The Fascinating World of Biostimulants

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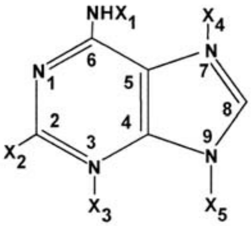
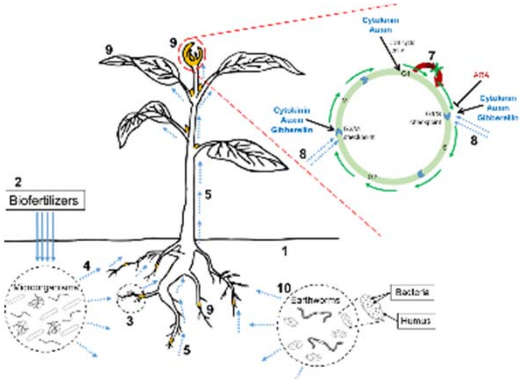


Cytokinins
细胞分裂素

The Fascinating World of Biostimulants or Biologicals



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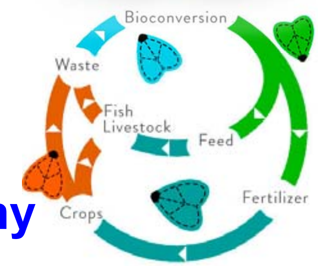
Circular Economy



Hortikulturell produktionsfysiologi (HPF),
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SLU
Swedish University of Agricultural Sciences

Curtin University
Singapore University of Technology and Design
Established in collaboration with MIT
The University of Western Australia
Nanyang Technological University

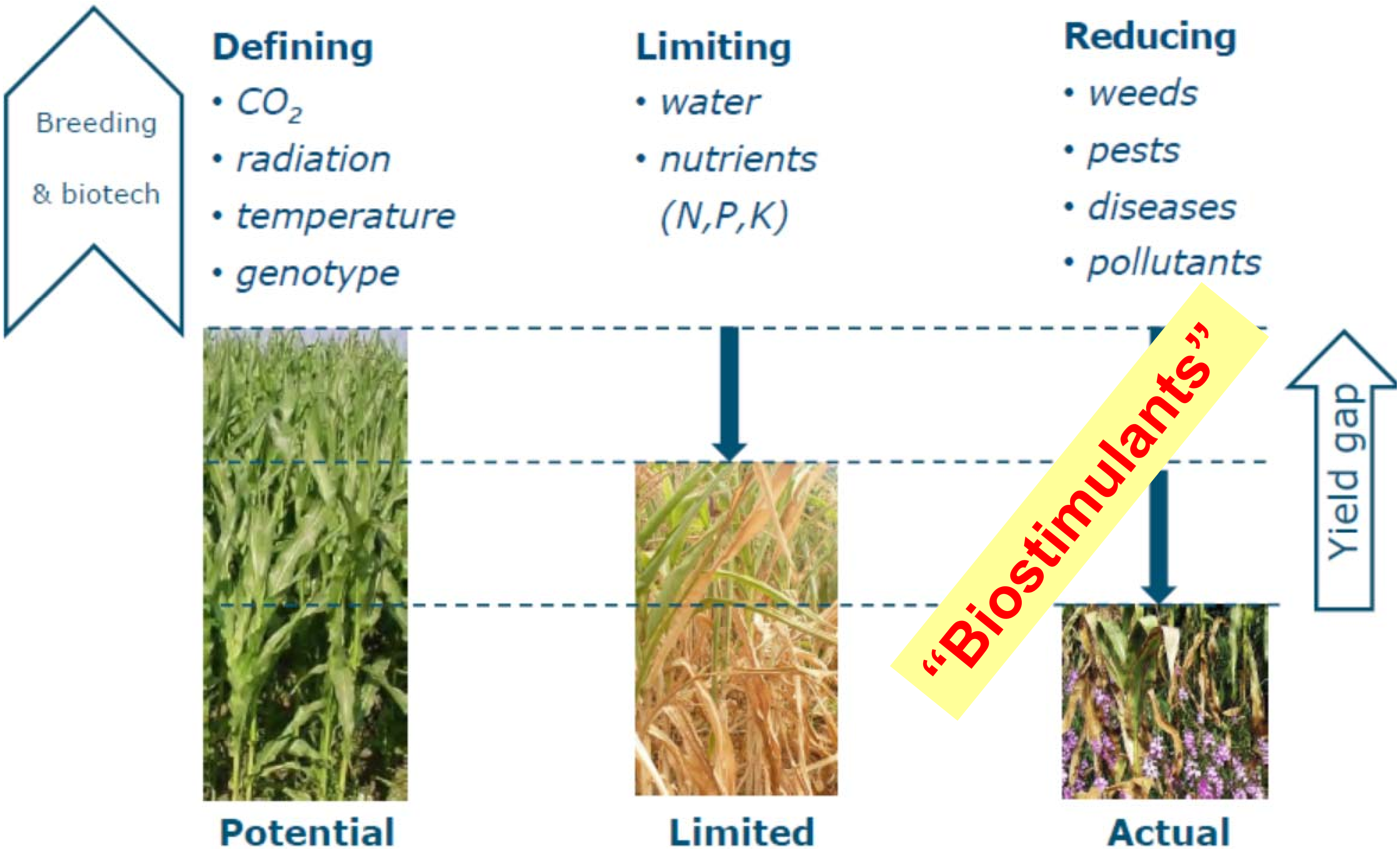
Traditional, Organic/Green Fertilizers

- Composts, Vermi-compost (earthworms)
- Liquid/pellet microbial applications
- Humo-organic

Biostimulants

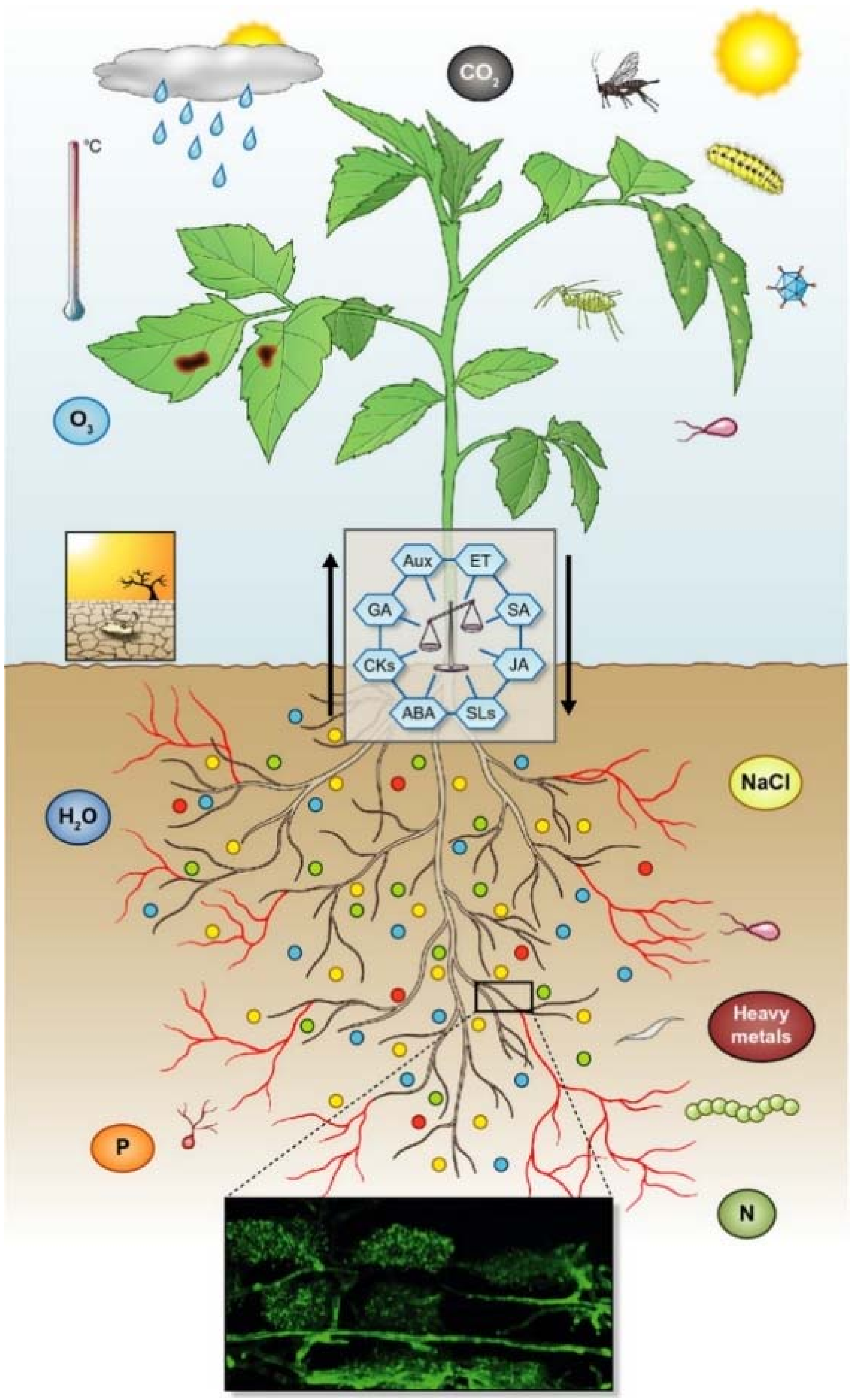
Plant biostimulants are diverse substances and microorganisms used to enhance plant growth.

Yield gap: how to close it?



Van Ittersum & Rabbinge (1997) Field Crops Research

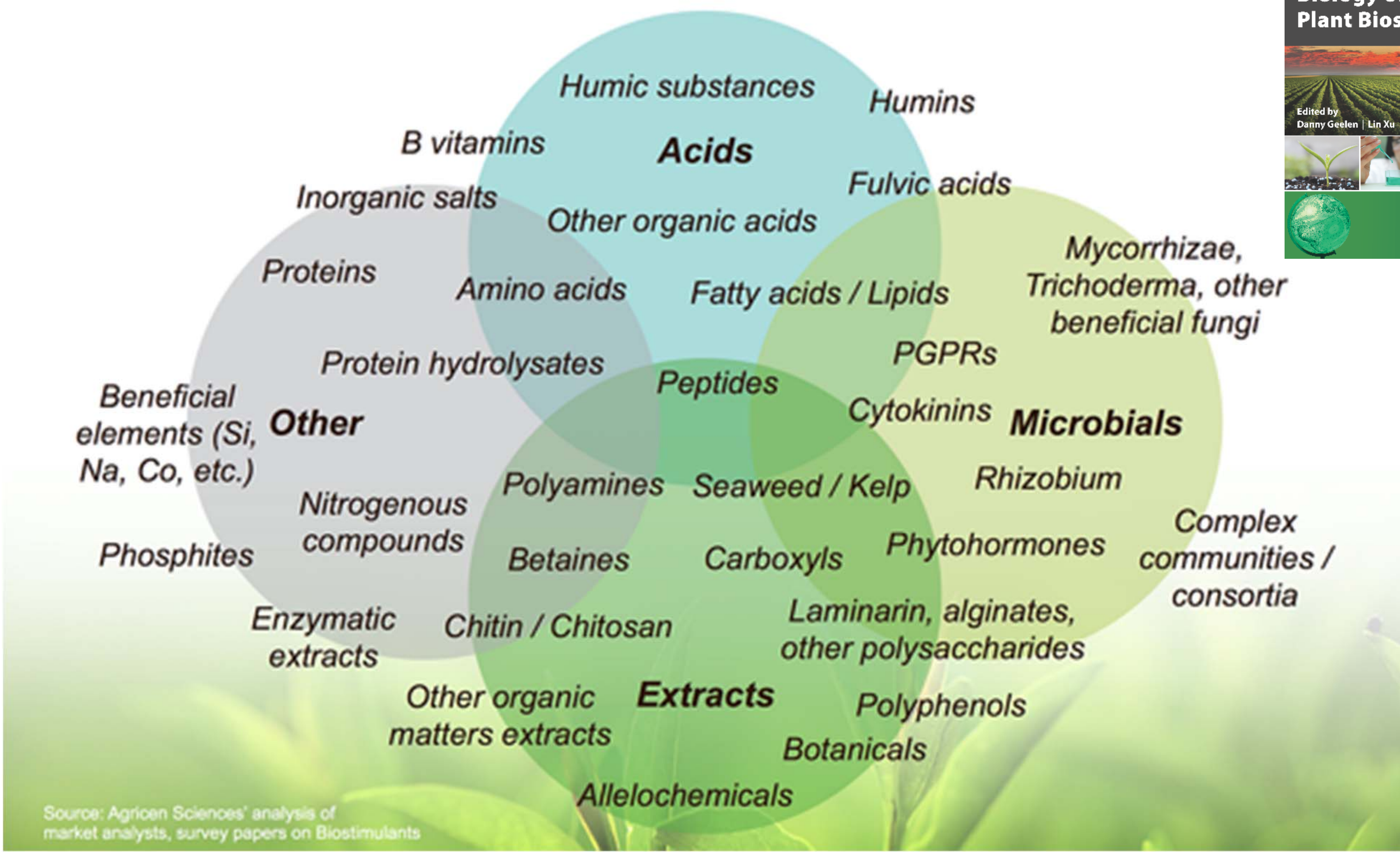
Prof. Van Ittersum – Biostimulant World Congress (2019) address

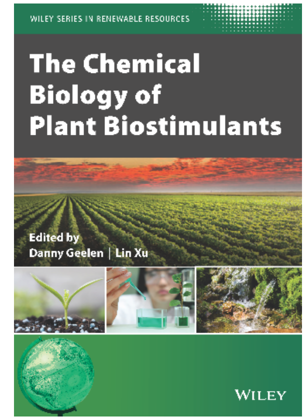


Complexity of Plants' responses

Pozo et al. 2015 (New Phyto)

Huge Diversity of Compounds



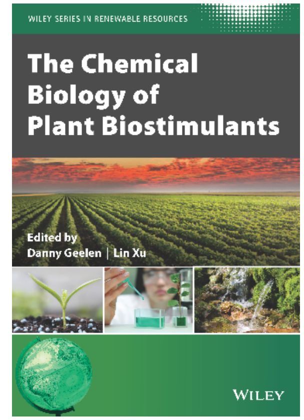


Biostimulants

https://www.agricen.com/agricultural-biostimulants

Biostimulants

Eight categories (Calvo et al. 2014)



- Microbial inoculants
- Humic acids (including Fulvic acids)
- Protein hydrolysates & amino acids (including **MicroProteins**)
- Seaweed extracts
- Complex organic materials (including **Phytohormones**)
- Beneficial chemical elements & Inorganic salts (including phosphite)
- Chitin and chitosan derivatives
- Anti-transpirants

Plant & Soil (2014) Marschner Review

Plant Soil (2014) 383:3–41
DOI 10.1007/s11104-014-2131-8

MARSCHNER REVIEW

Agricultural uses of plant biostimulants

Pamela Calvo · Louise Nelson · Joseph W. Kloepper

Received: 20 December 2013 / Accepted: 25 April 2014 / Published online: 8 May 2014

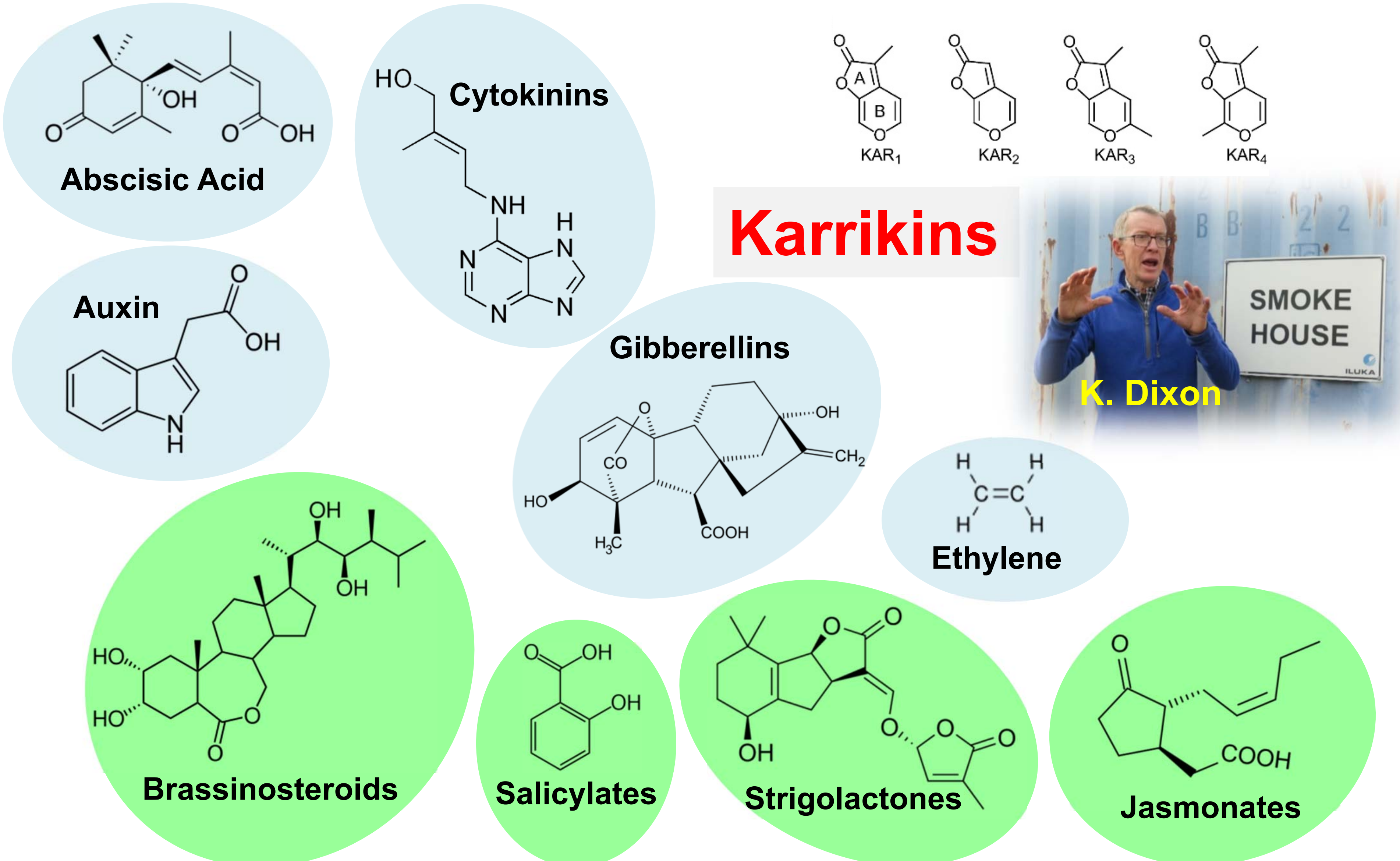
Abstract
Background Plant biostimulants are diverse substances and microorganisms used to enhance plant growth. The global market for biostimulants is projected to increase 12 % per year and reach over $2,200 million by 2018. Despite the growing use of biostimulants in agriculture, many in the scientific community consider biostimulants to be lacking peer-reviewed scientific evaluation.
Scope This article describes the emerging definitions of biostimulants and reviews the literature on five catego-

Keywords Microbial inoculants · Humic acid · Fulvic acid · Protein hydrolysates · Amino acids · Seaweed extracts · Biostimulants

Introduction

Plant biostimulants, or agricultural biostimulants, include diverse substances and microorganisms that enhance plant growth. The global market for biostimulants has been projected to reach $2,241million by 2018 and

Phytohormones – old timers and newcomers



Cell Cycle Control & Cytokinins

Planta (1996) 200: 2–12

Planta
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Cytokinin controls the cell cycle at mitosis by stimulating the tyrosine dephosphorylation and activation of $p34^{cdc2}$-like H1 histone kinase

Kerong Zhang[1], **David S. Letham**[1,2], **Peter C.L. John**[1,2]

[1] Plant Cell Biology Group, Research School of Biological Sciences, The Australian National University, ACT 2601, Australia
[2] Cooperative Research Centre for Plant Science, GPO Box 475, Canberra, ACT 2601, Australia

Received: 27 October 1995/Accepted: 8 January 1996

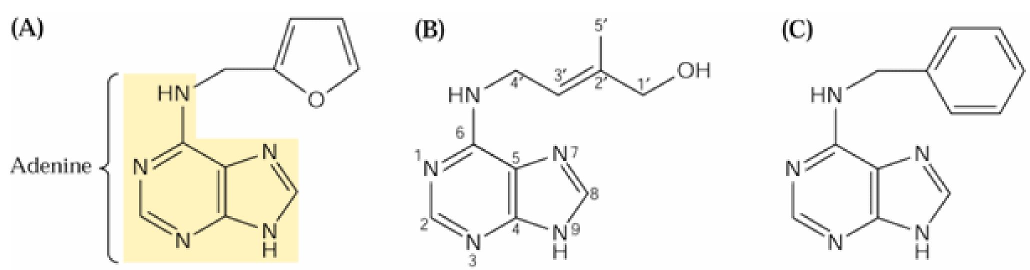
Abstract. In excised pith parenchyma from *Nicotiana tabacum* L. cv. Wisconsin Havana 38, auxin (naphthalene-1-acetic acid) together with cytokinin (6-benzylamino-purine) induced a greater than 40-fold increase in a $p34^{cdc2}$-like protein, recoverable in the $p13^{suc1}$-binding fraction, that had high H1 histone kinase activity, but enzyme induced without cytokinin was inactive. In suspension-cultured *N. plumbaginifolia* Viv., cytokinin (kinetin) was stringently required only in late G2 phase of the cell division cycle (cdc) and cells lacking kinetin arrested in G2 phase with inactive $p34^{cdc2}$-like H1 histone kinase. Control of the Cdc2 kinase by inhibitory tyrosine phosphorylation was indicated by high phosphotyrosine

Introduction

Cell cycle control can be exercised by interaction of the key cell division cycle (cdc) catalyst $p34^{cdc2}$ (the 34-kDa product of the *cdc2* gene) with different cyclin subunits that direct its protein kinase activity to specific substrates (Peeper et al. 1993), by cyclin dependent kinase inhibitor (CKI) proteins (Pines 1995) and by enzymes that control its enzyme activity through phosphorylation (Gould and Nurse 1987; Millar et al. 1991), so providing a likely universal mitotic control (Nurse 1990).

In plants we have noted changes in the level of $p34^{cdc2}$-like protein that are consistent with an hypothesis

D. Stuart Letham



Kinetin

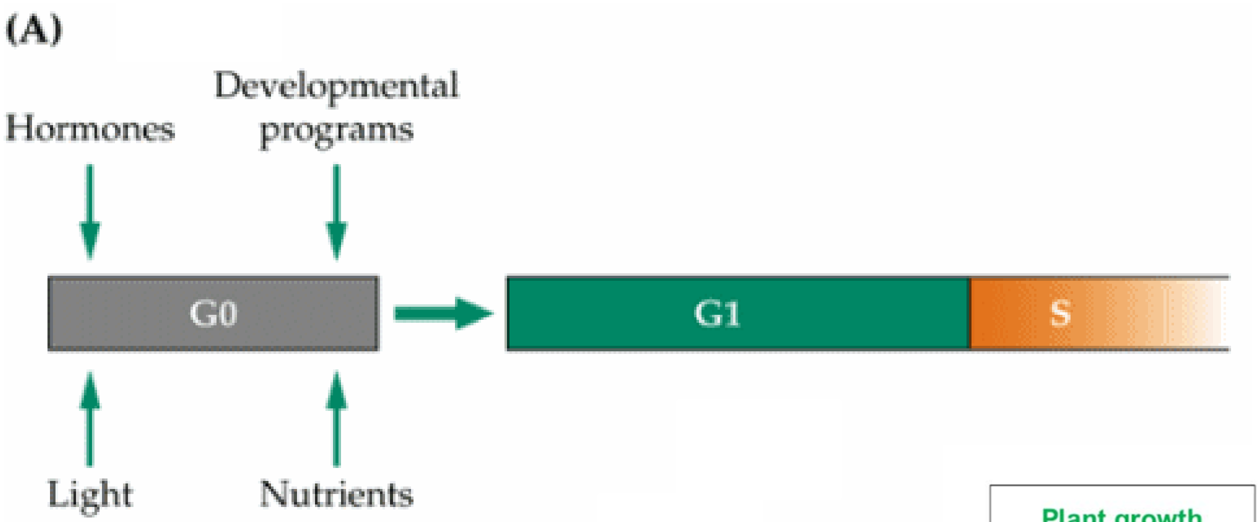
Zeatin

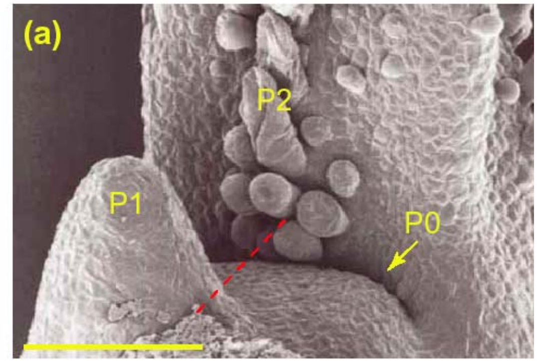
N^6- Benzyladenine

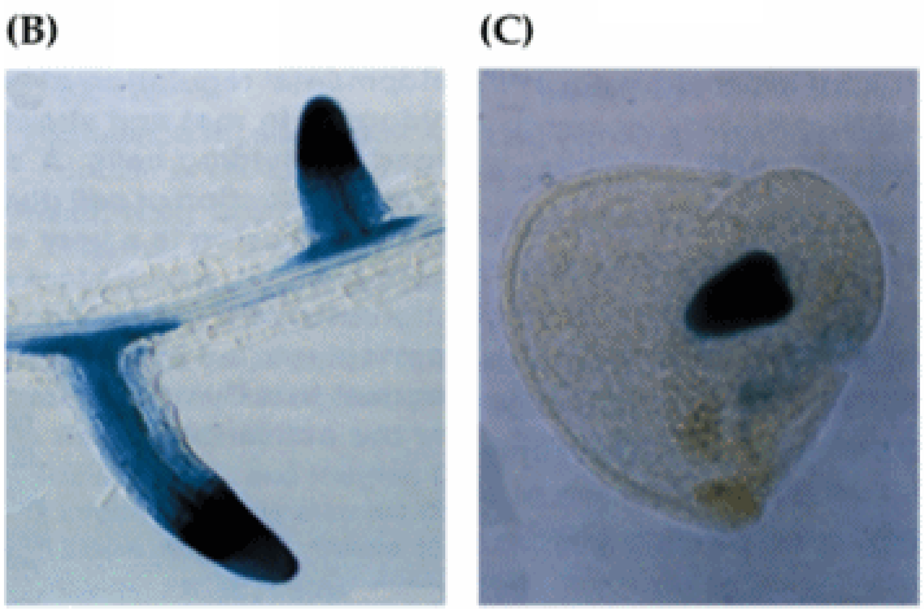
Cytokinins
细胞分裂素

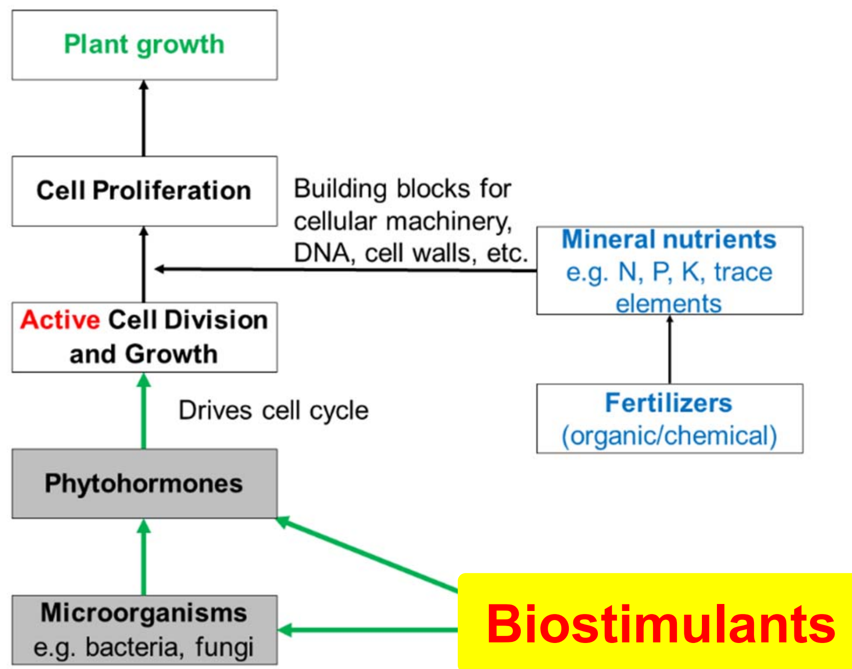
Cytokinins form a major group of **Biostimulants**

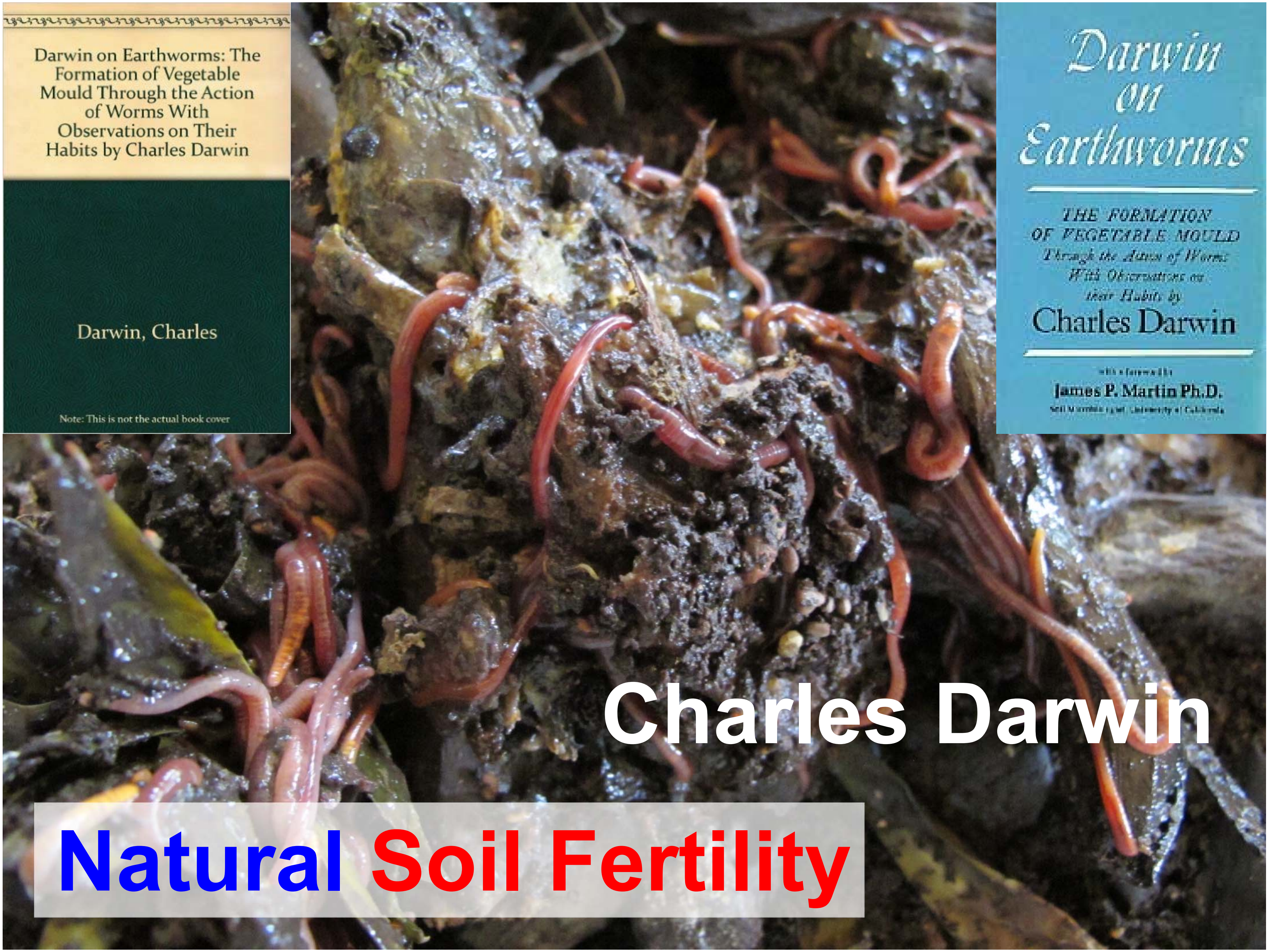
How Phytohormones drive the Cell Cycle?







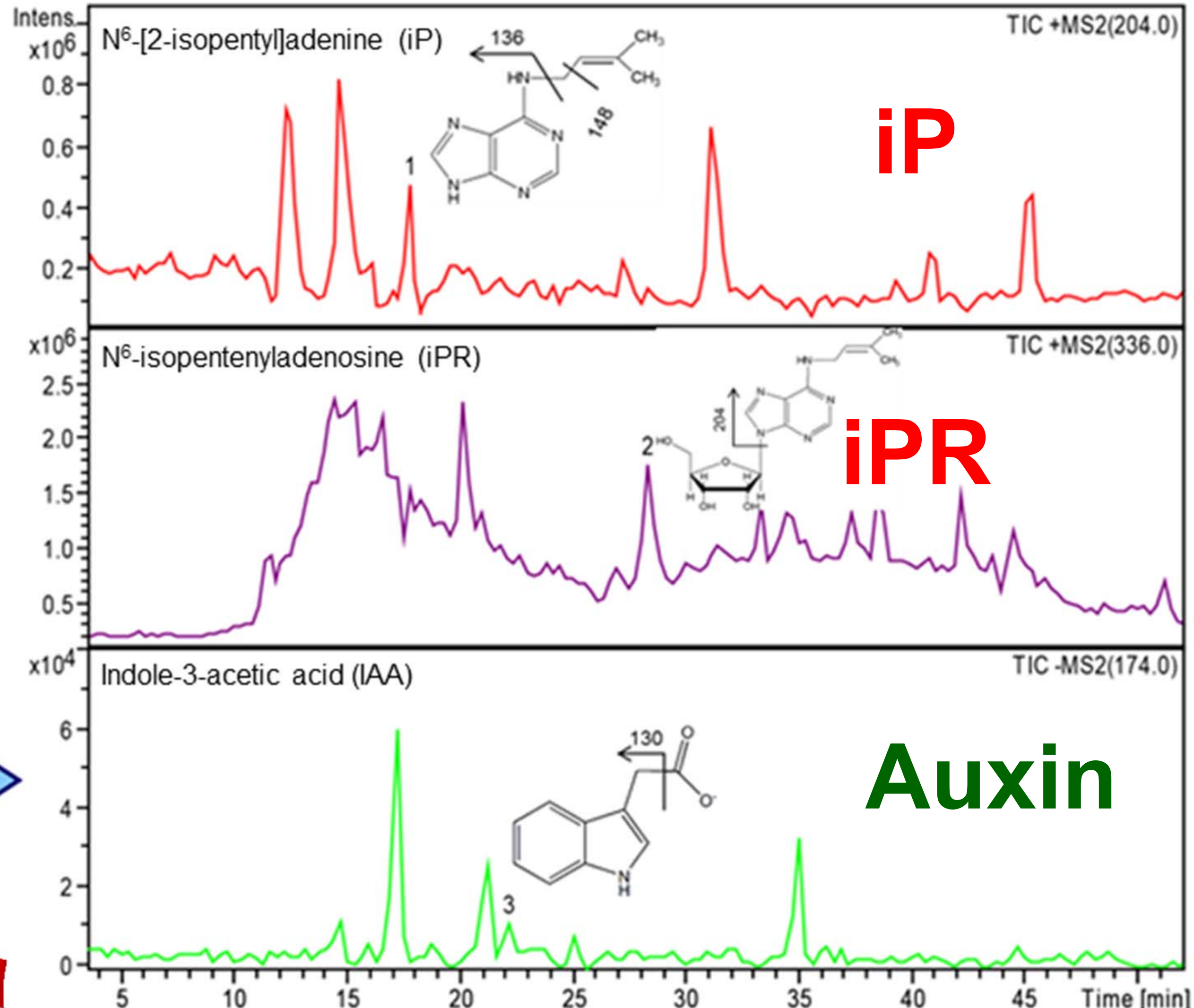



Darwin on Earthworms: The Formation of Vegetable Mould Through the Action of Worms With Observations on Their Habits by Charles Darwin
Darwin, Charles
Note: This is not the actual book cover
Darwin on Earthworms
THE FORMATION OF VEGETABLE MOULD Through the Action of Worms With Observations on their Habits by
Charles Darwin
James P. Martin Ph.D.
Charles Darwin
Natural Soil Fertility

Vermicomposts

1.UAE
2.SPE

LC-MS analysis



Zhang et al. 2015, Talanta

UAE - Ultra-Sound Assisted Extraction

Orchid

In-Vitro flowering

Basic Research

NUS National University of Singapore

Agribusiness – Control of Flowering

Mistletoe

without the host tree

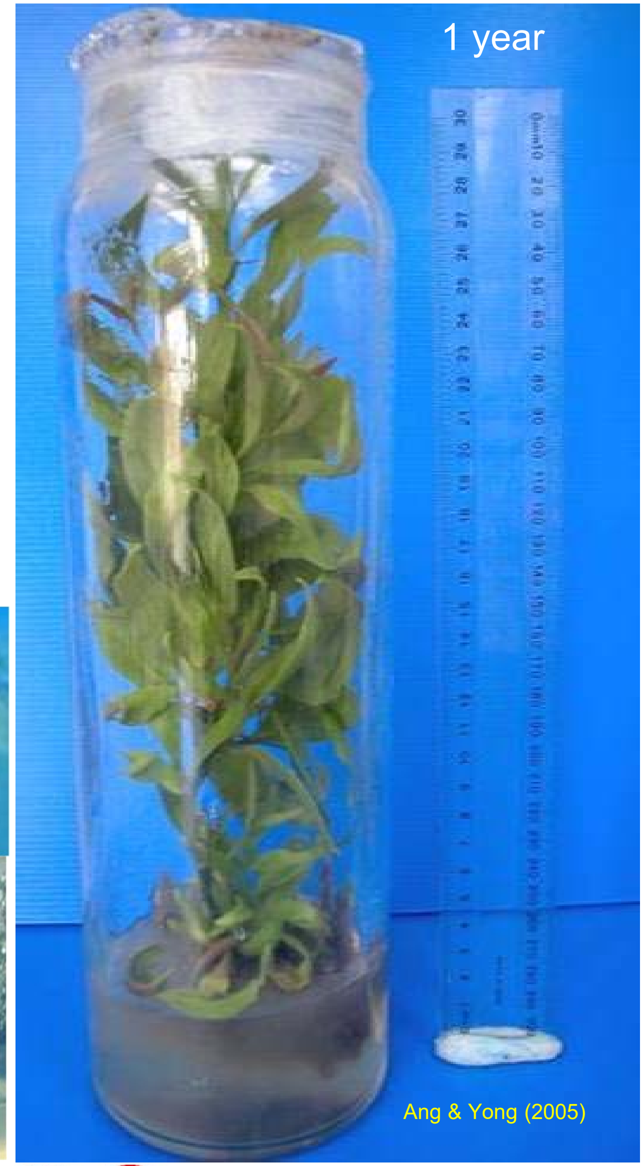
Common Malayan mistletoe

Natural

In-vitro

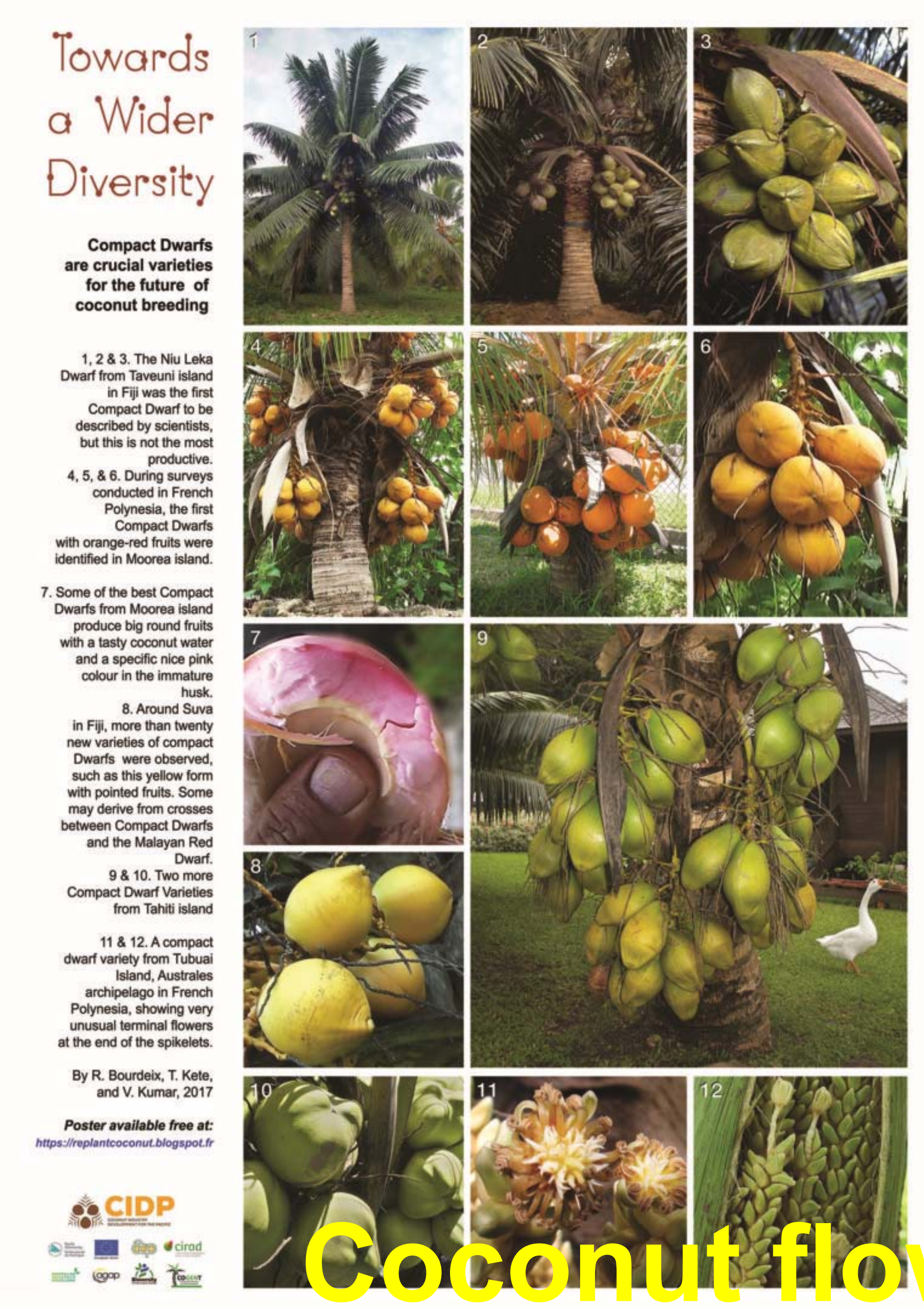
In-vitro

Natural



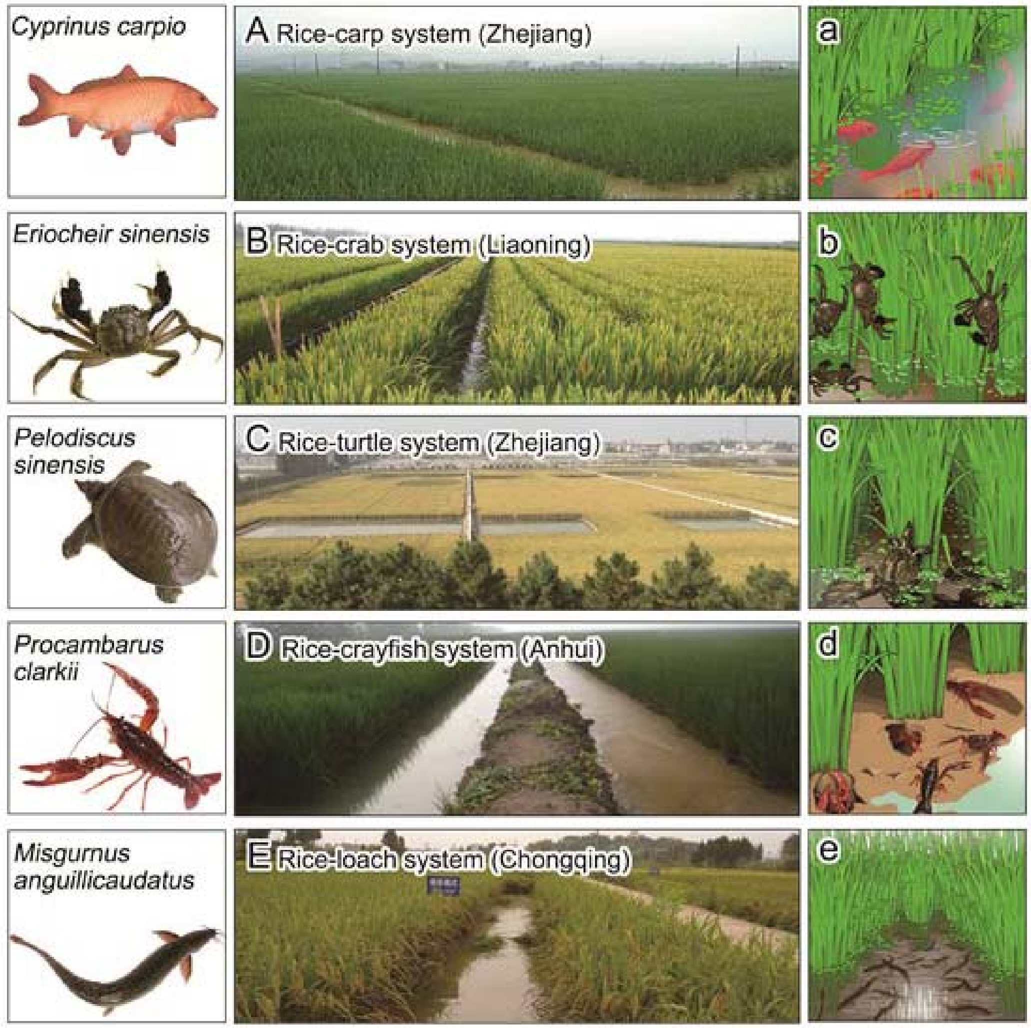
Basic Research

NANYANG TECHNOLOGICAL UNIVERSITY



Coconut flowers & fruits

Are there **natural** Biostimulants in animal waste?



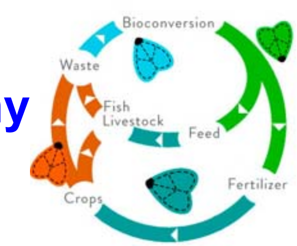
Dr Markus Langeland
(SLU Uppsala)

SCIENTIFIC REPORTS

OPEN **Can the co-cultivation of rice and fish help sustain rice production?**

Liangliang Hu[1,*], Jian Zhang[1,*], Weizheng Ren[1,*], Liang Guo[1], Yongxu Cheng[2], Jiayao Li[2], Kexin Li[3], Zewen Zhu[3], Jiaen Zhang[4], Shiming Luo[4], Lei Cheng[1], Jianjun Tang[1] & Xin Chen[1]

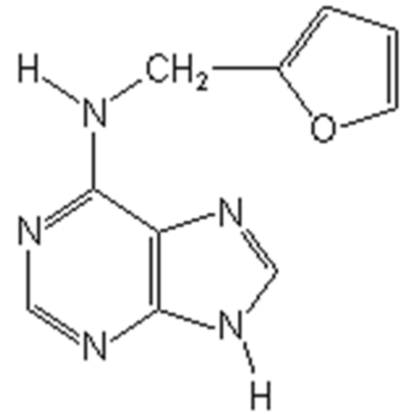
Circular Economy



Jenna Senecal, PhD candidate
(SLU Uppsala)

Dr Cecilia Lalander
(SLU Uppsala)

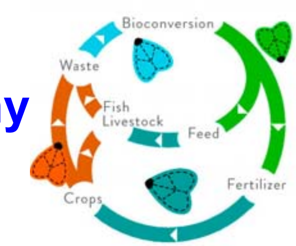
Kinetin

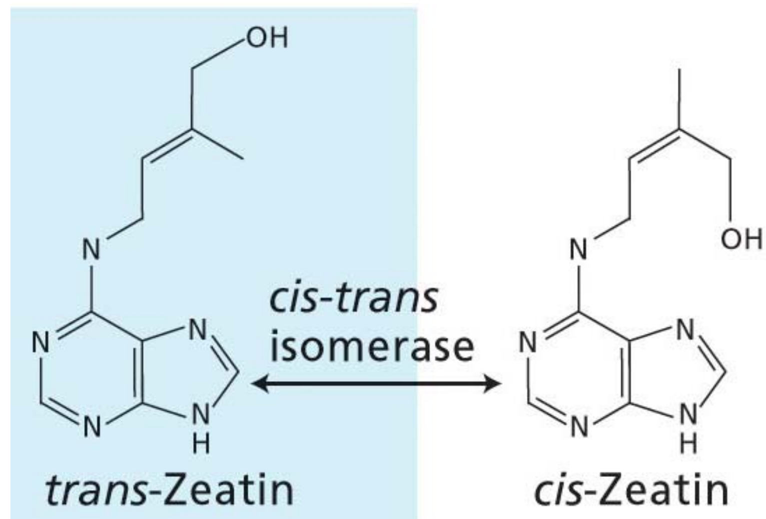


Human urine as a source of

Biostimulants

Circular Economy





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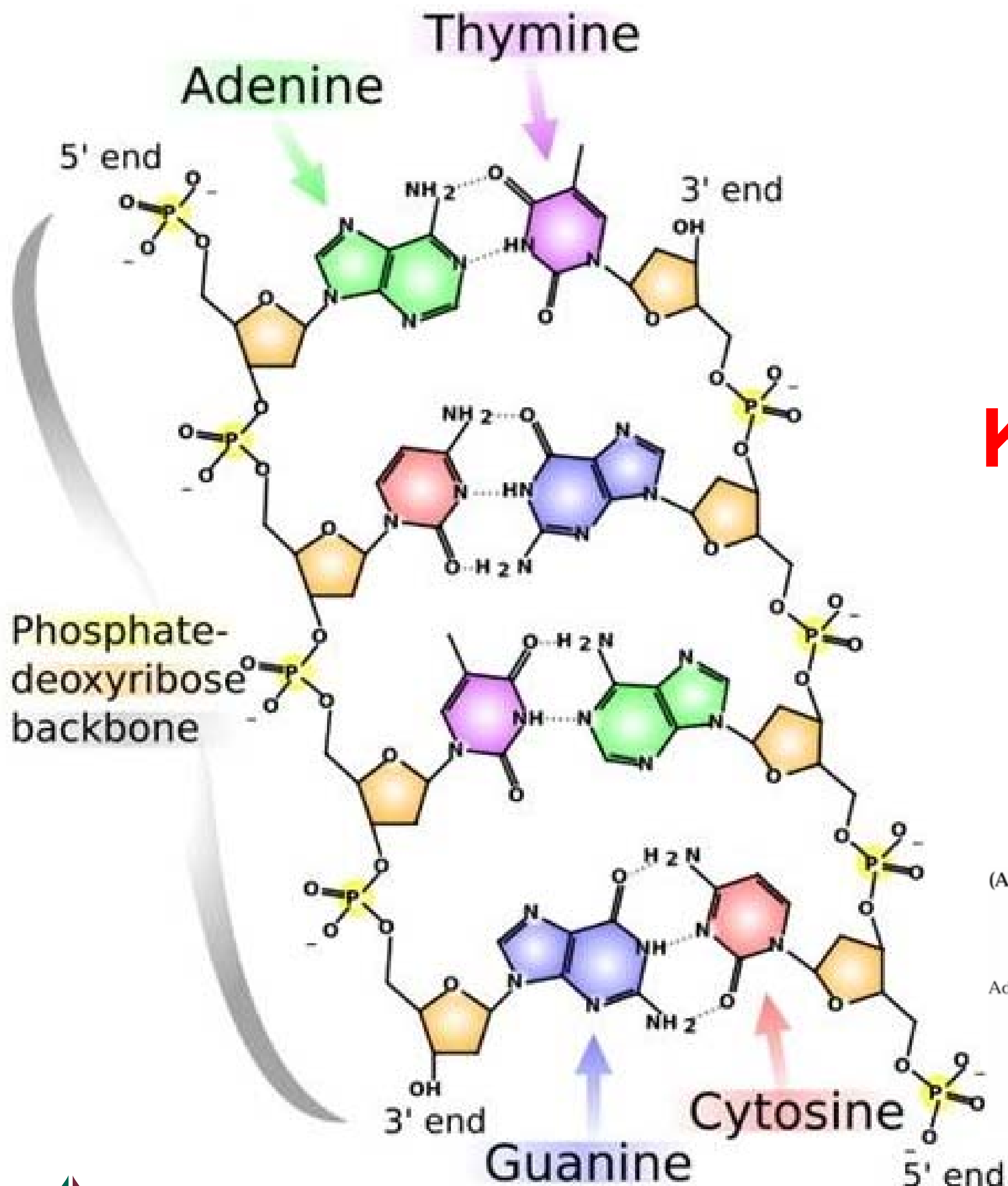
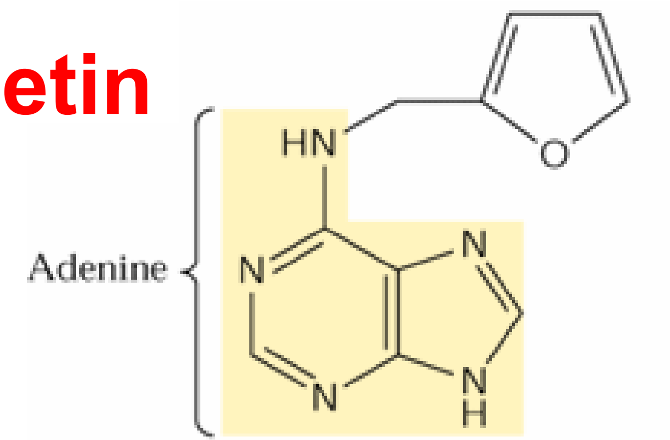
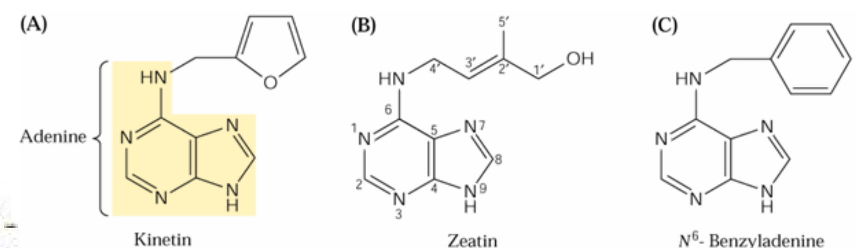
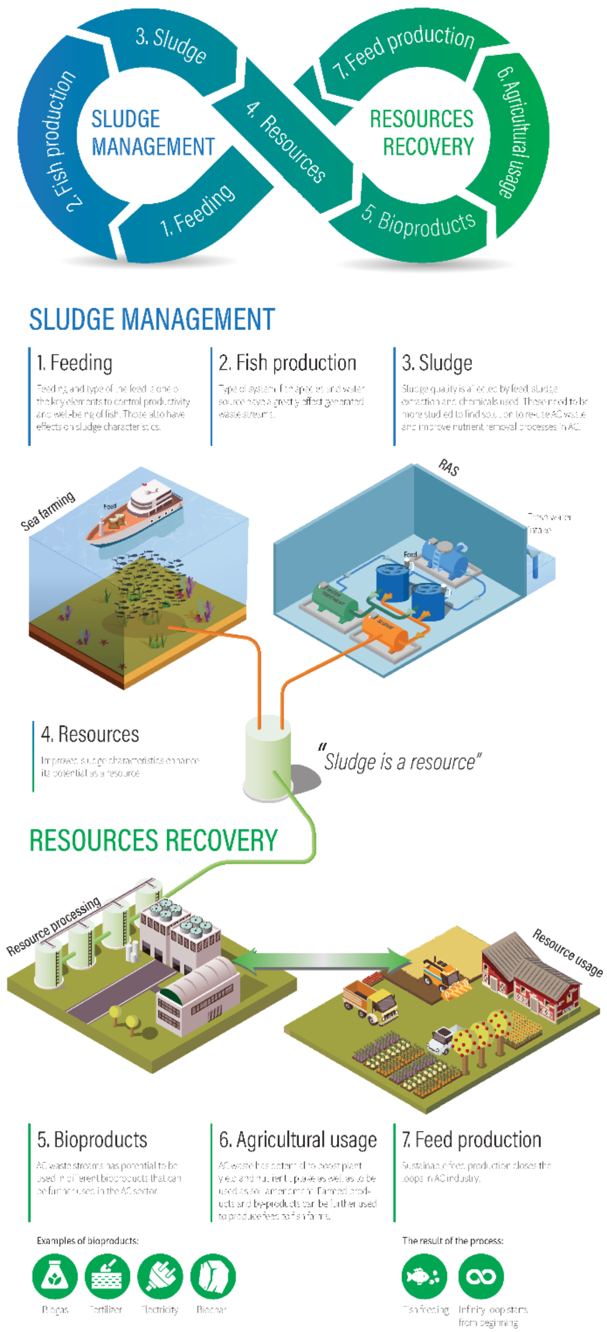
Components of the DNA



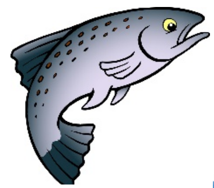
Kinetin

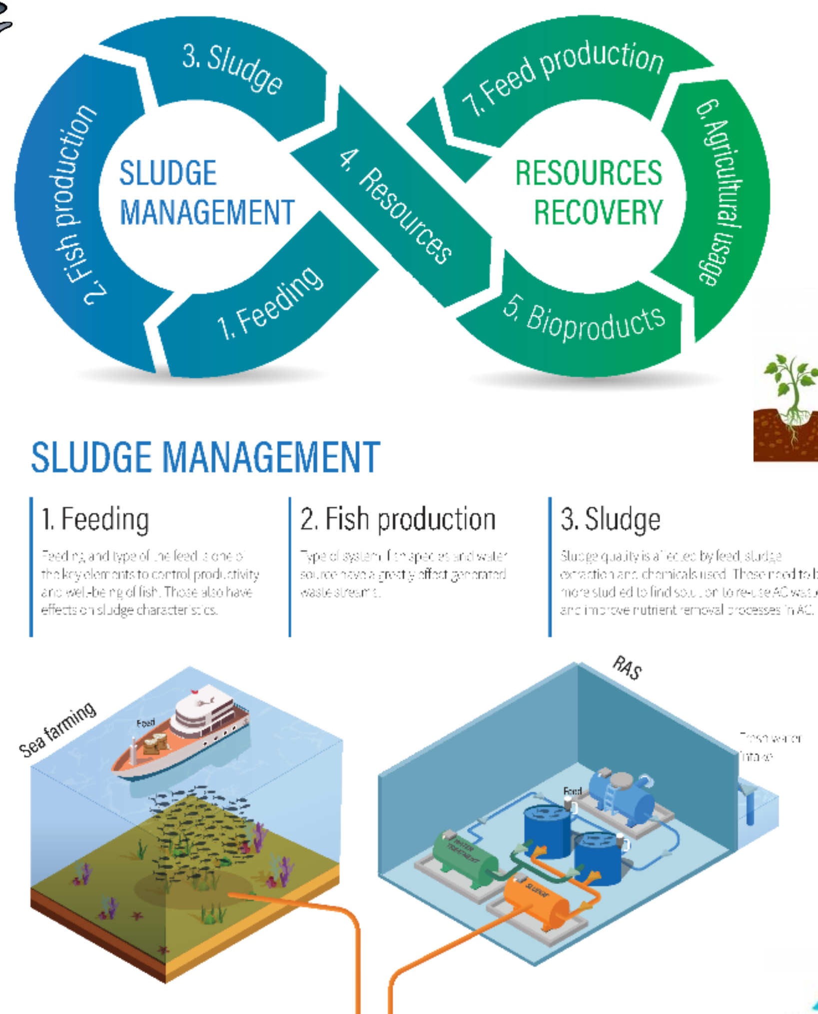


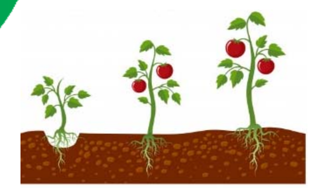




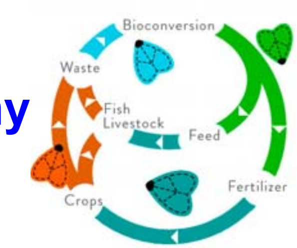
AQUA-FER





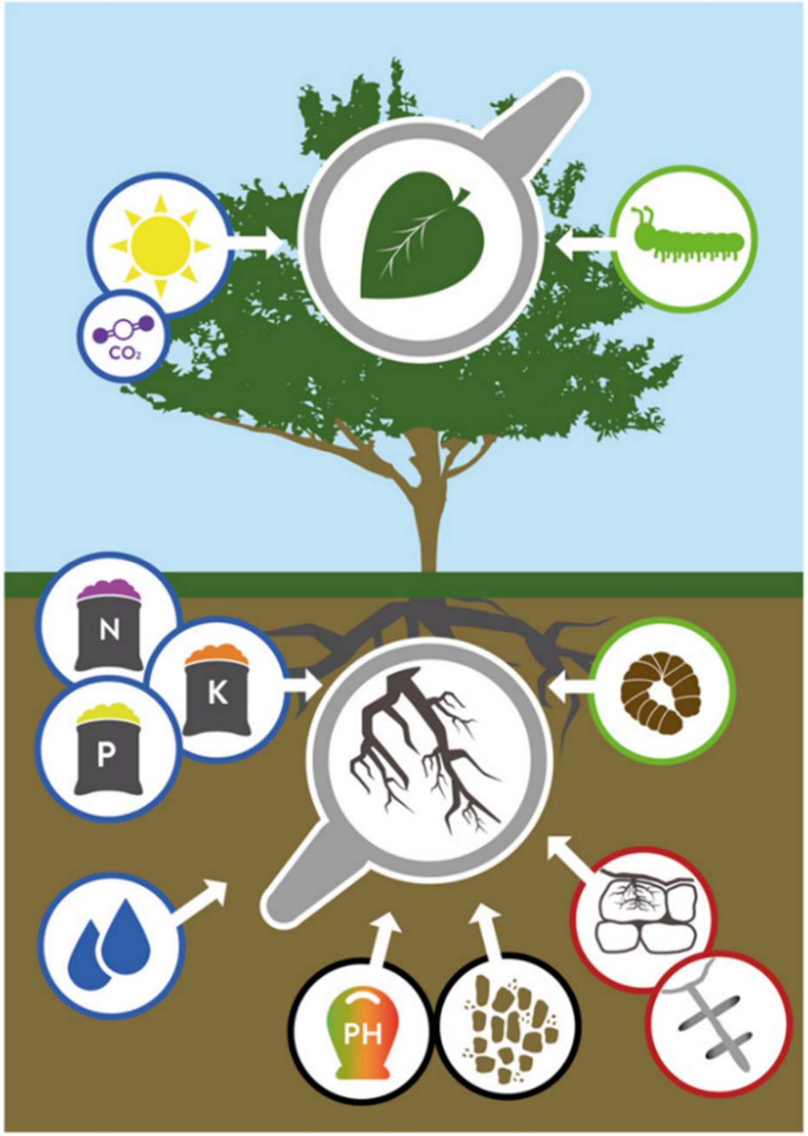


Circular Economy



What is a GOOD "Fertilizer"?

- Essential nutrients
  (Macro - NPK & micro-nutrients as building blocks)
- Improves soil structure & holds water
- Promoting **GROWTH**
  - plant cell division
    (**biostimulants**)
- Reduced incidence of plant diseases



“The true voyage of discovery lies not in finding new landscapes, but in having new eyes.”

- Marcel Proust

Thank You!

For more information,

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Latest update!

Plant Biostimulants in FPR

DEFINITION

"A plant biostimulant shall be an EU fertilising product the function of which is to stimulate plant nutrition processes independently of the product's nutrient content with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere:

(a) nutrient use efficiency,

(b) tolerance to abiotic stress,

(c) quality traits, or

(d) availability of confined nutrients in the soil or rhizosphere."

Dr Theodora Nikolakopoulou, EU Commission

FPR: Fertilizer Product Registration

Latest update!

Plant Biostimulants in FPR

component materials allowed

non-microbial PBs

In principle any of the Component Material Categories (CMCs)

CMC 1: Substances and mixtures, primary
CMC 2: Simple plant parts or extracts
CMC 3: Compost
CMC 4: Energy crop digestate
CMC 5: Other digestate
CMC 6: Food industry by-products
CMC 8: Nutrient polymers
CMC 9: Polymers other than nutrient polymers
CMC 10: Products derived from animal by-products
CMC 11: By-products in the meaning of Directive 2008/98/EC

microbial PBs

Micro-organism listed in CMC 7

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

Dr Theodora Nikolakopoulou, EU Commission

FPR: Fertilizer Product Registration