

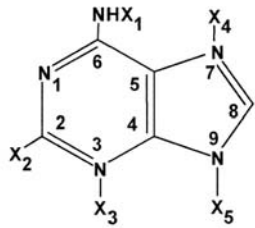
The **Fascinating World** of **Biostimulants**

Jean W. H. Yong (“John” 杨远方)



Hortikulturell produktionsfysiologi (HPF),
Institutionen för biosystem och teknologi

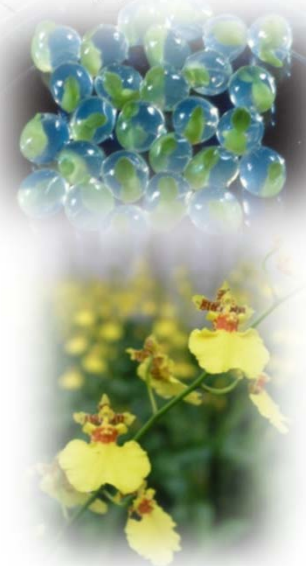
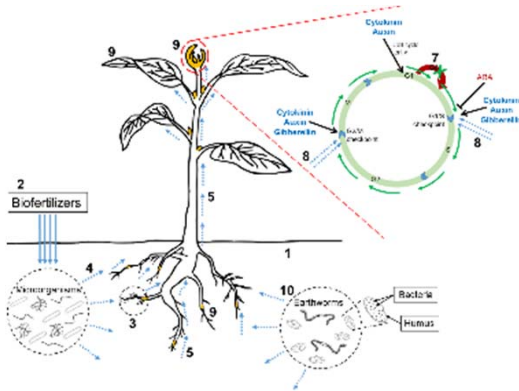
Swedish University of
Agricultural Sciences



Cytokinins
细胞分裂素

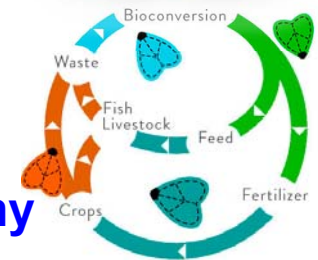


The Fascinating World of Biostimulants or Biologicals



Jean W. H. Yong (“John” 杨远方)

Circular Economy



Hortikulturell produktionsfysiologi (HPF),
Institutionen för biosystem och teknologi



Swedish University of
Agricultural Sciences



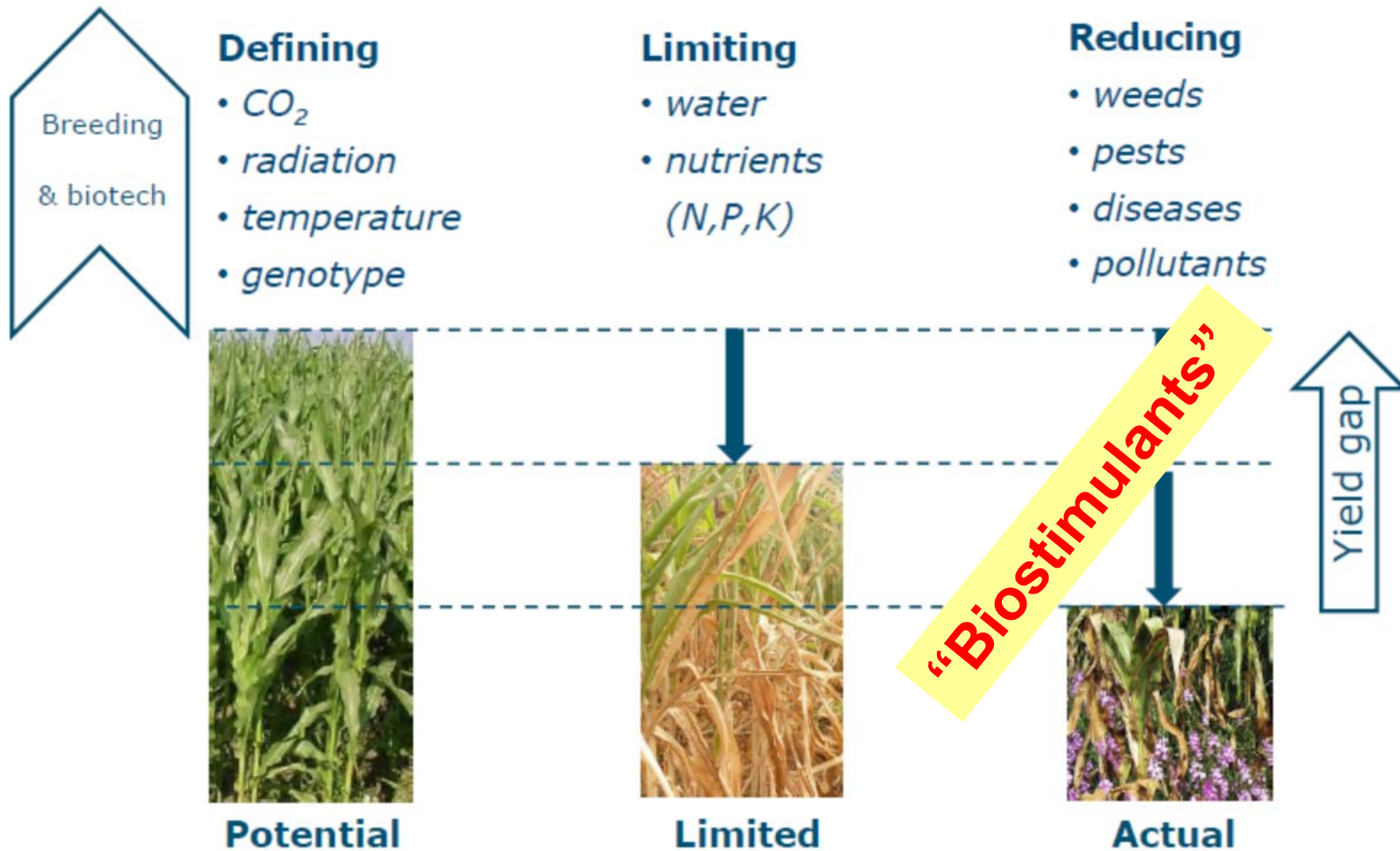
Traditional, Organic/Green Fertilizers

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

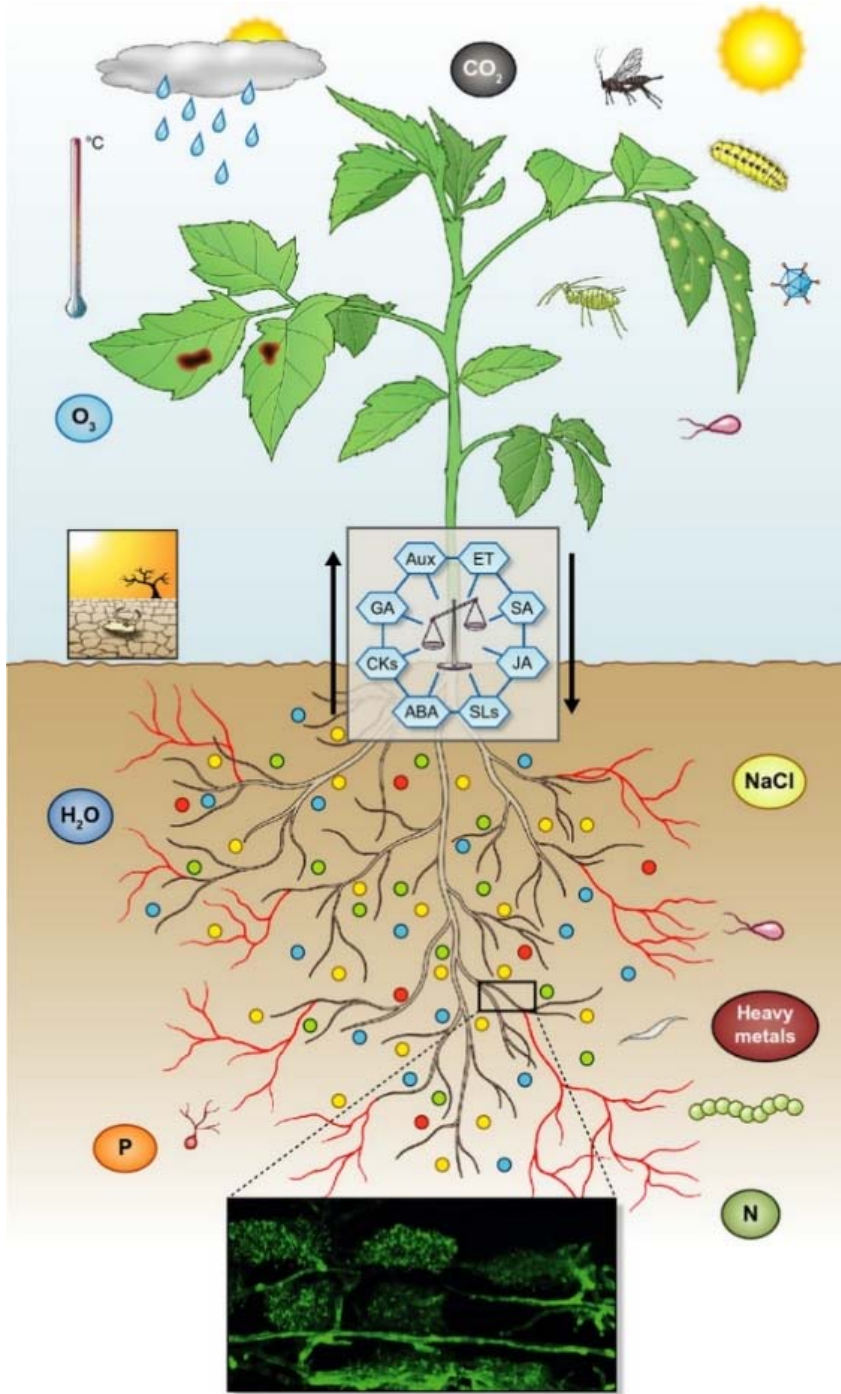
Biostimulants

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

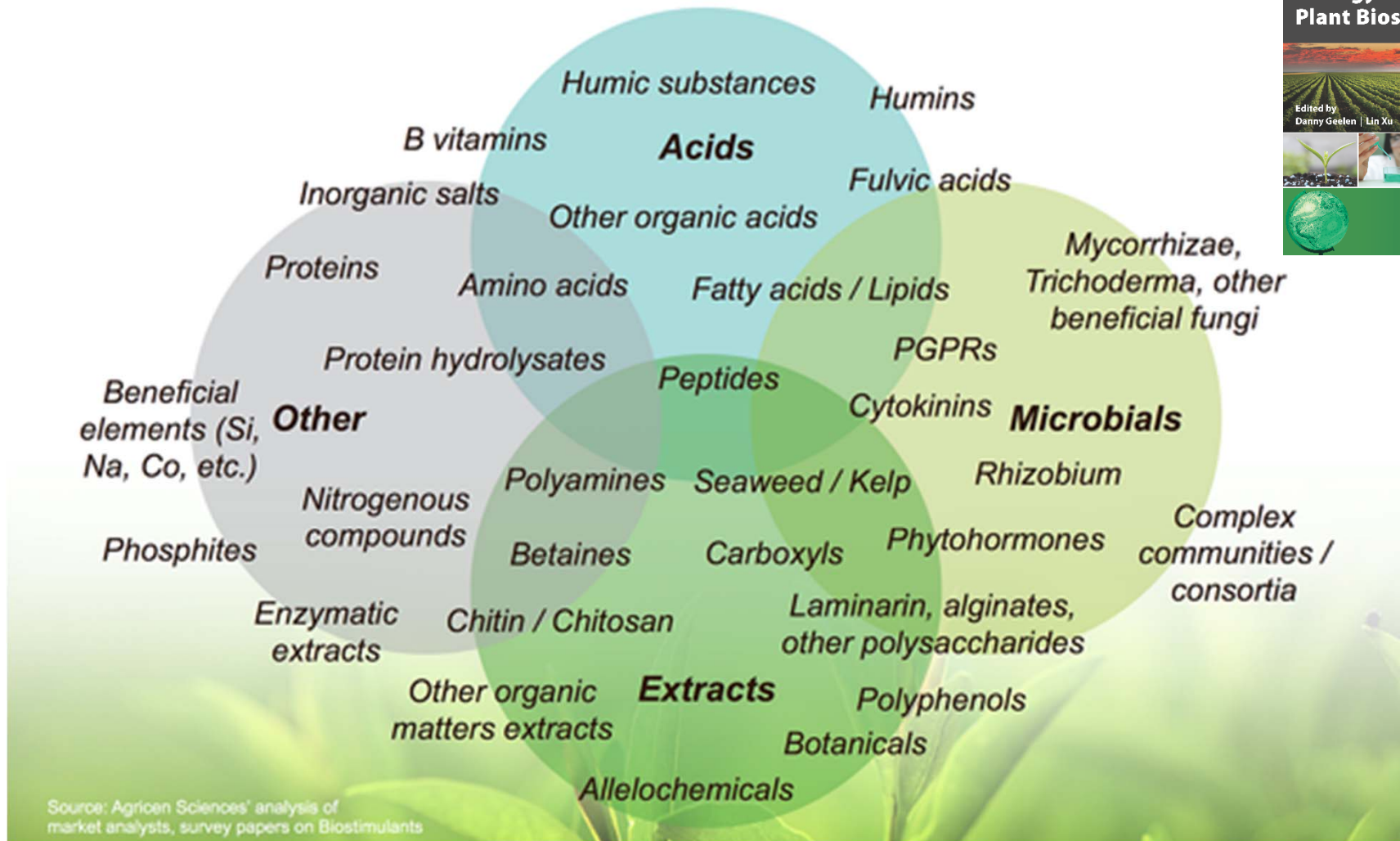
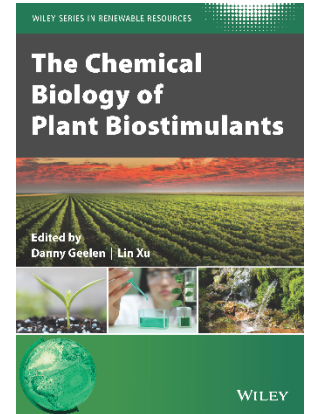


Complexity of Plants' responses

Pozo et al. 2015 (New Phyto)

Huge Diversity of Compounds

A Very Broad Landscape of Emerging Products



Source: Agricen Sciences' analysis of market analysts, survey papers on Biostimulants

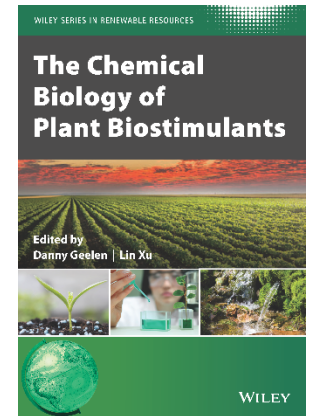
Biostimulants

<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) 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
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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 categories

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

Introduction

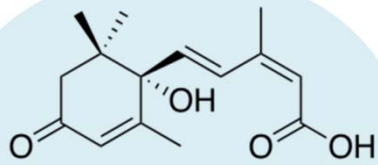
Plant biostimulants, or agricultural biostimulants, include diverse substances and microorganisms that enhance plant growth. The global market for biostimulants has been projected to reach \$2,241 million by 2018 and

Plant & Soil (2014) Marschner Review



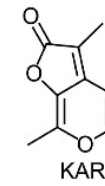
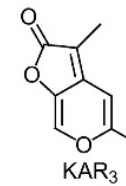
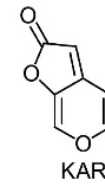
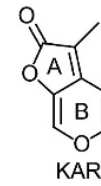
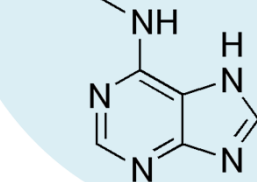
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Phytohormones – old timers and newcomers

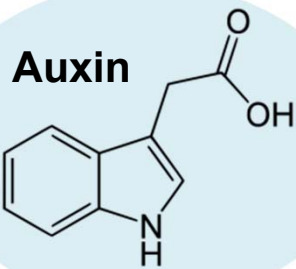


Abscisic Acid

Cytokinins

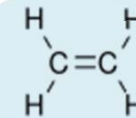
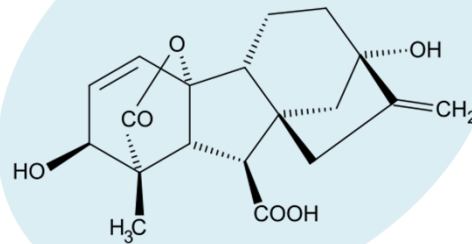


Karrikins

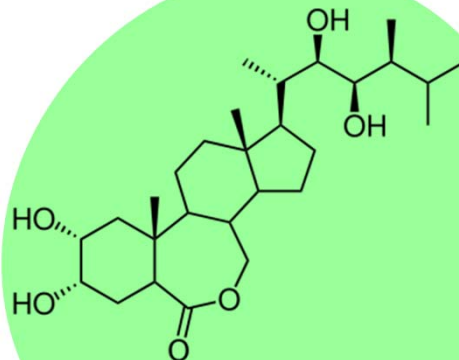


Auxin

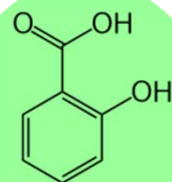
Gibberellins



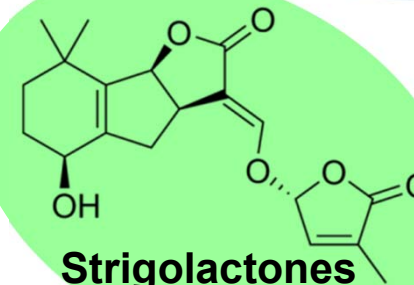
Ethylene



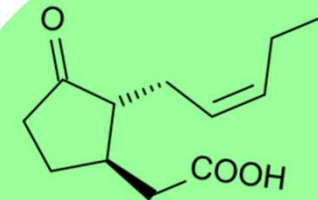
Brassinosteroids



Salicylates



Strigolactones



Jasmonates

Cell Cycle Control & Cytokinins

Planta (1996) 200: 2–12

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

Kerong Zhang¹, 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

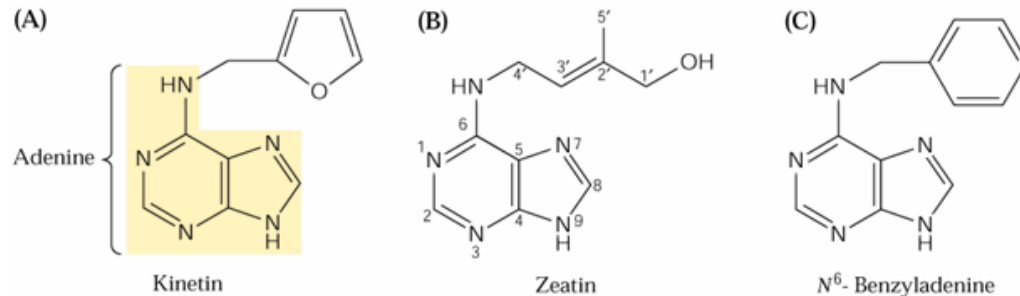
Cell cycle control can be exercised by interaction of the key cell division cycle (cdc) catalyst p34^{cdc2} (the 34-kDa product of the *cdc2* gene) with different cyclin subunits that direct its protein kinase activity to specific substrates (Peeper et al. 1993), by cyclin dependent kinase inhibitor (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

Planta
© Springer-Verlag 1996



D. Stuart Letham

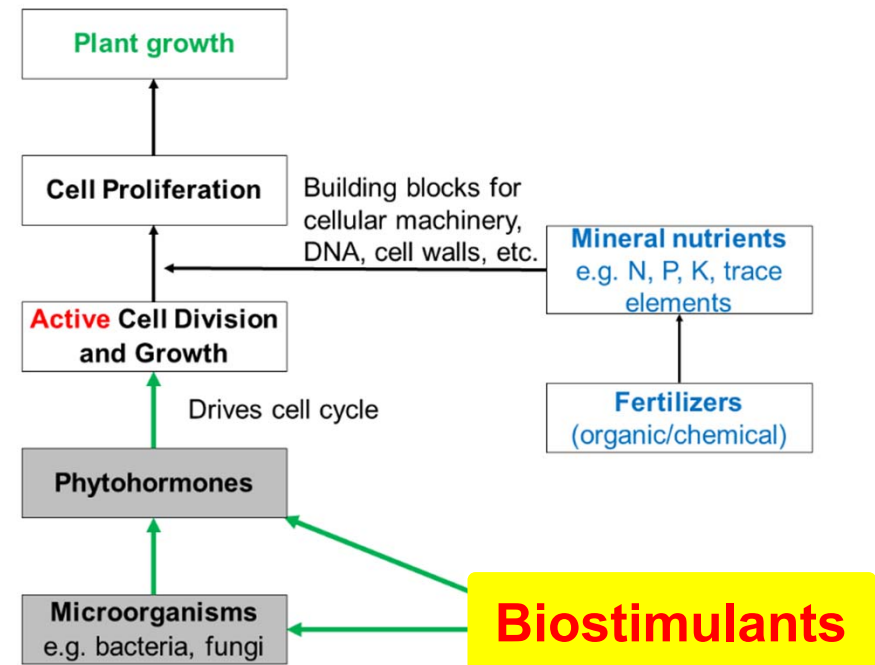
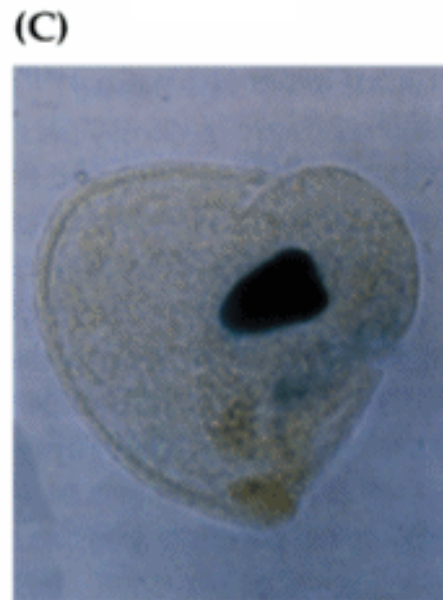
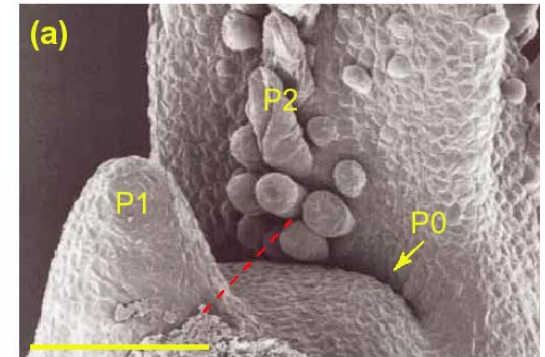
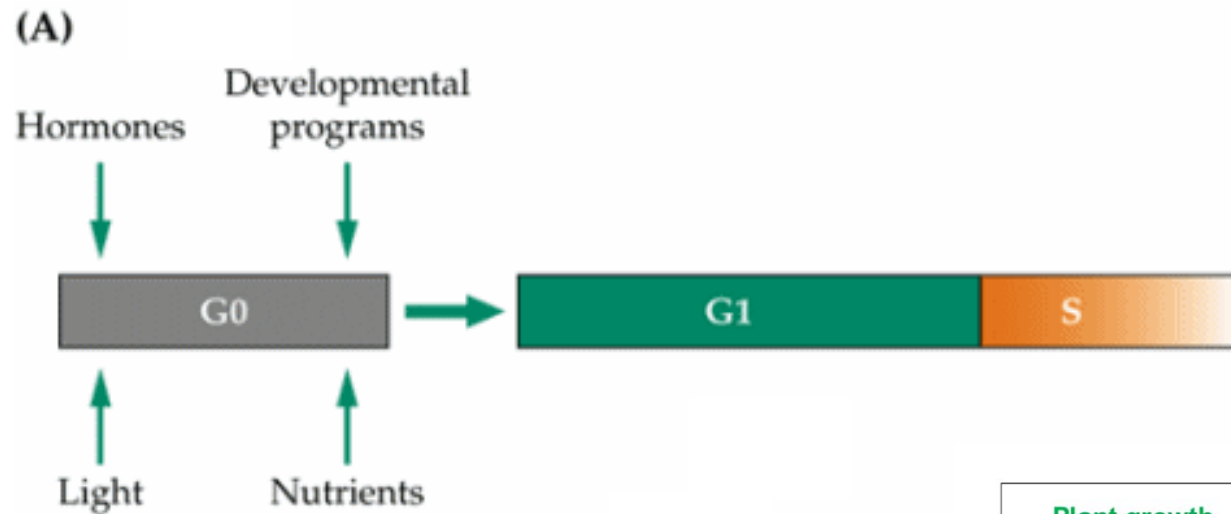


Cytokinins
细胞分裂素



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

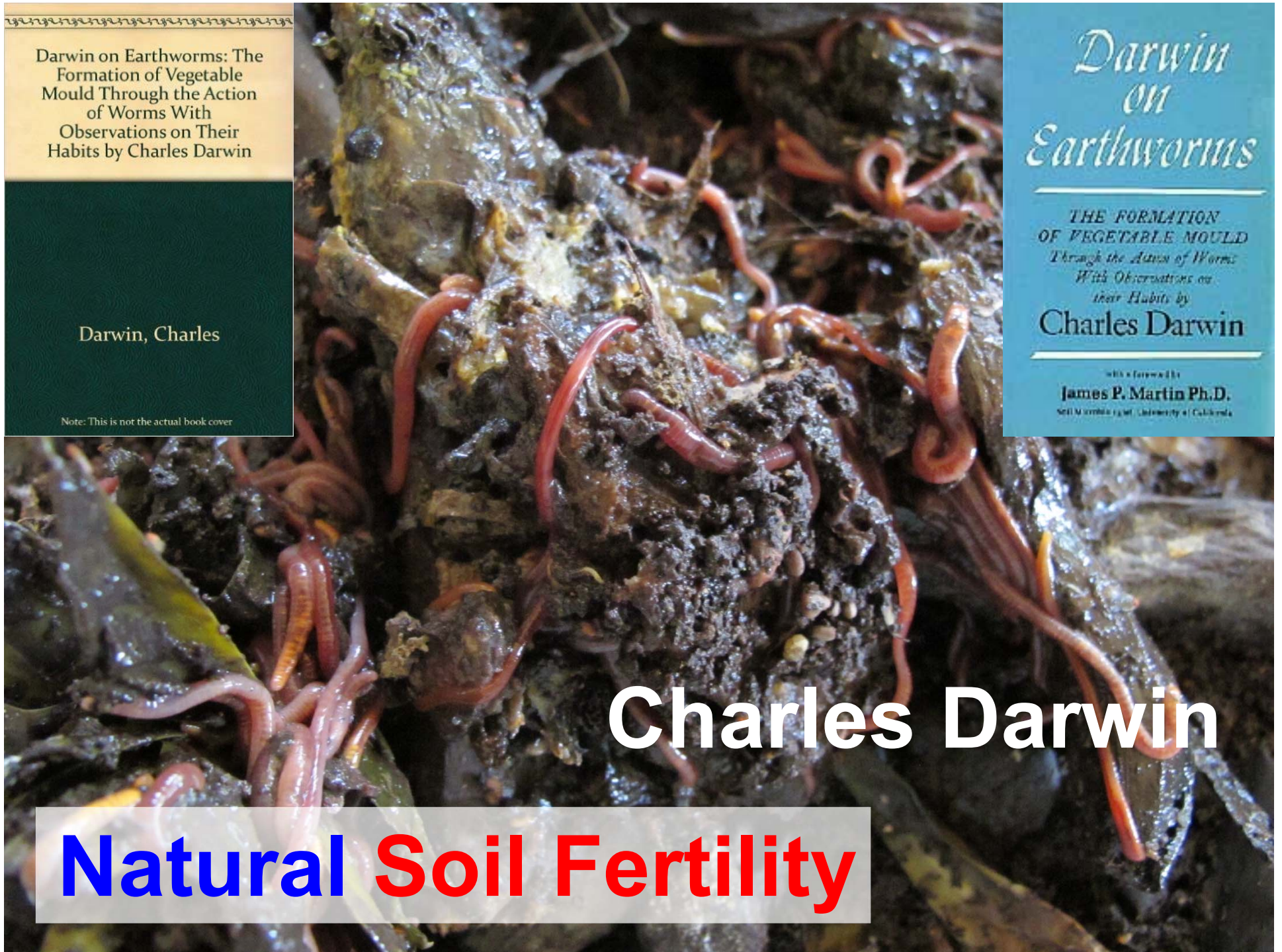
THE FORMATION
OF VEGETABLE MOULD
Through the Action of Worms
With Observations on
their Habits by

Charles Darwin

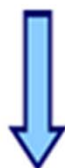
with a foreword by
James P. Martin Ph.D.
Soil Microbiologist, University of California

Charles Darwin

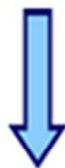
Natural Soil Fertility



Vermicomposts



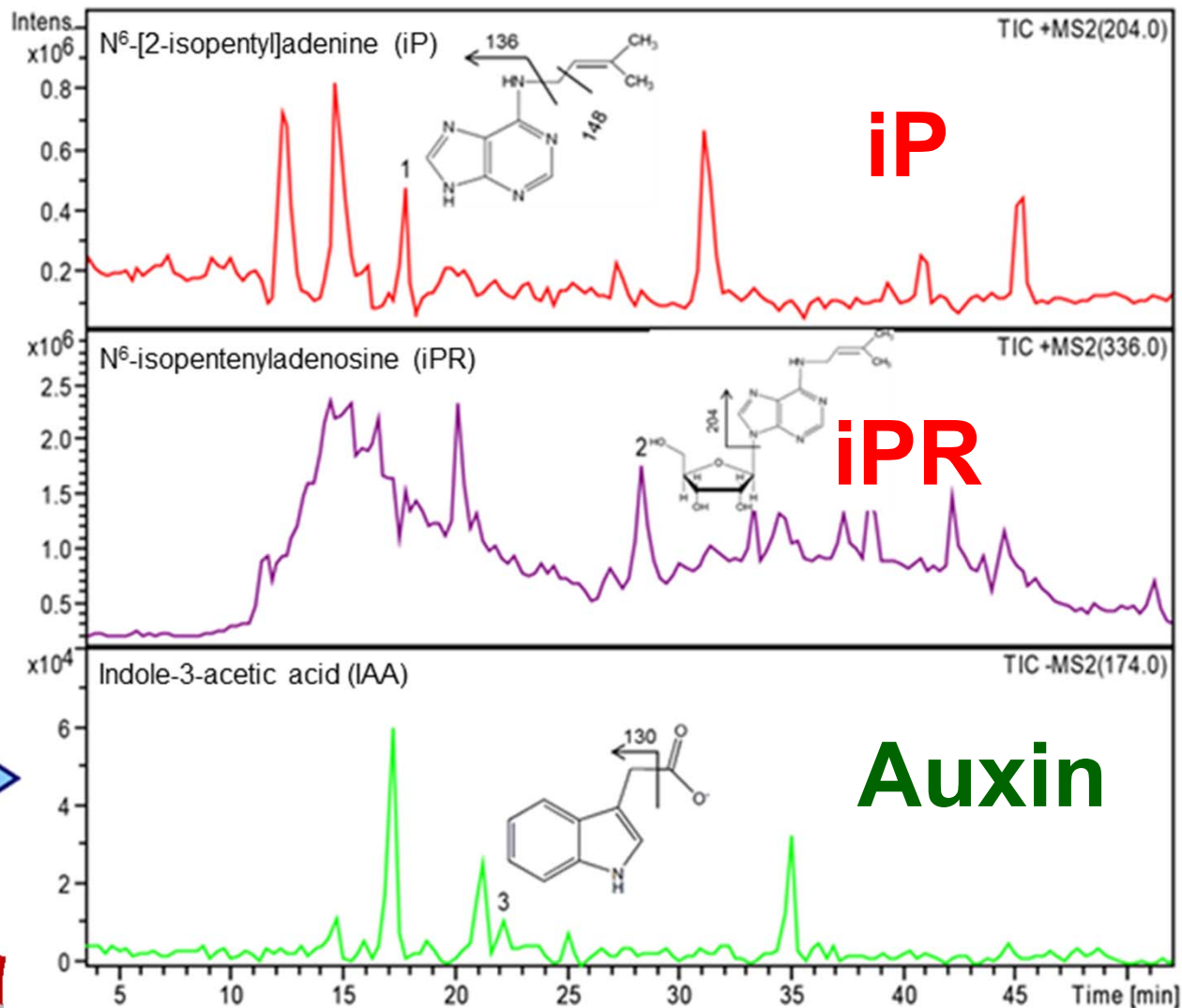
1.UAE
2.SPE



LC-MS
analysis



Zhang et al. 2015, Talanta



UAE - Ultra-Sound Assisted Extraction

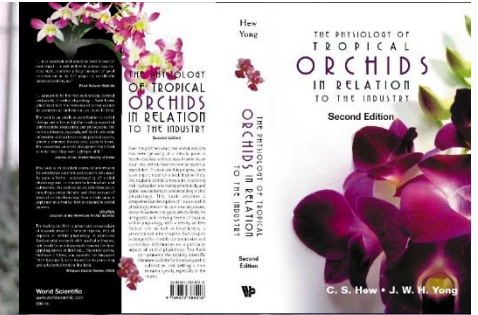
Orchid

In-Vitro flowering



Basic Research





Agribusiness – Control of Flowering

Mistletoe

without the host tree



Natural



In-vitro



In-vitro



Natural



Common Malayan mistletoe



Basic Research



Towards a Wider Diversity

**Compact Dwarfs
are crucial varieties
for the future of
coconut breeding**

1, 2 & 3. The Niu Leka Dwarf from Taveuni island in Fiji was the first Compact Dwarf to be described by scientists, but this is not the most productive.
4, 5, & 6. During surveys conducted in French Polynesia, the first Compact Dwarfs with orange-red fruits were identified in Moorea island.

7. Some of the best Compact Dwarfs from Moorea island produce big round fruits with a tasty coconut water and a specific nice pink colour in the immature husk.

8. Around Suva in Fiji, more than twenty new varieties of compact Dwarfs were observed, such as this yellow form with pointed fruits. Some may derive from crosses between Compact Dwarfs and the Malayan Red Dwarf.

9 & 10. Two more Compact Dwarf Varieties from Tahiti island

11 & 12. A compact dwarf variety from Tubuai Island, Australes archipelago in French Polynesia, showing very unusual terminal flowers at the end of the spikelets.

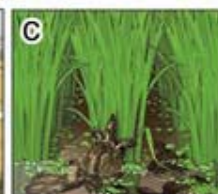
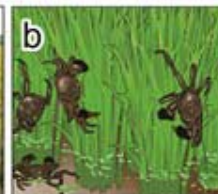
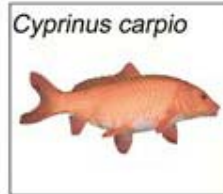
By R. Bourdeix, T. Kete, and V. Kumar, 2017

Poster available free at:
<https://replantoconut.blogspot.fr>



Coconut flowers & fruits

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



Dr Markus Langeland
(SLU Uppsala)



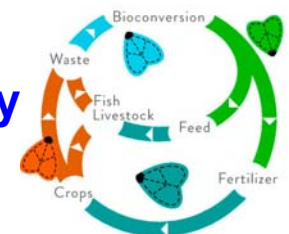
SCIENTIFIC REPORTS

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

Liangliang Hu¹, Jian Zhang¹, Weichang Ren¹, Liang Guo¹, Yonguo Cheng¹, Binuo Li¹, Kazuki Ue², Zhenzhen Zhu¹, Jian Zhang¹, Shiming Luo¹, Lei Cheng¹, Jianjun Tang¹ & Xin Chen¹



Circular Economy

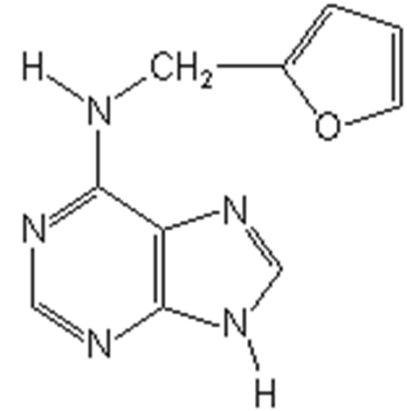




Jenna Senecal, PhD candidate
(SLU Uppsala)

Dr Cecilia Lalander
(SLU Uppsala)

Kinetin

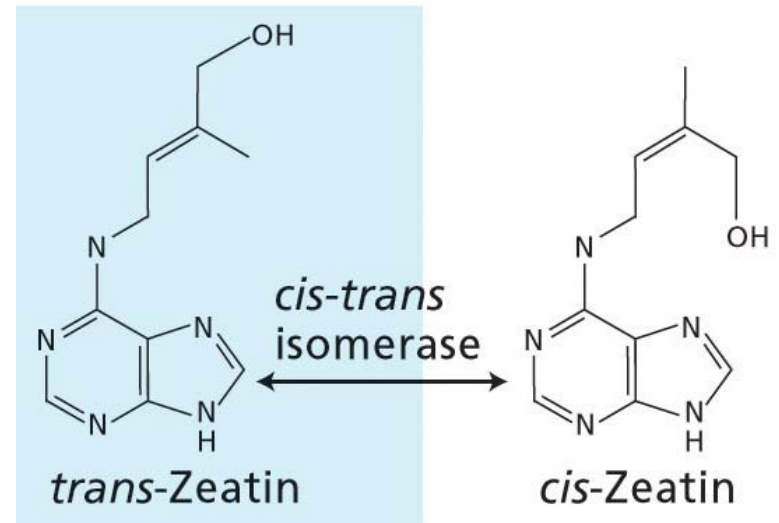
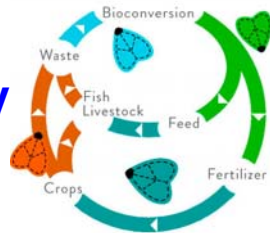


Human urine as a source of

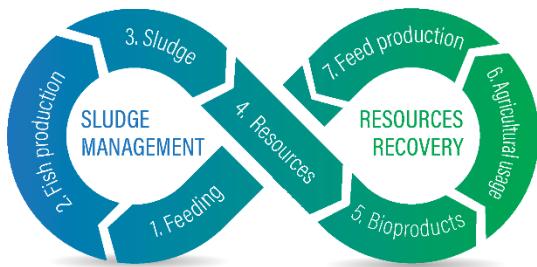


Biostimulants

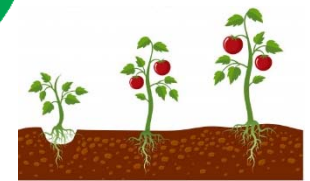
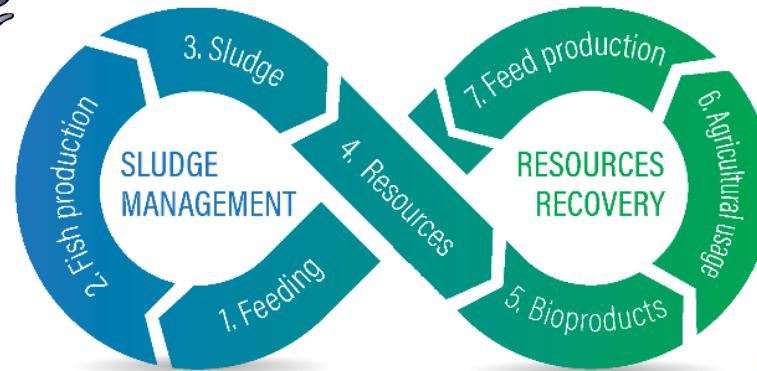
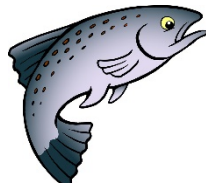
Circular Economy



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AQUA-FER



SLUDGE MANAGEMENT

1. Feeding

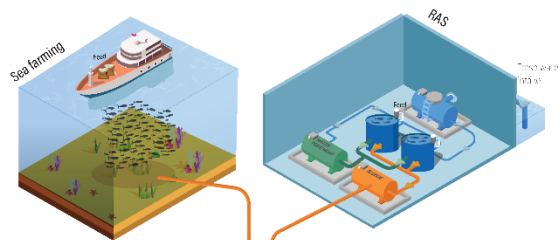
Feeding and type of the feed is one of the key elements to control productivity and well-being of fish. Those also have effects on sludge characteristics.

2. Fish production

Type of system, temperature and water quality have a great effect generated waste streams.

3. Sludge

Sludge quality is affected by feed, sludge characteristics and chemicals used. Those need to be monitored to find solutions to reduce AC waste and improve nutrient removal processes in AC.

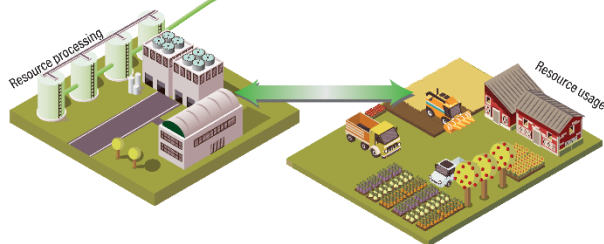


4. Resources

Improves sludge characteristics enhance its potential as a resource.

"Sludge is a resource"

RESOURCES RECOVERY



5. Bioproducts

AC waste streams has potential to be used in different bioproducts that can be further used in the AC sector.

6. Agricultural usage

AC waste has potential to be used in agriculture as fertilizer or to be used as soil amendment. Fertilizer products and bioproducts can be further used to produce feed for fish farms.

7. Feed production

Substrate for feed production also can be used in AC industries.

Examples of bioproducts:



The result of the process:



Enabling infinity loops from beginning.

SLUDGE MANAGEMENT

1. Feeding

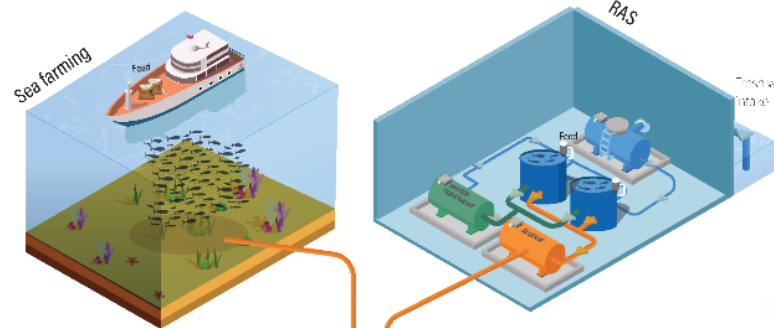
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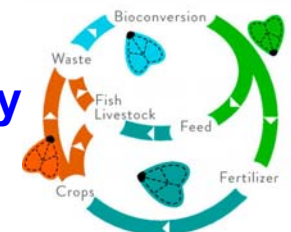
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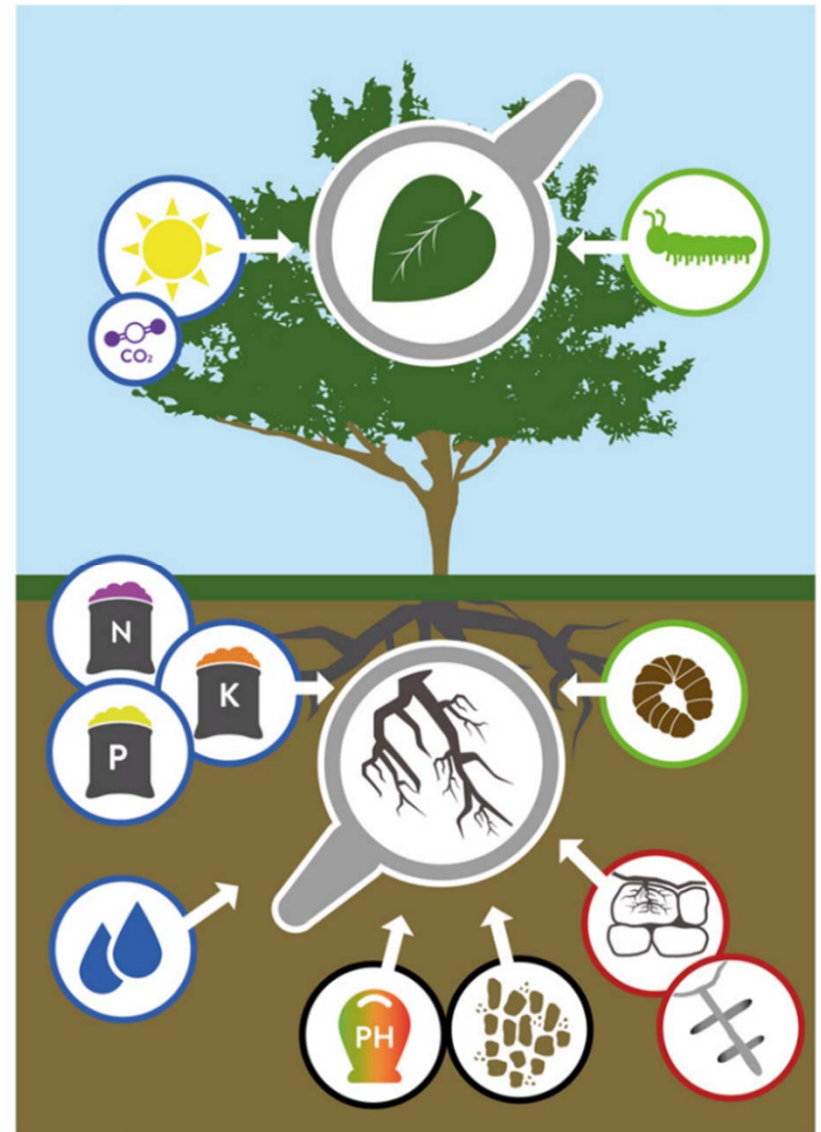


Circular Economy



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,

jean.yong@slu.se

+46 70 249 23 21



Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences



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.
- *Azospirillum* spp.

Dr Theodora Nikolakopoulou, EU Commission



FPR: Fertilizer Product Registration