ERA CoBioTech (ERA-Net Cofund on Biotechnologies)

ACHEMA2018

Kick-off session: "Biotechnology for a sustainable bioeconomy"

Sustainable Bioproduction of Pheromones for Insect Pest Control in Agriculture

Project acronym: SUSPHIRE

SUSPHIRE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant 722361

Frankfurt am Main, 13.06.2018

SUSPHIRE CONSORTUM

PROJECT DURATION
36 Months (01 / 2018 to 12 / 2020)

TOTAL REQUESTED FUNDING
1.643.000 €

TOTAL COSTS
1.861.000 €

CONSORTIUM

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Pheromones for sustainable crop protection

- The insect pest control market was valued at $ 11.89 billion in 2015
- Pesticides are progressively being restricted by European Legislation
- Sex pheromones are species-specific substances already successfully employed in the environmentally-friendly control of many lepidopteran and coleopteran species
- The availability and sustainability of insect pheromones are compromised by current manufacturing systems

Sustainable bioproduction of pheromones

- For large scale agricultural operations, many pheromones are not cost-competitive, mainly due to the prohibitively high manufacturing costs.
- Costs per gram of even the most affordable pheromones start at USD$ 1.00 per gram, ranging up to USD$ 20.00 per gram.
- These high prices generally reflect the complexity of chemical synthesis, often involving one or more stereoselective steps.
- Price is not the only drawback. Despite the efforts of 'green chemistry' to decrease toxicity, it is often impossible to avoid the use of toxic substances during manufacturing.

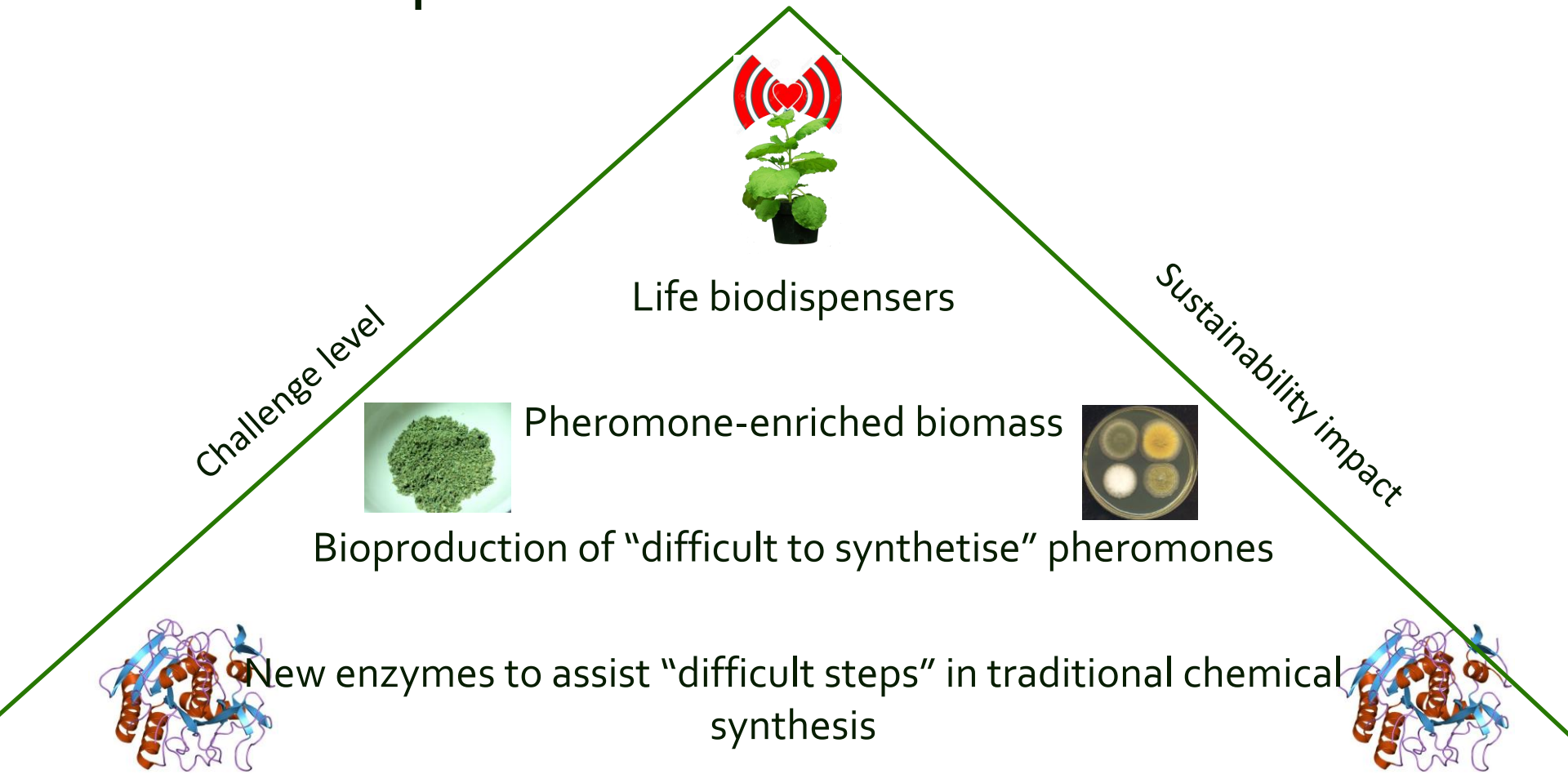
Sustainable bioproduction of pheromones

More economic strategies for both the synthesis of pheromones and formulation of active ingredients into dispensers can be developed using biotechnology

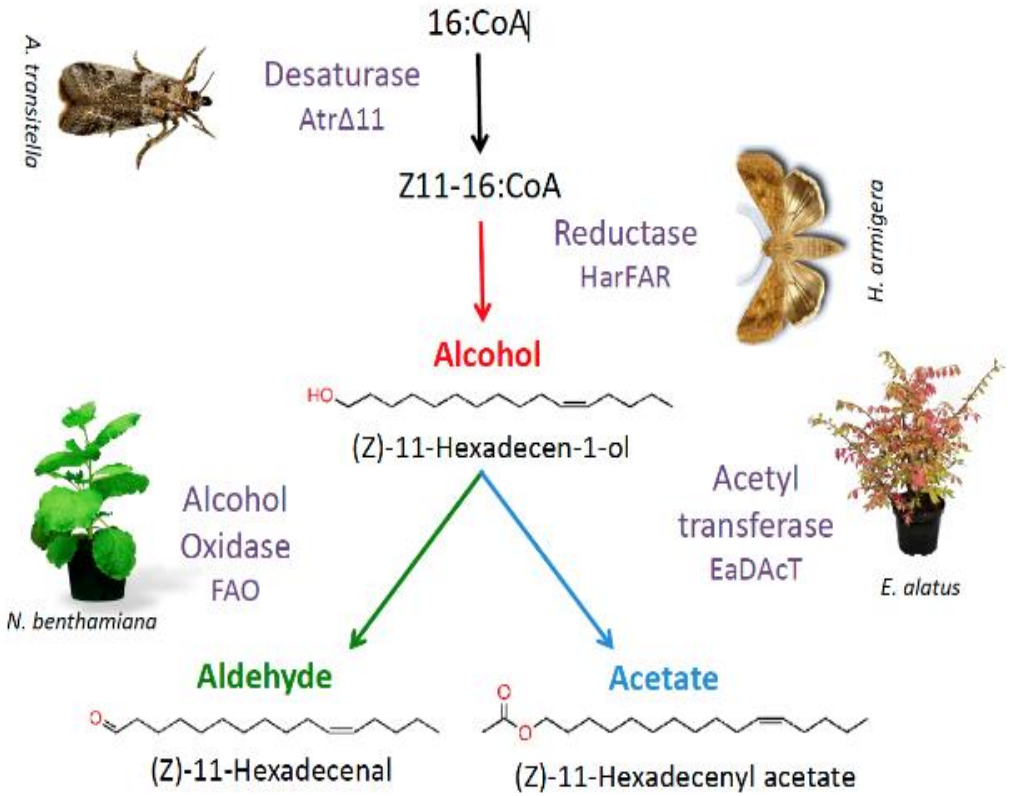
This could lead to increased viability of insect pheromones for pest control in agriculture

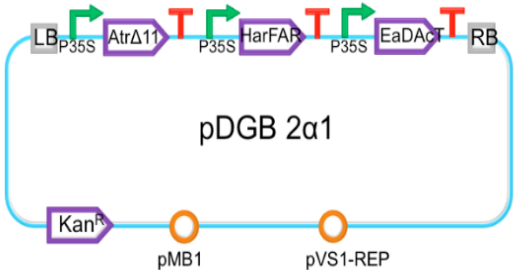
More environmentally friendly biosynthetic production methods for pheromone-based aligns with Europe's Bioeconomy objectives.

Sustainable bioproduction



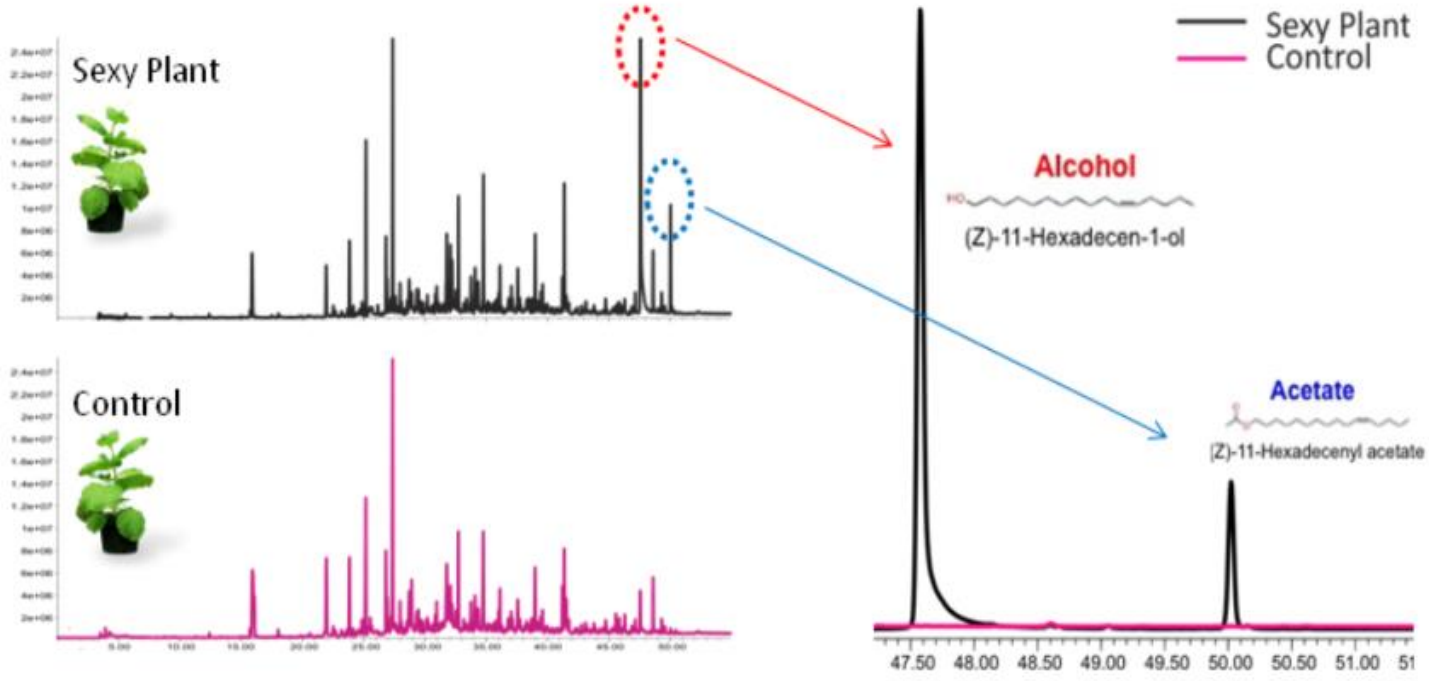
Plant-made moth pheromones





Ding et al 2013; iGEM UPV team 2014; Quijano et al, in prep.

Plant-made moth pheromones



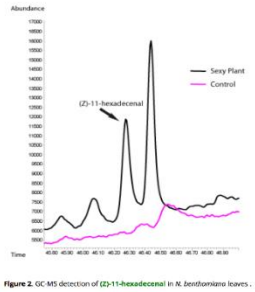
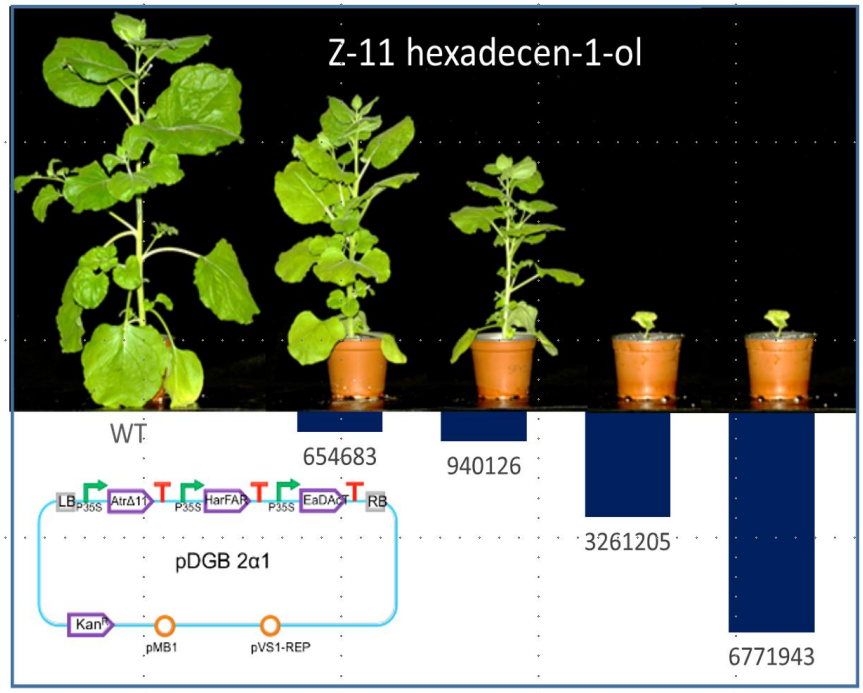


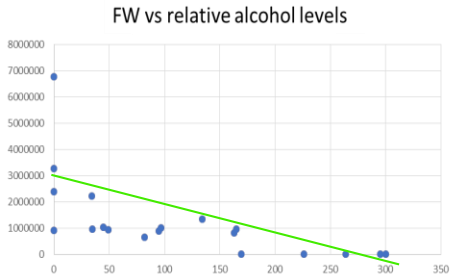
Figure 2. GC-MS detection of (Z)-11-hexadecenal in *N. benthamiana* leaves.

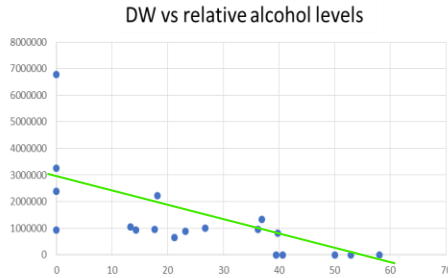
Ding et al 2013; iGEM UPV team 2014; Quijano et al, in prep.

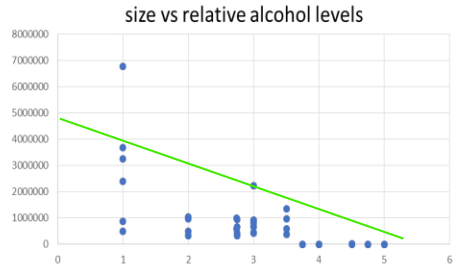
PoC: The Sexy Plant

Improvements for version 2

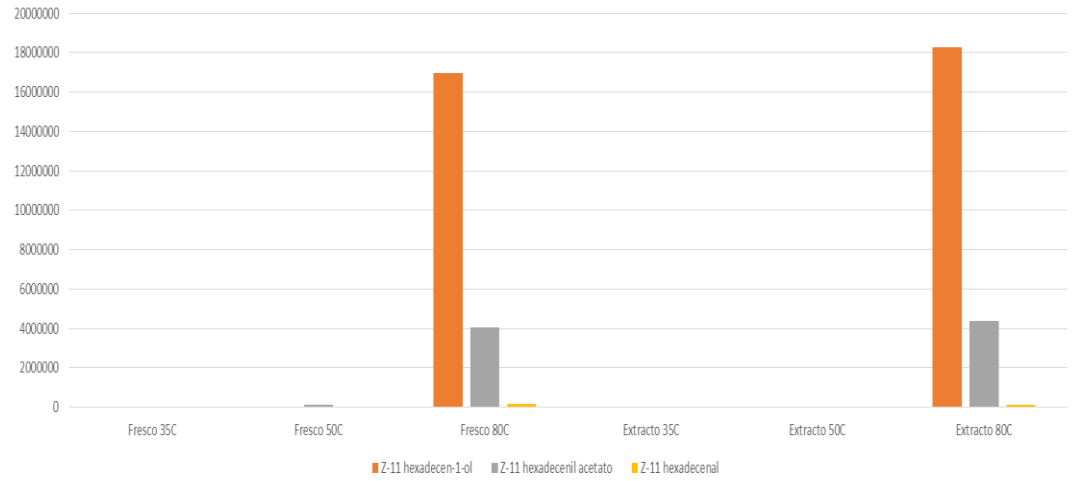






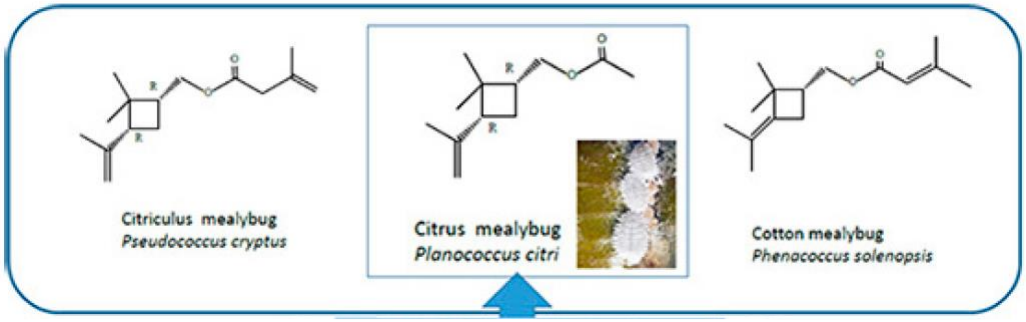


Biodispenser vs Biofactory: The volatility issue



PoC: The Sexy Plant

Irregular monoterpenoids



DISCOVER, DESIGN AND BUILD

1. **Develop** and test orthogonal genetic elements that enable user control of expression from heterologous gene circuits. (WP1)
2. **Uncover** the metabolic/cellular constraints limiting the synthesis and release of fatty acid-derived moth pheromones in plants. (WP1)
3. **Engineer** an improved moth pheromone-producing plant that incorporates the tools and design principles from objectives 1 and 2. (WP2)
4. **Engineer** an initial demonstration of moth pheromone production in a filamentous fungi (WP2)
5. **Elucidate** the biosynthetic pathway for the *Planococcus citri* sex pheromone (WP3). **Identify** additional IMDSs from related Coccoidea species. (WP3)
6. **Heterologously express** the biosynthetic pathway of *Planococcus citri* sex pheromone in plant and fungal biofactories (WP3)

EVALUATE

8. **Evaluate** the plant and fungal biofactories as living bio-dispensers of moth and mealybug pheromones in laboratory conditions. (WP2&3)

9. **Evaluate** the use of (semi) purified pheromone extracts from plant and fungal biofactories developed in the project as constituents of pheromone biodispensers in laboratory and field conditions. (WP2&3)

10. **Evaluate** the use of pathway intermediates and purified enzymes as source of precursors andcatalysts to aid the production of Coccoidea pheromones by chemical synthesis. (WP3)

DISSEMINATE AND EXPLOIT

11. **Engage** with stakeholders to **disseminate and communicate** the project objectives and results and to investigate and develop best practices for the integration of societal values in the research process, enabling two-way dialogue on the use of genetically engineered organisms for bioproduction. (WP4)

12. Establish the basis for the follow up of SUSPHIRE through TRL5-9 and towards **commercialization**. (WP4)

SUSPHIRE Workpackages

<u>WP1. Molecular tools</u>. Develop optimal **genetic constructs** for **controlled** heterologous biosynthesis of moth and Coccoidea pheromones in **plants and fungi**.

GoldenBraid 3.0

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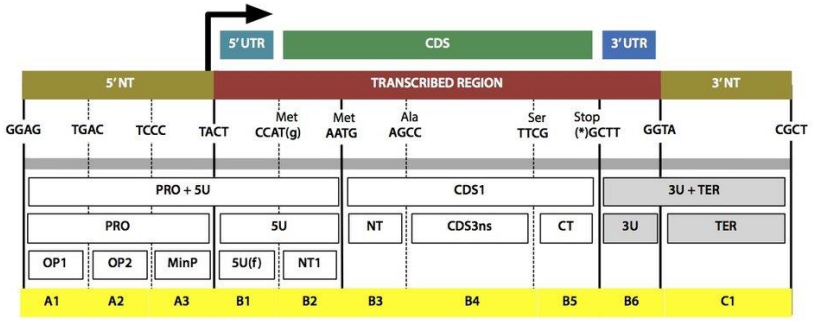
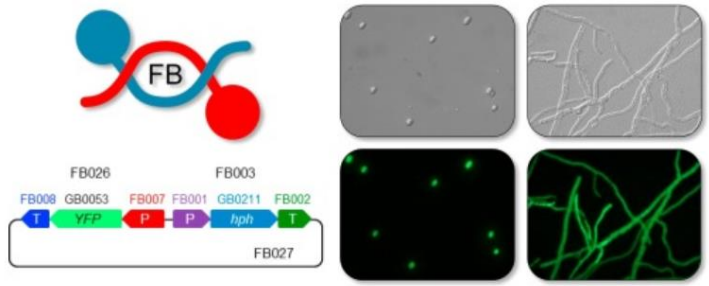
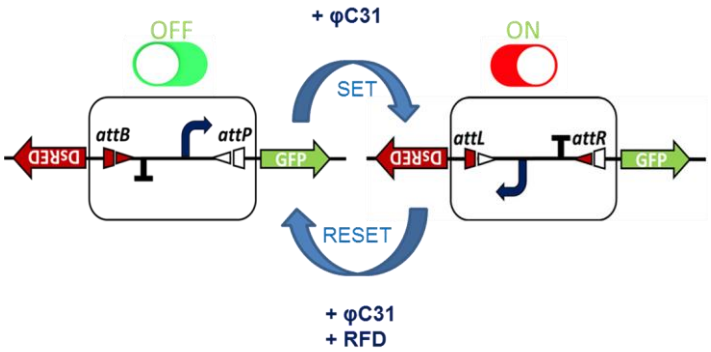
A Digital Toolbox for Plant Synthetic Biology

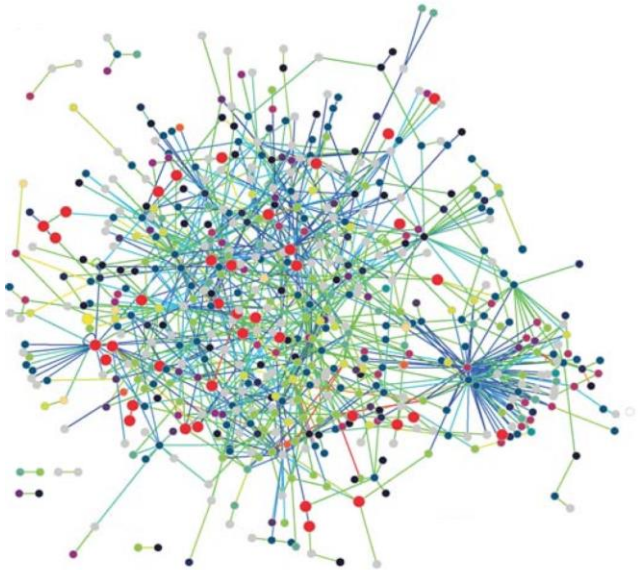






SUSPHIRE Workpackages

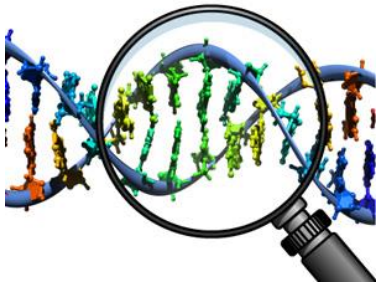
<u>WP2 Lepidoptera Pheromone</u>. Systems data and modelling to inform the metabolic engineering strategy. Assembly of WP1 elements for plant fungal prototypes. Evaluate efficacy.



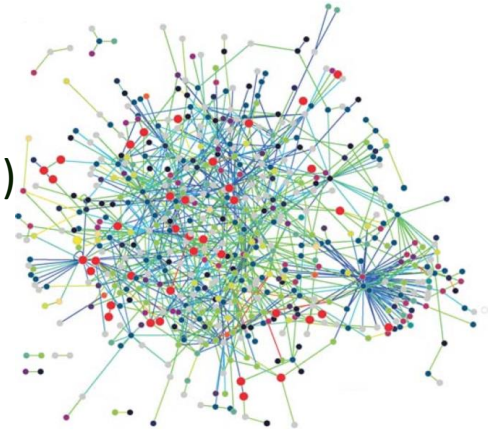
Conditional expression (WP1)
Organ-specific expression(thricomes)
Optimization in filamentous fungi

SUSPHIRE Workpackages

<u>WP3. Coccoidea pheromone</u>. Generate transcriptomic data and identify enzymes. Assembly of WP1 elements for plant and fungal prototypes. Evaluate purity and efficacy of mealybug pheromones produced in plants and fungi.



- Differential expression
- (mated vs virgin females)
- PACBIO transciptome
- Phylogenetic analysis
- Bioinformatics

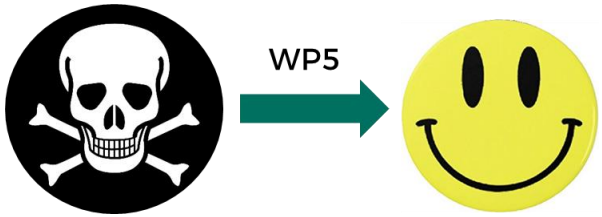


SUSPHIRE Workpackages

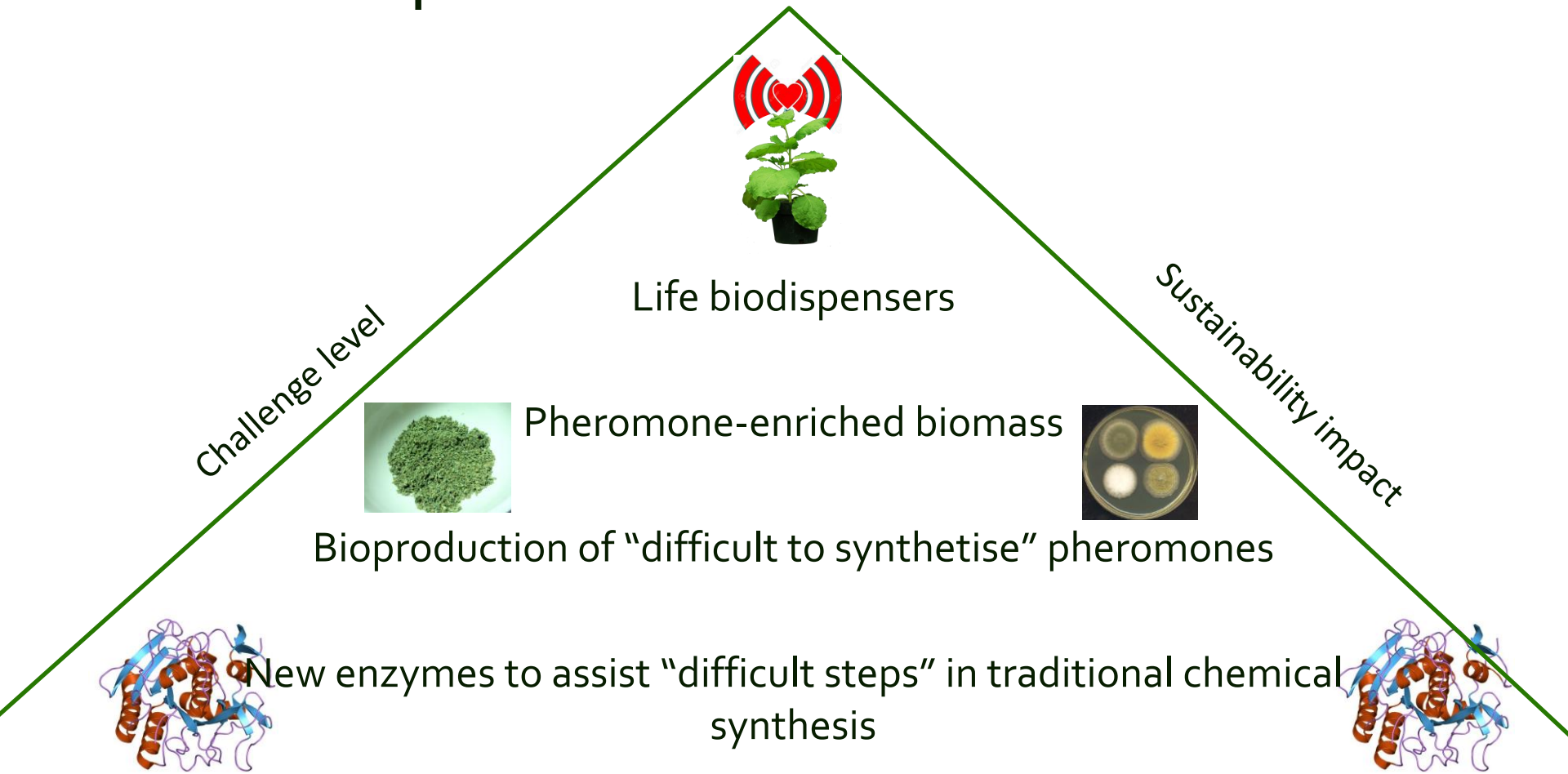
<u>WP4. Ethics, dissemination and outreach</u>. LCA and scoping exercises for the commercialisation of the project outcomes. Data stewardship according to the FAIR principles. **DMP leader**: NIB Slovenia

Responsible Research and Innovation. Communication and dissemination plan.

<u>WP5. Coordination and management:</u> Steering and Innovation committees, project management meetings, progress reports.



Sustainable bioproduction



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SUSPHIRE

Sustainable Bioproduction of Pheromones for Insect Pest Control in Agriculture

http://susphire.info

SUSPHIRE PARTNERS:

iata ibmcp | Universitat Politècnica de València | Technische Universität Darmstadt | Earlham Institute | NIB

Ecologia y Protección Agrícola

SUSPHIRE PARTNERS ARE GRATEFUL FOR FUNDING RECEIVED FROM

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