



# Agronomical Plant Extracts & Essential Oils

ABIM –Innovation session – October 24, 2023

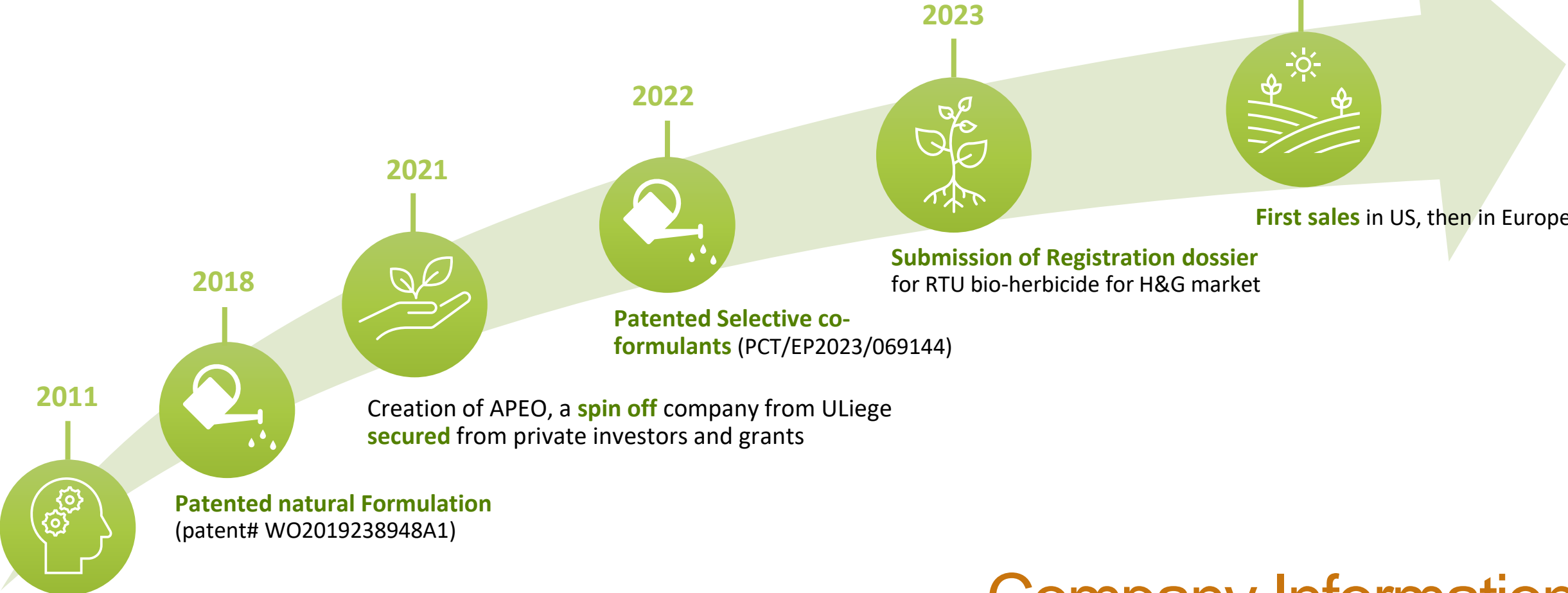
Developing sustainable Agriculture,  
Putting Science and Agronomy at the heart of our activities

# Mission

Shifting towards sustainable agriculture and gardening by bringing innovative bio-pesticides based on Science and Essential Oils



2026-2027 Plant Protection Products & Essential Oils



# Company Information

# APEO Team Who/Background



A complementary team focusing on science and business with an adequate ecosystem



## Pr. Haïssam Jijakli, co-founder and CEO

Bio Ingenieur FSAGx (1991)

32 years experiences

Full Professor at ULiège/Gembloux,

Director of Phytopathology lab,

Research & Development,

Registration of biocontrol agents,

**Creation of 4 Spin-Offs and 10 patents**



## Simon Dal Maso, co-founder and Technical director

Bio Ingenieur (2016)/Chemistry

7 years experiences

Accelerated Management Program/Solvay Business

School 2018

Modes of Action, Formulation,

Field & Lab trials,

Registration, Supply Chain

**With a team of 7 persons dedicated to R&D, Regulatory, Production and Commercialization**

### Advisors

**Thierry Nuytten**

Regulatory

Finance  
support

Business developer

### Investors

**Private investor 1**

Sourcing support

**Private investor 2**

Experiences in Agriculture

**Private investor 3**

Finance support



Agronomical Plant Extracts & Essential Oils

2011



From research to first  
development

# Pre-selection considering plant protection market and EO market

- Among 3000 EOs, pre-selection of 91 EOs for fungicidal and herbicidal activities based on :

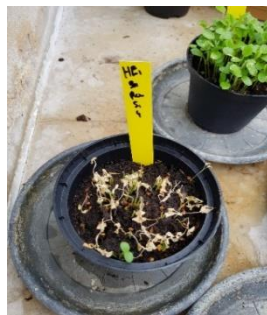


- Literature
- Composition
- Majority of the chemical families (Terpens, phenol, alcohol)
- Cost
- Availability

# Selection of bioherbicides under greenhouse conditions

## Activity against

	Type of major peak	Monocotyledon	Dicotyledon	Mosses	Horsetail
EO1	Aromatic	+++	++++	++++	++++
EO2	Aromatic	++++	++++	undertermined	undertermined
EO3	Terpenic	++++	+	undertermined	undertermined



Efficacy of EO1



EO2



EO3



Untreated



Untreated



Efficacy of EO1

# Importance of the formulation

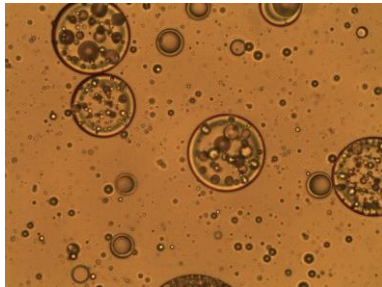


- Influences the modes of action
- Protects the EOs against the environment
- Influences the stability

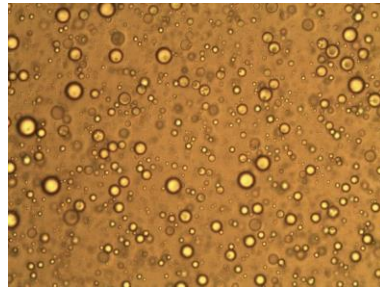
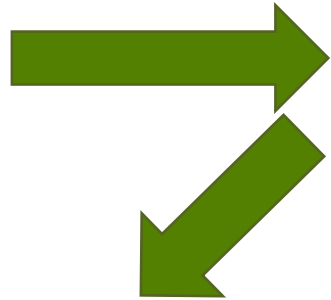
It affects the efficacy

# Formulation from chemical to biological adjuvants

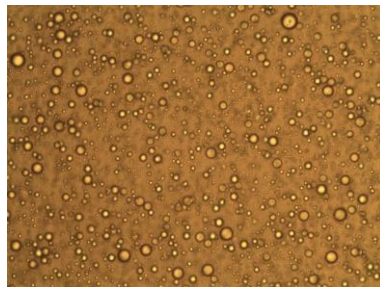
Microscopy



Basic Formulation



chemical Formulation

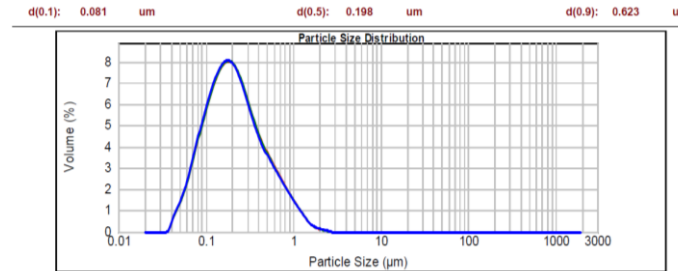


Biological Formulation

Type	Droplet size	appearance	Stability
Marco emulsion	2-20 $\mu$ m	Milky white	Instable
Mini emulsion	0.1-0.3 $\mu$ m	Bluish white	Several week
Micro emulsion	<0.1 $\mu$ m	translucent	Several months



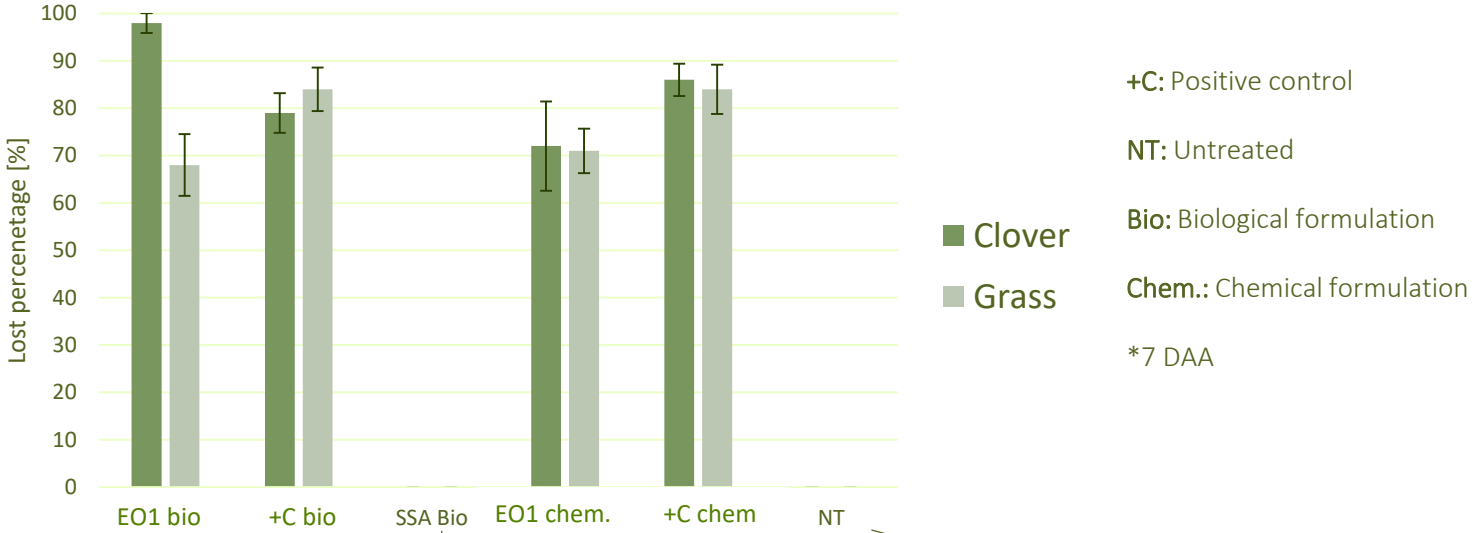
Laser granulometry





# Formulation from chemical to biological adjuvants

Efficacy on clover and grass

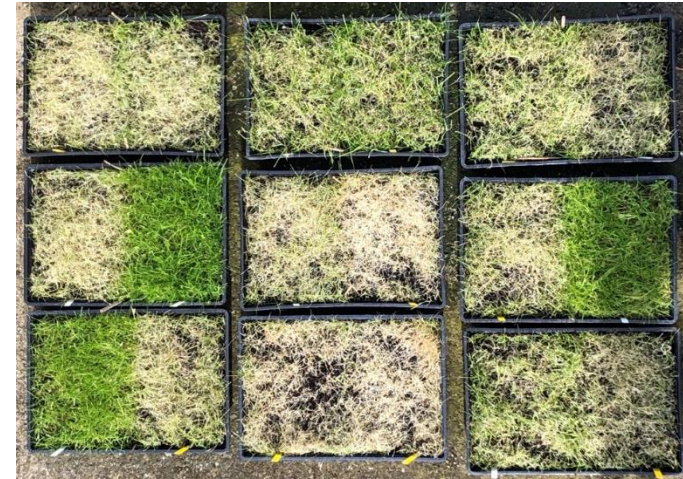


Patented formulation (2018)



In greenhouse

# Validation of the biological formulation with efficacy trials at different scales





Agronomical Plant Extracts & Essential Oils



# From development to first products

# Characteristics of APEO EO1



- ✓ APEO EO1 is a unique novel biobased **biocontrol herbicide** active ingredient **based on essential oil**
- ✓ As such, APEO EO1 has a **general positive perception** from the public and essential oils are also known in other **positive applications** (medical, para-medical, cosmetic,...)
- ✓ **RTU (Ready to use)** and 7x concentrated formulations are fully from natural organic ingredients
- ✓ Pleasant odor
- ✓ Fully, steadily biodegradable
- ✓ (Will be) OMRI certified and certified as biocontrol
  - ✓ All ingredients are OMRI certified

# Characteristics of APEO EO1 – EFFICACY



under field conditions

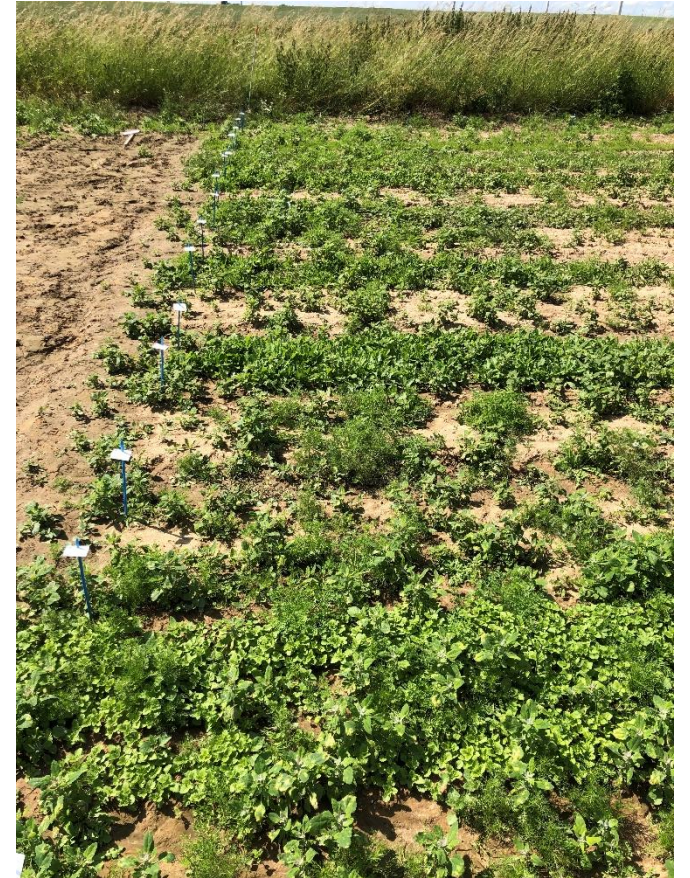
June 2019 in Belgium

Sown weeds in fields (4 monocotyledons and 12 dicotyledons)

Application of EO1 with final formulation

2 applications (10 days between applications)

4 replicates

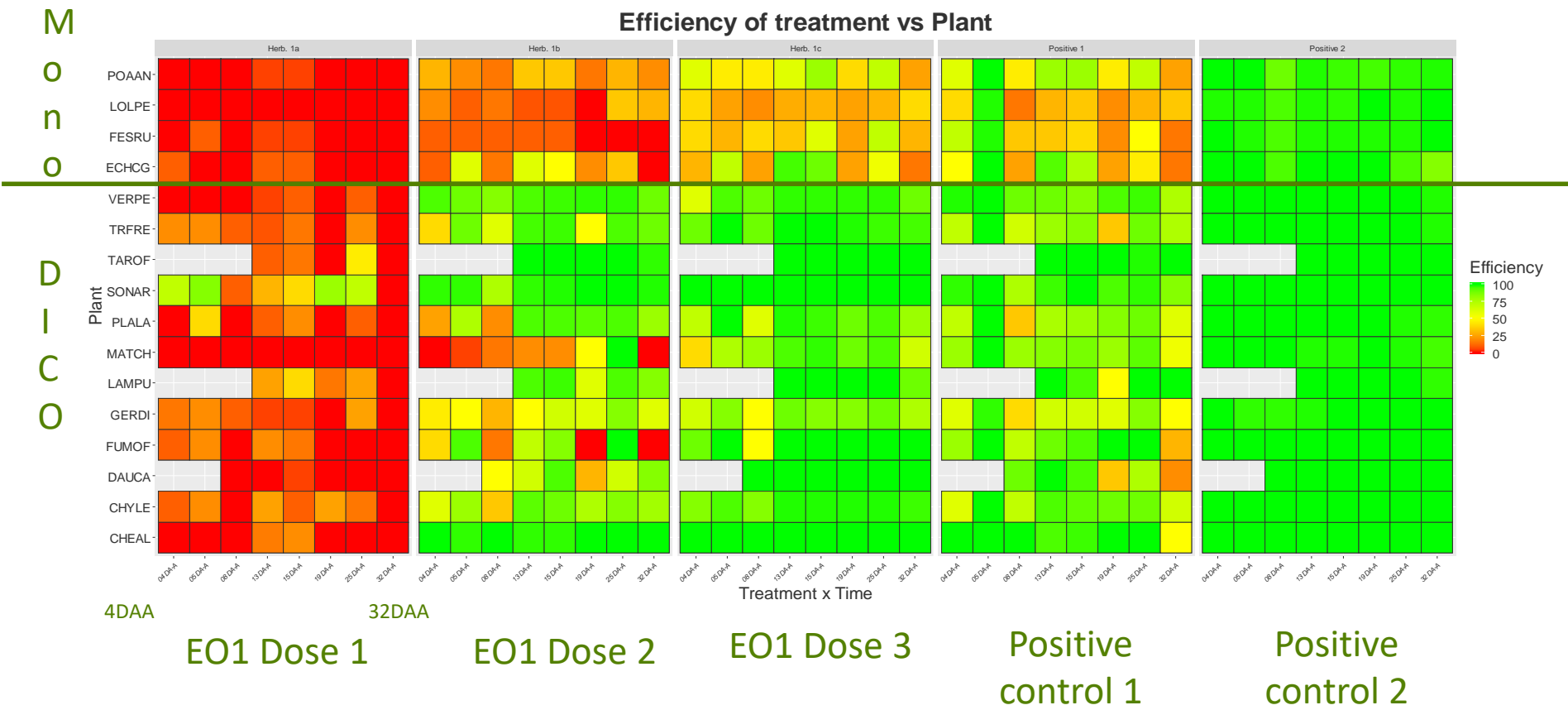


# Characteristics of APEO EO1 – EFFICACY

under field conditions



## APEO EO1 – Belgium



# Characteristics of APEO E01 – EFFICACY

under field conditions

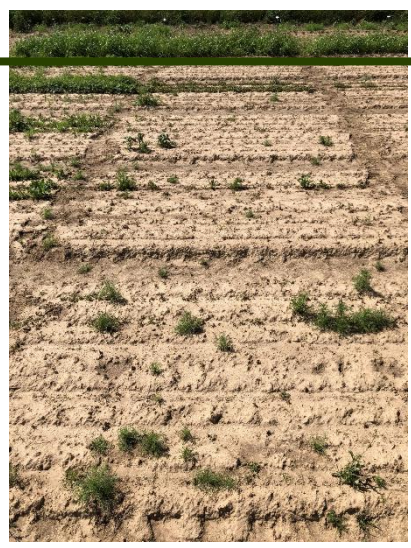


M  
o  
n  
o  
  
D  
I  
C  
O

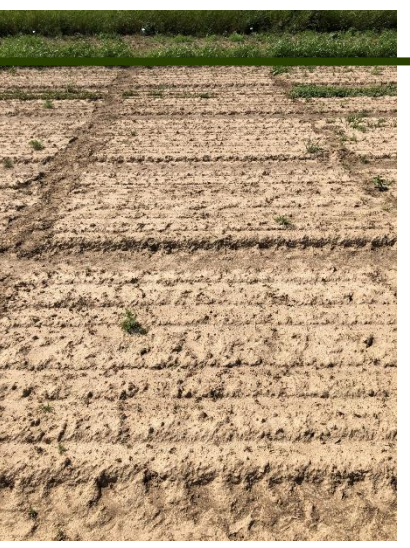
## APEO E01 – Belgium



E01 Dose 1



E01 Dose 2



E01 Dose 3



Positive control 1



Positive control 2



Untreated control

# Characteristics of APEO EO1 – EFFICACY



## 5 years of GEP trials

- ✓ APEO EO1 has a **broader and higher global efficacy against DICOT** than registered positive control
  - ✓ APEO EO1 has a higher efficacy on **29/40** species of DICOT
- ✓ APEO EO1 has a **global similar efficacy against MONOCOT** than registered positive control
  - ✓ APEO EO1 has a higher efficacy on **4/7** species of MONOCOT
- ✓ APEO EO1 has a **global similar activity in comparison with US market reference** products based on Fatty acids and hydrazide maleic
- ✓ High Residual activity
- ✓ Germicidal action
  - ✓ No regrowth of seeds produced by the treated plant

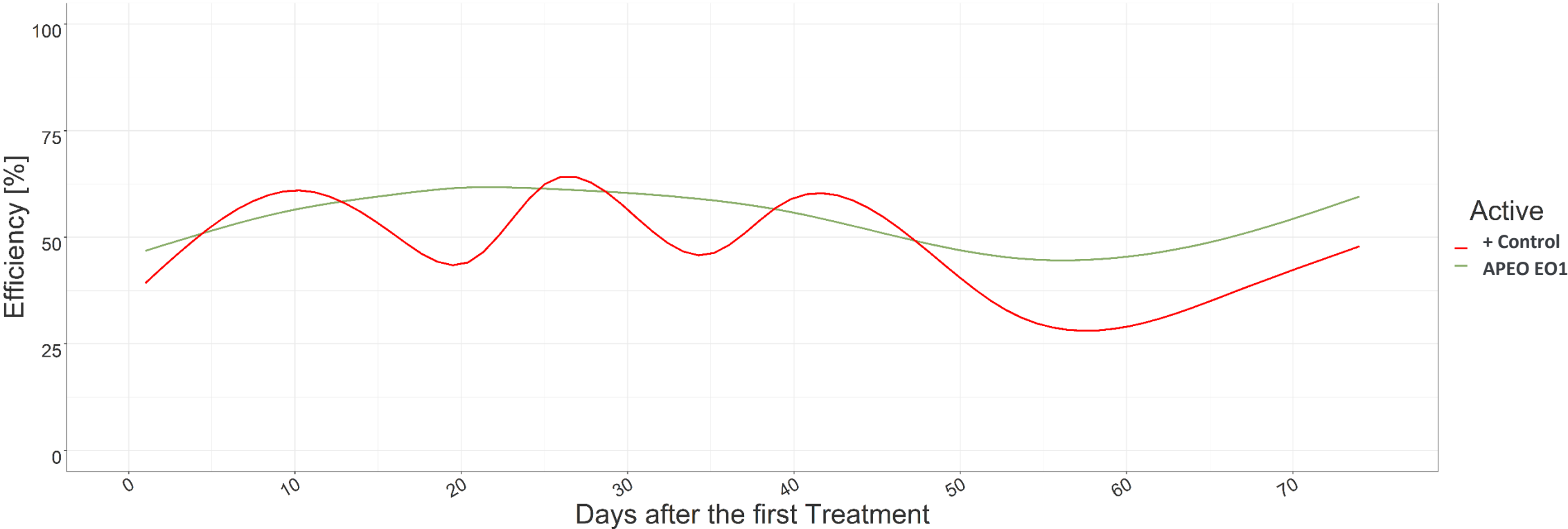


# Characteristics of APEO EO1 – EFFICACY



## Residual activity

### Evolution of efficiency on all Plants



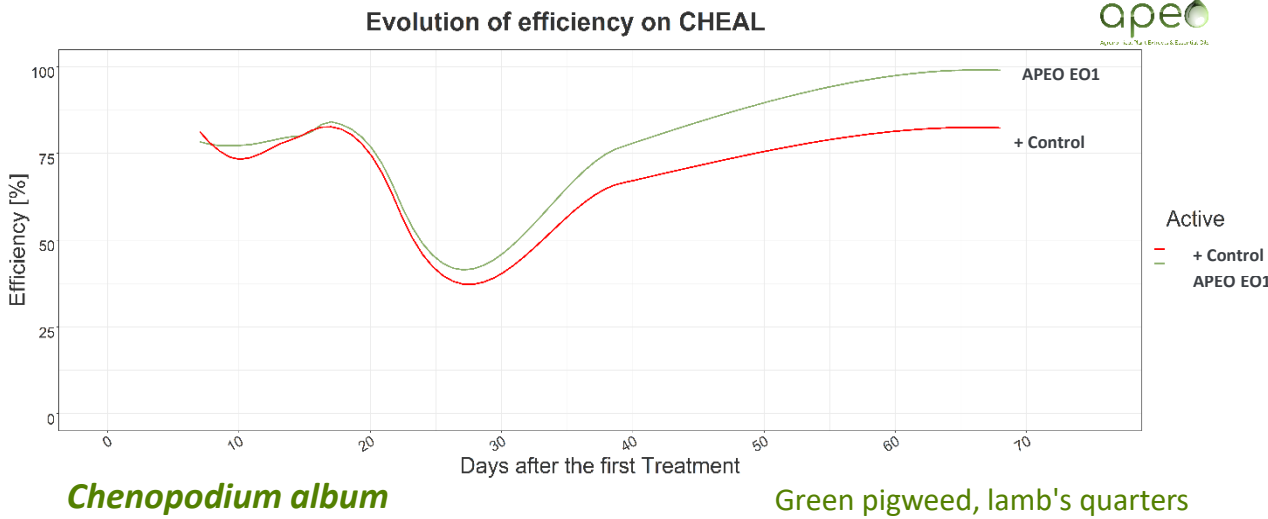
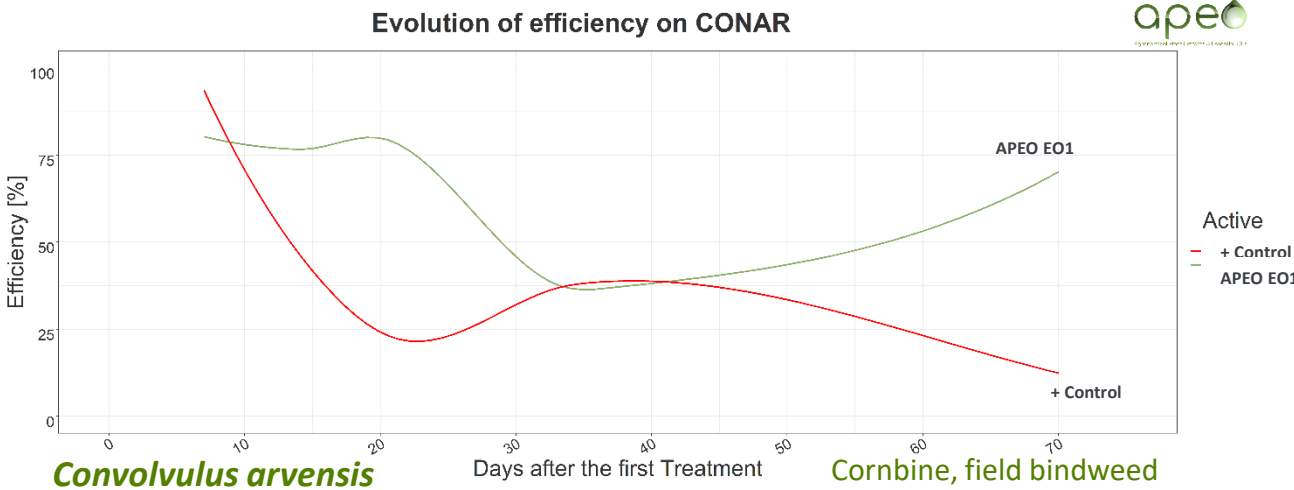
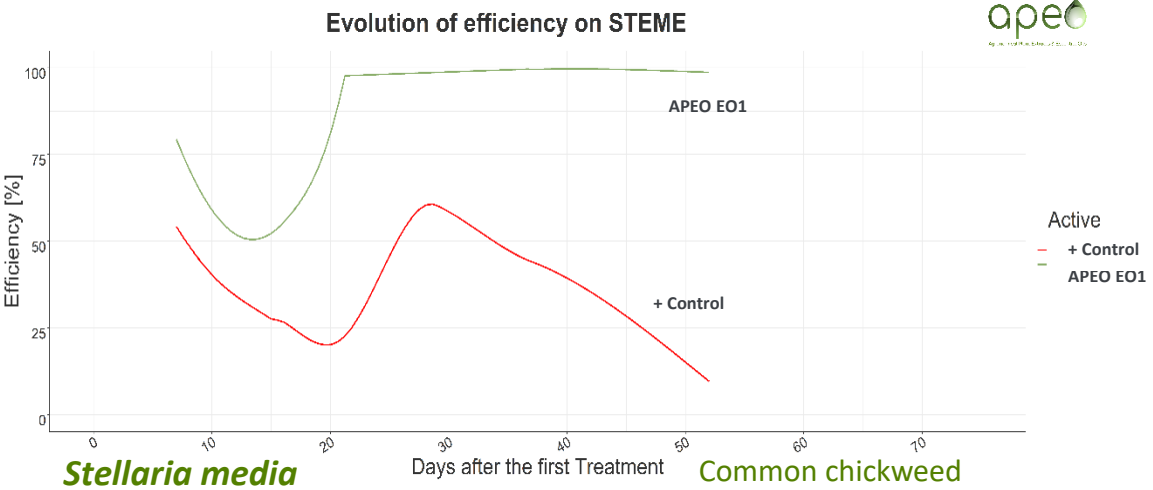
21 trials on 49 plants from 8 countries

APEO Property  
Commercial Use Only

# Characteristics of APEO EO1 – EFFICACY



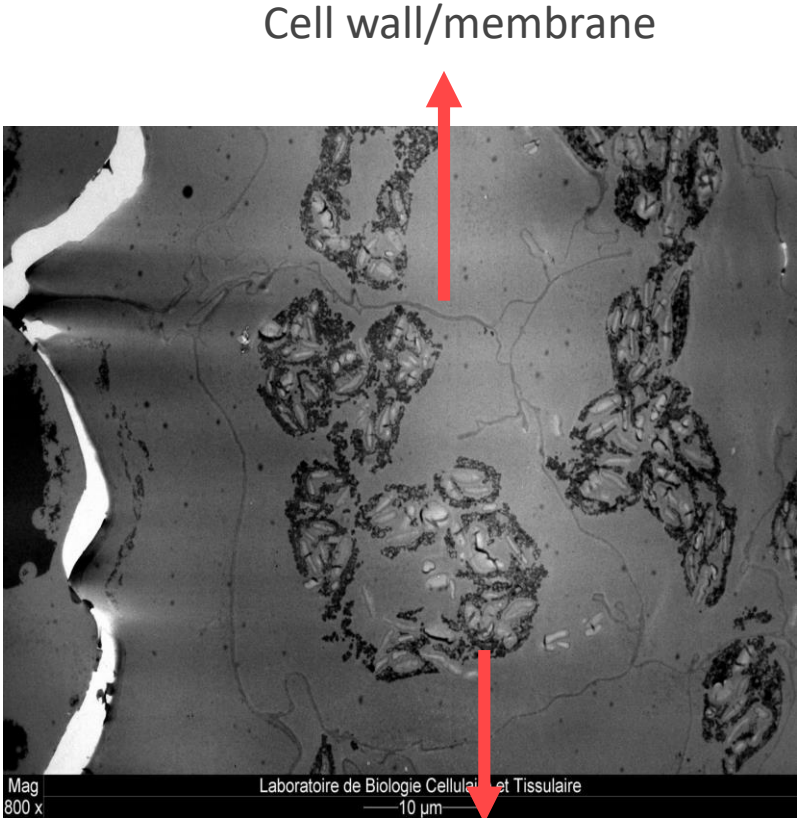
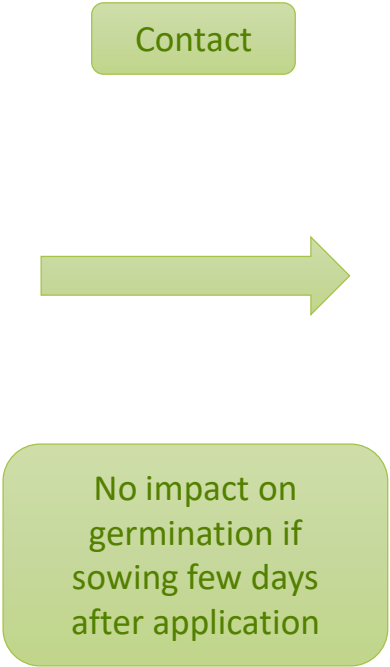
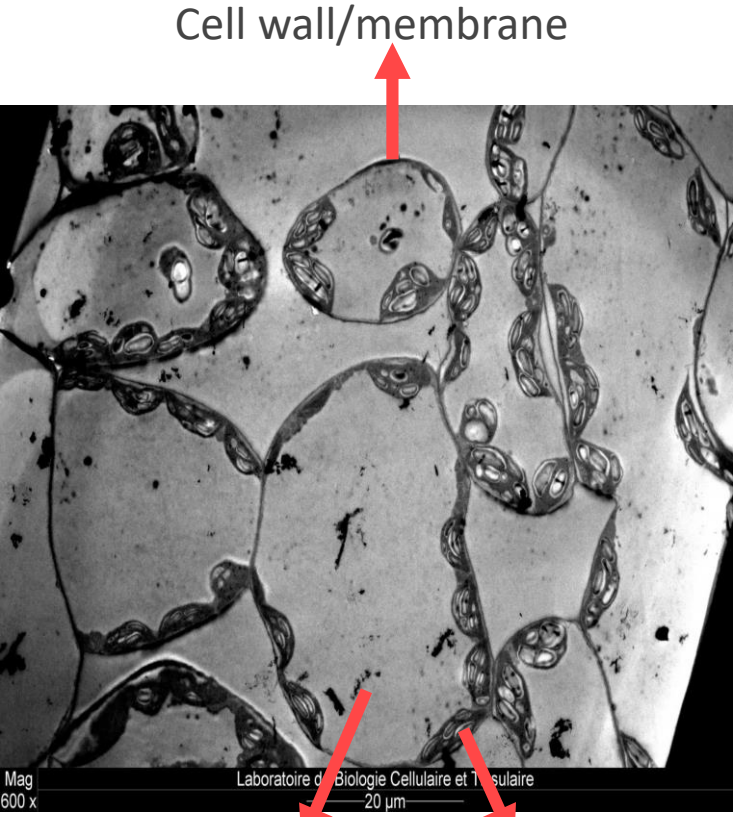
## Residual activity



# Characteristics of APEO EO1 – MODES OF ACTION



## Effect on plant cells



Effect on roots



Vacuole      Cytoplasm

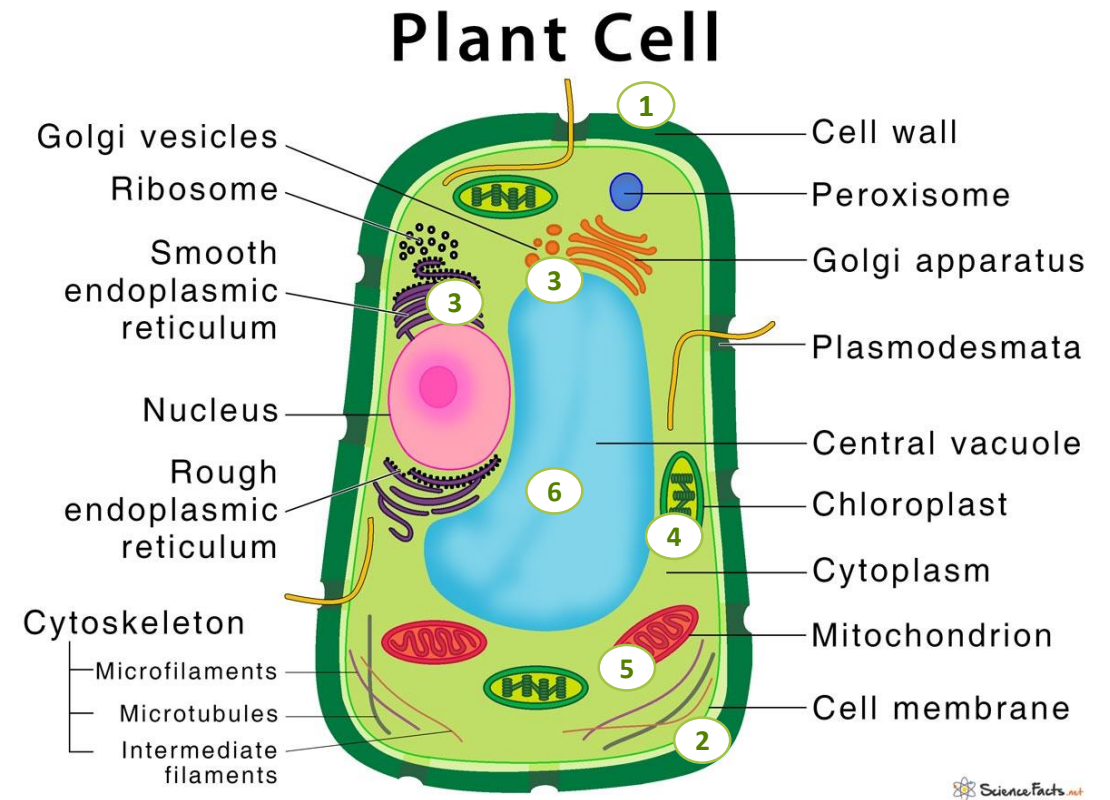
Normal plant cell

Plant cell after application of APEO EO1

# Characteristics of APEO EO1 – MODES OF ACTION

## Multisite effect

1. Inhibition of membrane cell synthesis
2. Alteration of membrane proteins,
3. Destabilization of lipid organization and electrolyte leakage
4. Destabilization of protein synthesis
5. Inhibition of photosynthesis (Chloroplast)
6. Inhibition of cellular respiration
7. Total disappearance of the vacuole



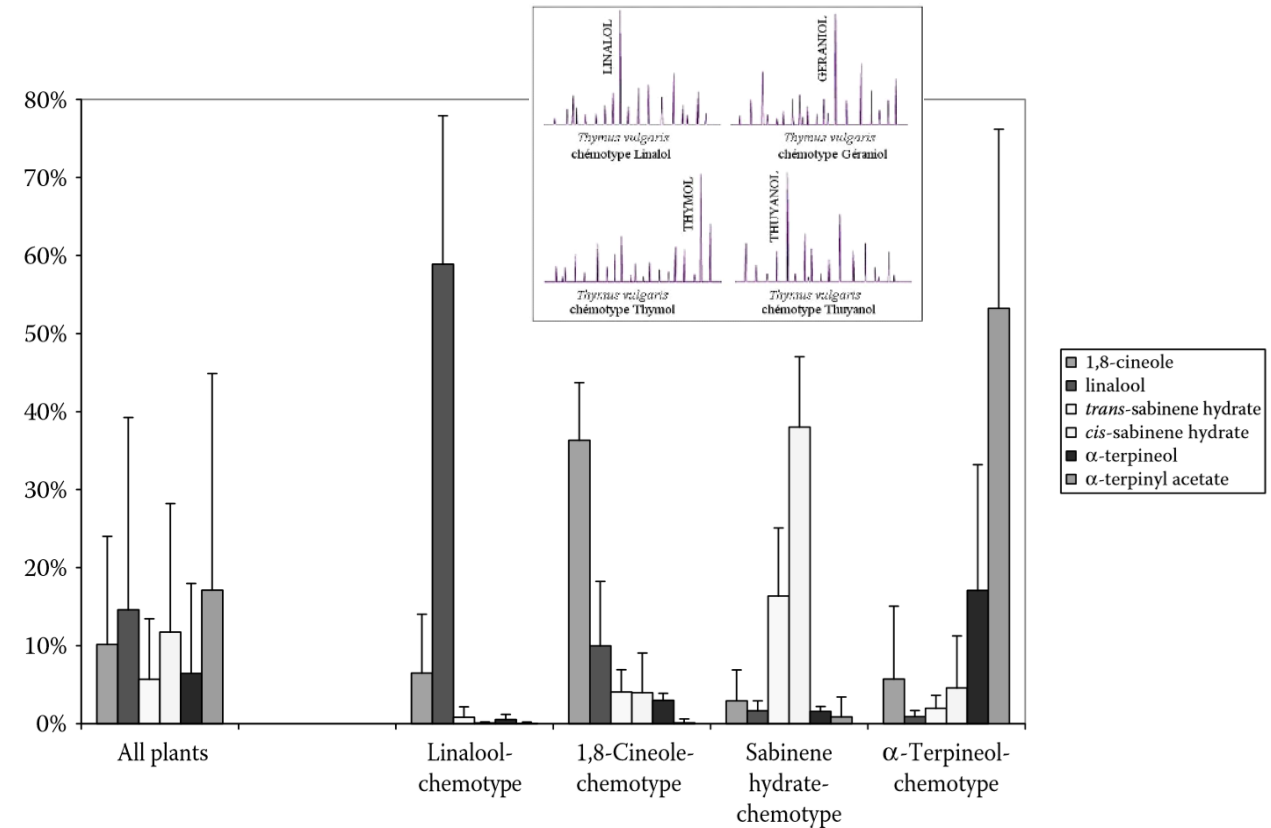
# Characteristics of APEO EO1- Insuring the sourcing

## Chemotype

Chemotype = intraspecific variation  
Chemotype of *Thymus vulgaris*



Selection of our suppliers  
according to the right chemotype  
and its stable composition



Source graph : Baser, K. H. C., & Buchbauer, G. (2015). *Sources of essential oils. Handbook of Essential Oils: Science, Technology, and Applications, Second Edition*, p.52 . <https://doi.org/10.1201/b19393>

This is not our active ingredient but just an example

# Conclusions



- **APEO E01**

- ✓ RTU formulation for H&G, water based
- ✓ Ongoing submission of registration dossier
- ✓ Ongoing distributorship investigation

RTU herbicide by spraying application



- **APEO E04**

- ✓ One formulation for professional use under development
- ✓ Non-selective weed control
- ✓ Potato leaf kill
- ✓ Vines shoot control

Suckering test – France 2021



APEO E04



Untreated

# Perspectives



Code	Market	USES	Formulation	First Sales	
APEO EO1	H&G	Non-selective Herbicide on permeable an non- permable soil	RTU	2026	} Herbicides
APEO EO2	H&G	Non-selective Herbicide on permeable an non- permable soil	Concentrated	2027	
APEO EO3	H&G	Algicide on semi and non-permeable soil/material	RTU	2027	} Biocide
APEO EO4	PRO	Non-selective Herbicide Grapes, Fruit trees, Potatoes	Concentrated	2028	} Herbicides
APEO EO5	H&G	Selective Herbicide on permeable an non- permable soil	RTU	2028	
APEO EO6	H&G	Selective Herbicide on permeable an non- permable soil	Concentrated	2028	
APEO EO7	PRO	Selective Herbicide Cereals	Concentrated	2030	
APEO EO8	PRO	Fungicide against Potato mildew	Concentrated	2029	} Fungicides
APEO EO9	PRO	Fungicide against Apple scab	Concentrated	2029	
APEO EO10	PRO	Fungicide against Powdery mildew on grapes, strawberries...	Concentrated	2030	
APEO EO11	PRO	Fungicide against Cercospora leaf spot on sugar beet	Concentrated	2030	

# Thank you for your attention



2026-2027 Plant Protection Products & Essential Oils



First sales in US, then in Europe

2023



Submission of Registration dossier for RTU bio-herbicide for H&G market

2022



Patented Selective co-formulants (PCT/EP2023/069144)

2021



Creation of APEO, a **spin off** company from ULg **secured** from private investors and grants

2018



Patented natural Formulation (patent# WO2019238948A1)

2011



Selection of **Essential oils** for their fungicidal and herbicidal properties

## Follow us

[apeosolutions.com](http://apeosolutions.com)

Website



APEO solutions

LinkedIn

