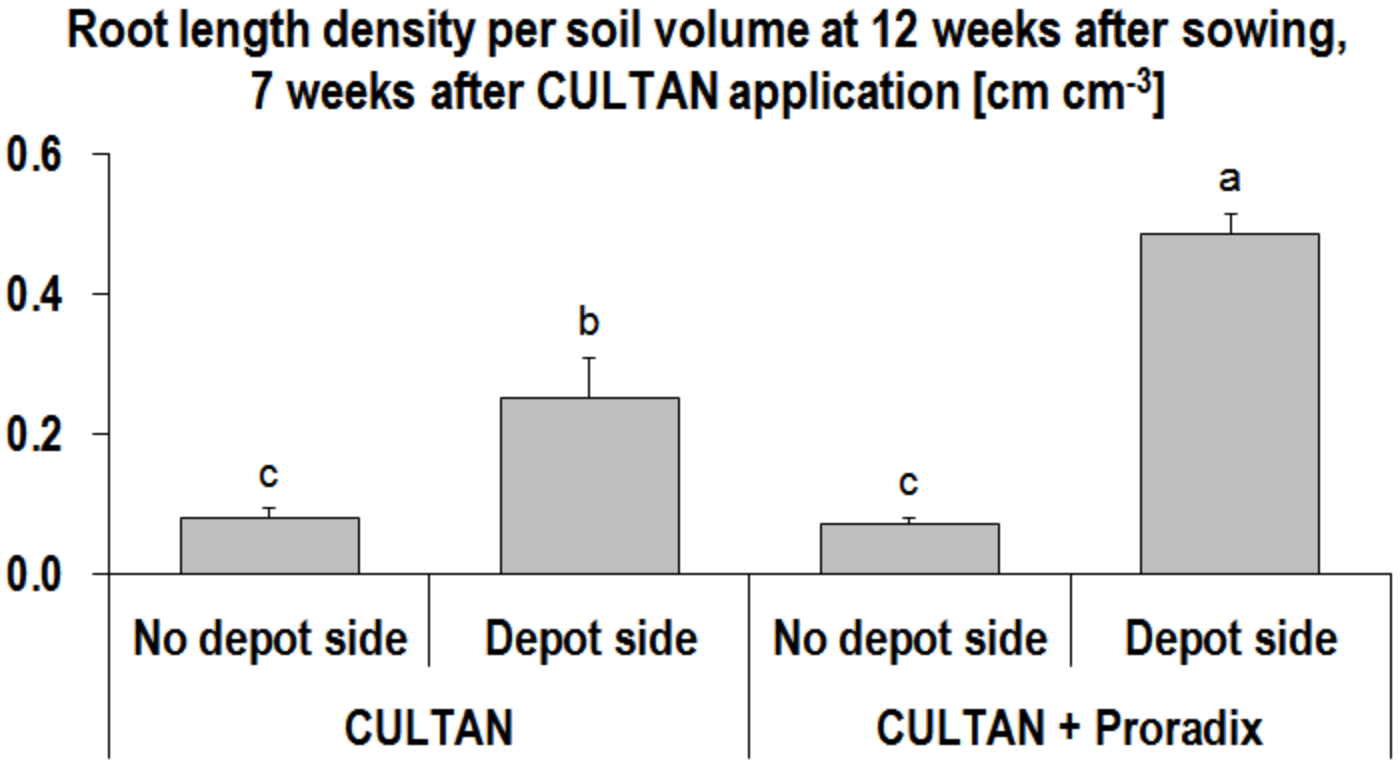
Placement strategies in Maize



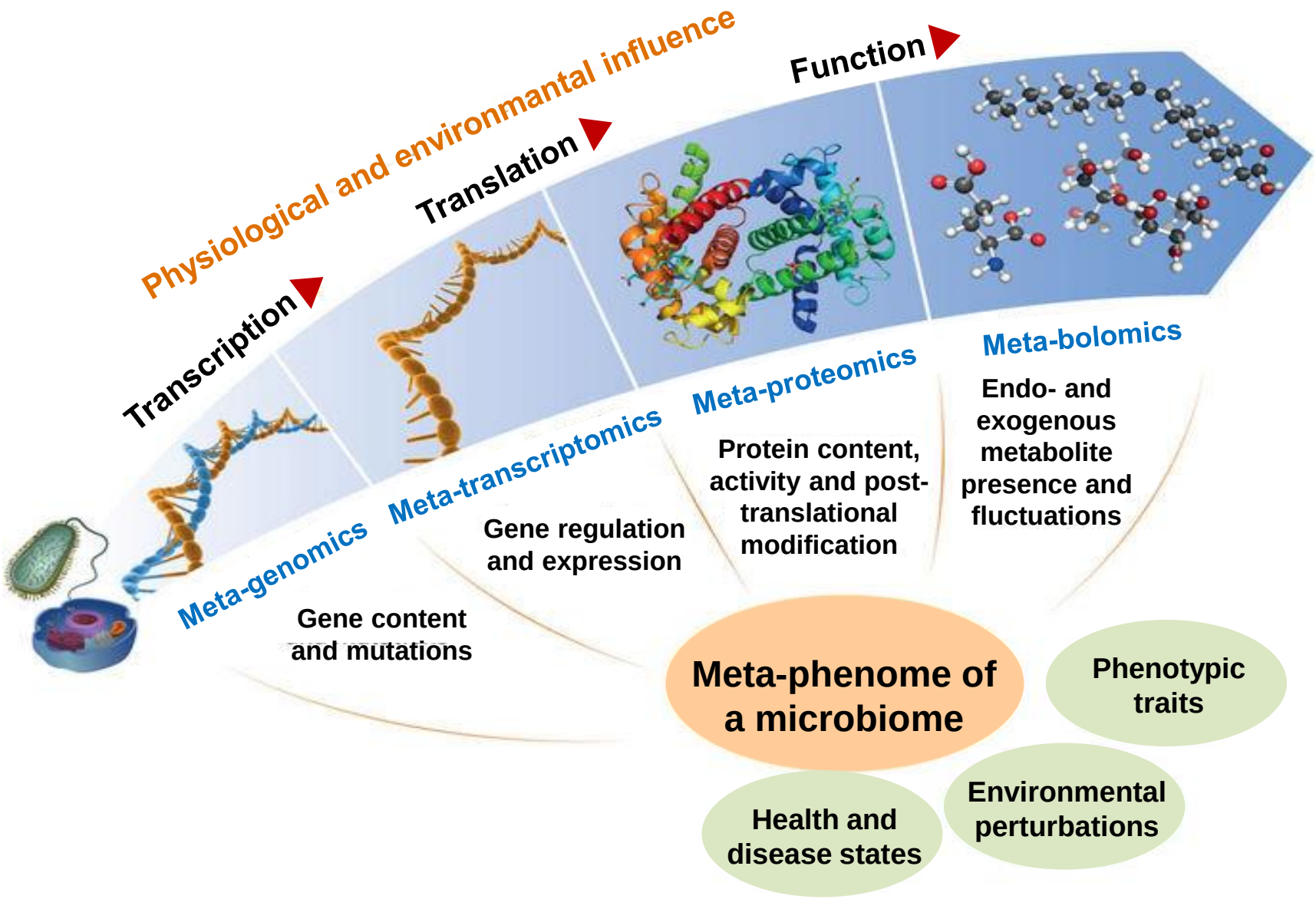
Higher root density at the depot side compared to the side without depot.
Proradix® further increased the root density at the depot side.

(Tukey test; $p < 0.05$; data not normally distributed)

Nkebiwe et al. (2016)

BIOFECTOR is funded by the European Union within the 7th Framework Programme, Grant Agreement No. 312117

Microbiomes are Meta-Phenomena:

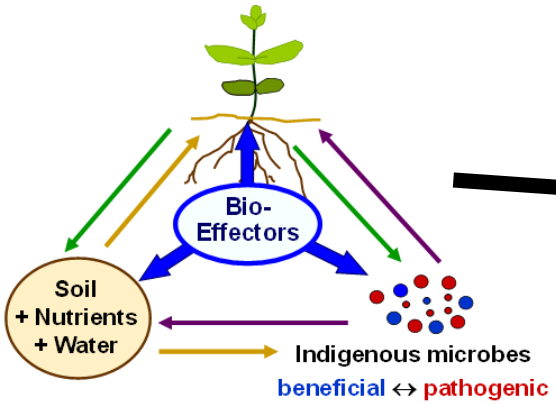


Jansson and Baker (2016). Nature Microbiology 1, 16049

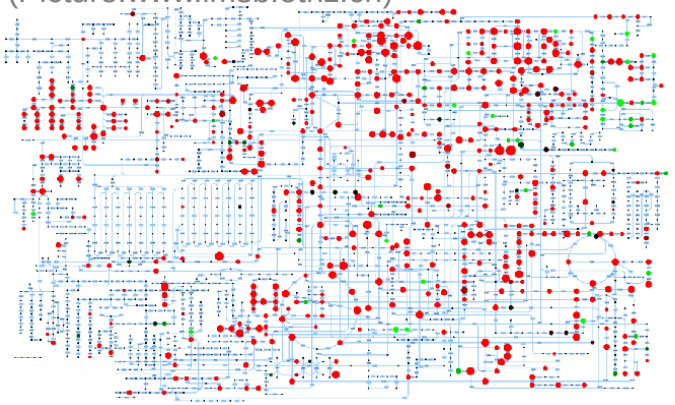
Better understanding of functional traits by multi-omics ?

Future Grand Challenge ?

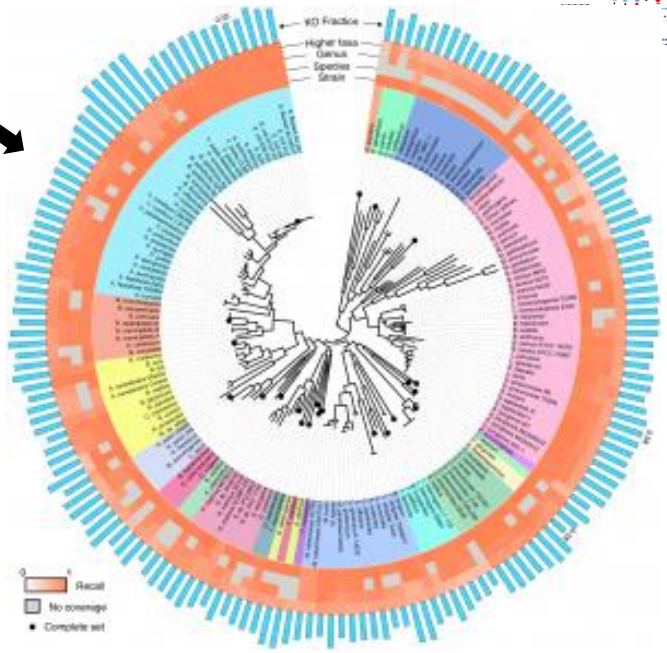
Meta-Analyses to evaluate Multi-Omics BIG DATA !



(Picture:www.imsb.ethz.ch)

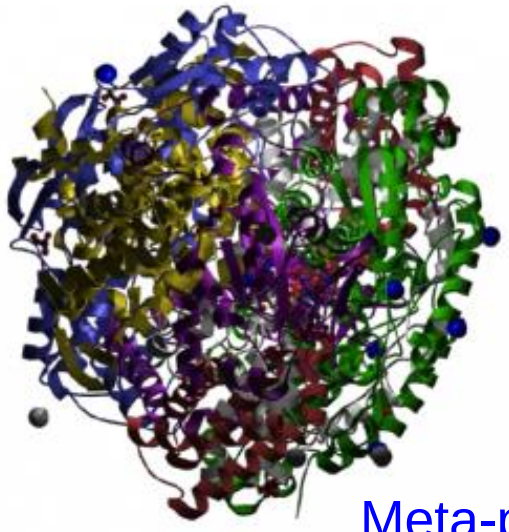


Meta-bolomics:
tens of thousands of metabolites



Meta-genomics:
millions of genes

(Picture: Carr and Borestein, 2014)

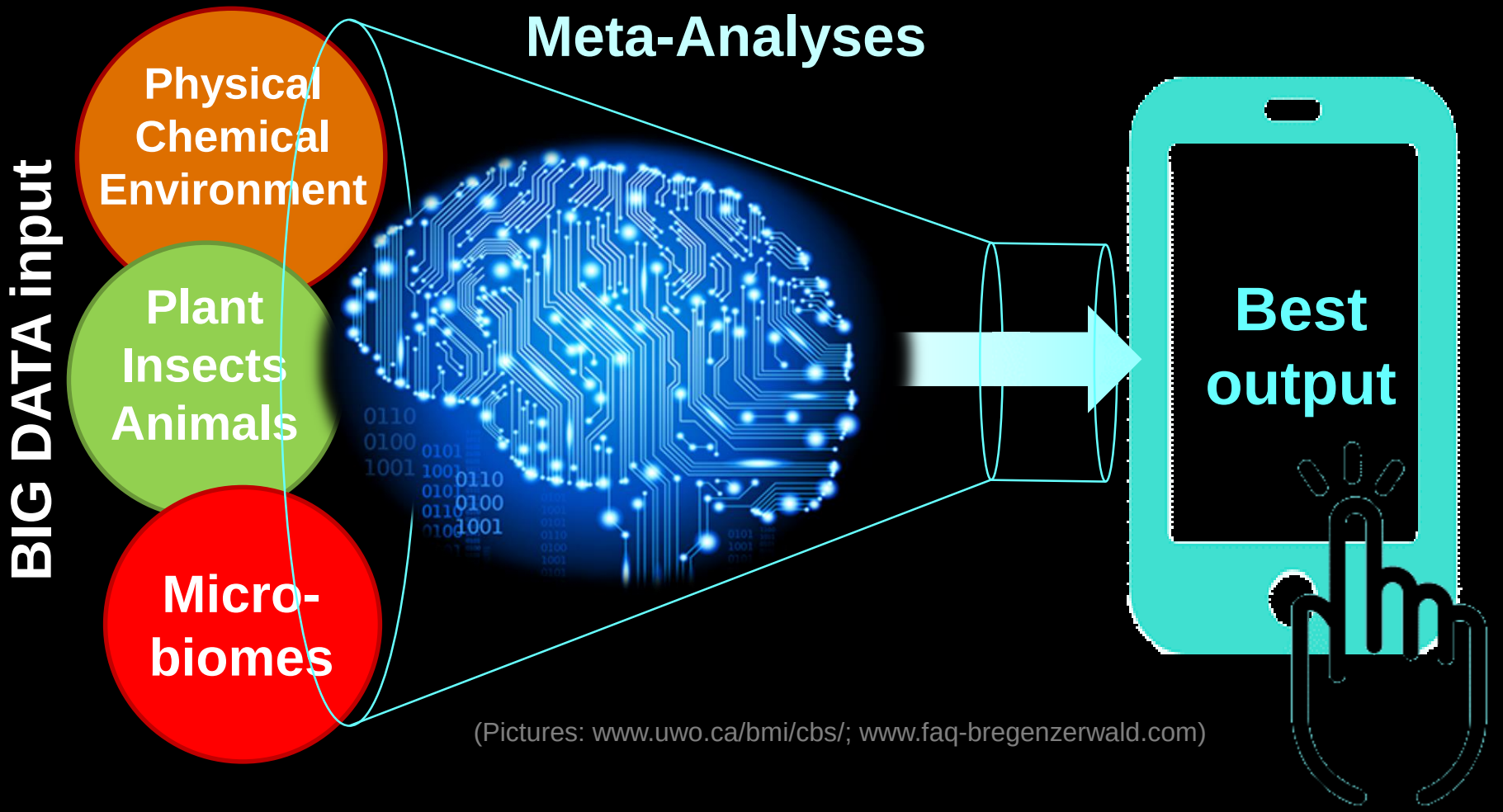


(Picture: www.ruminomics.eu)

Meta-proteomics:
tens of thousands of proteins

Adapted from Jansson (2017) miCROPe, Vienna

Vision of an Evidence Based Agricultural Science



Producing recommendations based on computational management of empirical data or reason-able learning?

Are Meta-Physical Questions Dispensable in a holistic Meta-Worldview ?

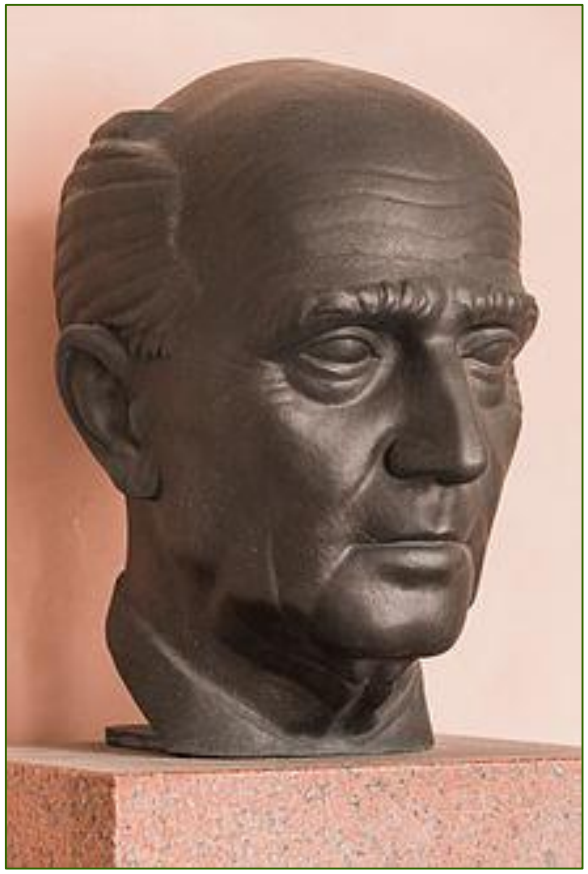
- **What is the best (n or n + 1) ?**
- **What is the optimal ?**
  - Individual ↔ social interests
  - Economic ↔ ecological imperatives
- **What is justice ?**
  - Objective criteria
  - Distinction of good ↔ bad
- **What enables true knowledge?**
  - Empirism (posteriori)
  - Reason-ability (apriori)

(Picture: Raffael, 1510-1511)

(Picture: Camille Flammarions, 1888)

Legal Positivism [from Latin ponere, 'to put']

Laws are commands of human beings recognized as legal authorities



Bust of Hans Kelsen 1881-1973,
University of Vienna

"*Nature is an aggregate of objective data linked together in terms of cause and effect*"

Norms can only come from the will.

Nature can only contain norms if a will had put them there.

This would presuppose a Creator God, whose will had entered into nature.

Cited from: Benedict XVI, German Bundestag, 2011

Legislation of Bio-pesticides in the European Union

REGULATION (EC) No 1107/2009: concerning the placing of **plant protection products** on the market

Article 2.2:

"*… shall apply to substances, including* ***micro-organisms having general or specific action*** *against harmful organisms …*"

Article 77, ***Guidance documents:***

"The Commission may, …, adopt or **amend** technical and other guidance documents … concerning micro-organisms, pheromones and biological products, for the implementation of this Regulation."

- REG. (EU) No 283/2013: **data requirements** for active substances
  PART B MICRO-ORGANISMS
- REG. (EU) 2017/1432 **approval of low-risk active substances**

Scientific understanding of “Bio-logical control”

Bio = living → activity of living organisms

Bio = biotic → mechanisms, processes and products related to living organisms

Bio = biological → reason-able use of knowledge on living organisms and their vital processes

“*Biological control is **based on human’s understanding** of living organisms which is implemented for the purposeful management of natural controls …*”

(Barbosa and Braxton, 1993)

Legislation of Bio-stimulants and Bio-fertilizers

Proposal for a REGULATION (EC) laying down rules on the making available on the market of CE marked fertilizing products

Bio-stimulants: are not as such nutrients (independent of the nutrient content), but nevertheless stimulate plant nutrition processes tolerance to abiotic stresses, quality traits

Bio-fertilizers: not extra defined (included under bio-stimulants)

Positive list for Microorganisms:

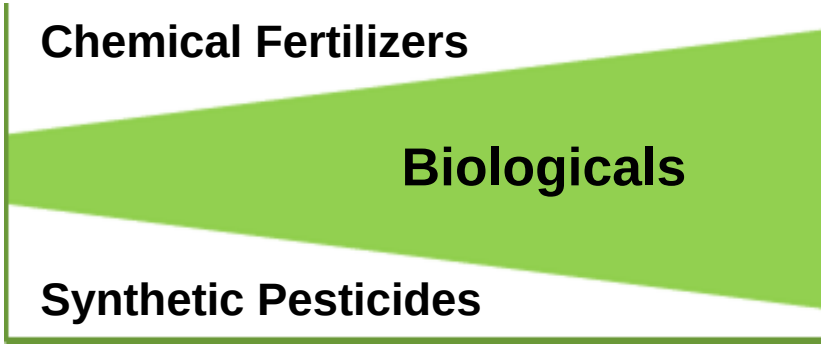
- *Azotobacter* spp.
- Mycorrhizal fungi
- *Rhizobium* spp.
- *Azospirillum* spp.

Ravensberg (2017), miCROPe, Vienna

Outlook on the role of bio-logicals in agriculture

Increasing interest from big companies and regulatory authorities

- Success rates screening of new microbial products 100 times higher than for chemical compounds
- Costs for product development 10 times lower
- Are regulatory policies compromising future developments?



The global market for agricultural “biologicals” has been estimated to be worth 15 billion US $ in 2016 and is projected to reach 20 billion US $ by 2021 (CAGR of 6 %).

Bio-pesticides having the largest share.

(Agra-Europe, 2017; Market Data Forecast, 2017; Ravensberg, miCROPe, 2017)

Conclusions

- A strict legal categorization as bio-pesticides or bio-stimulants (bio-fertilizers) may hamper a holistic view of plant ecology and agricultural problem-solving

- A one-sided functional classification of microbial agents as bio-pesticides would disregard many of their other beneficial traits that could be reasonably used in integrated strategies for sustainable plant nutrition.

- The term “bio-effector” is more appropriate when the active agent and not the purpose of a specific application is meant

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Cordial Thanks for Your Attention !

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