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

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

“\textit{In the beginning was the Word, …}”
\hfill (John 1,1)

\begin{itemize}
\item \textbf{Bio}: from Greek βίος, bios, ‘life’
\item \textbf{Logical}: from Greek λόγος, logos, ‘word, reason’
\item \textbf{Rational}: from Latin ratio, ‘reason’
\end{itemize}

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

(Picture: Georg Friedrich Kersting, 1829)
What is Reasoning?

“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

Market Overview by DunhamTrimmer

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

Soil
+ Nutrients
+ Water

Bio-Eflectors

Indigenous microbes
beneficial ↔ pathogenic

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
Bio-effector treatments induced strong yield increased in tomato production (Tukey test, p < 0.05, data not normally distributed)
Strategic combination of bio-effector and fertilizer placement

1. Band of bio-effectors (BEs)
2. Underfoot placement of start-up NP fertilizers
3. CULTAN depot to induce localized root proliferation
4. Intensive colonization of roots passing the band of BEs
5. Formation of dense rooting zones around the CULTAN depot

Placement strategies in Maize

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

Rooting density

CULTAN depots induced the formation of dense rooting zones
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)
Microbiomes are Meta-Phenomena:

Meta-phenome of a microbiome

Physiological and environmental influence

Translation

Function

Transcription

Meta-genomics

Gene content and mutations

Meta-transcriptomics

Gene regulation and expression

Meta-proteomics

Protein content, activity and post-translational modification

Meta-bolomics

Endo- and exogenous metabolite presence and fluctuations

Better understanding of functional traits by multi-omics?
Future Grand Challenge?

Meta-Analyses to evaluate Multi-Omics BIG DATA!

Meta-bolomics: tens of thousands of metabolites

Meta-genomics: millions of genes

Meta-proteomics: tens of thousands of proteins

Adapted from Jansson (2017) miCROPe, Vienna

(Picture: Carr and Borestein, 2014)

(Picture: www.imsb.ethz.ch)

Soil + Nutrients + Water

Bio-Effectors

Indigenous microbes
beneficial ↔ pathogenic
Vision of an Evidence Based Agricultural Science

Meta-Analyses

BIG DATA input

Physical Chemical Environment

Plant Insects Animals

Microbiomes

Best output

(Pictures: www.uwo.ca/bmi/cbs/; www.faq-bregenzerwald.com)

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)
Legal Positivism [from Latin ponere, ‘to put’]

Laws are commands of human beings recognized as legal authorities.

“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 $\rightarrow$ activity of living organisms

Bio = biotic $\rightarrow$ mechanisms, processes and products related to living organisms

Bio = biological $\rightarrow$ 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.
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.


References


References


Cordial Thanks for Your Attention!


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