ESSENTIAL OIL-BASED BIOPESTICIDE FOR APPLICATION BY TREE-INJECTION IN FRUIT ORCHARDS

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Laboratory of chemistry of natural molecules
Presentation summary

- Apple and pear productions
- Orchards main pests
- Conventional pesticides
- Essential oils in agriculture
- Research axes and progress
- Biological test : Rosy apple aphid
- Take home message
Apple and pear productions

- World = 89 million tons
- Europe = 10 million tons
- Belgium = 240,000 tons

- World = 16 million tons
- Europe = 2.6 million tons
- Belgium = 280,000 tons

(FAOSTAT, 2016)

Important market but many damages...

- Apple scab – Venturia inaequalis (Cooke)
- Codling moth of apples and pears – Cydia pomonella L.
- Fire blight – Erwinia amylovora (Burrill)
Orchards main insect pests

- Sap sucking insects
  - Deformation / Loss of leaves and fruits
  - Decrease in photosynthesis
  - Sugar-rich honeydew secretion (mold development)
  - Disease transmission (phytoplasma)

**Yield loss of 20%!**
Conventional pesticides

- Pyrethroids, neonicotinoids, etc…
- Effects on human health
- Chemical residues
- Biodiversity loss
- Water pollution
- Insects’ resistance

Need for alternatives!
Essential oils in agriculture

- Renewable source
- Biological properties!
  - Repulsive and insecticidal properties
- Constraints
  - High volatility
  - Sensitivity to abiotic factors
  - Phytotoxicity of some EOs
Research axes and progress

- 1) Selection, formulation and application of essential oils
- 2) Study of phytotoxic properties
- 3) Emitted and contained volatile organic compound (VOC) profiles
1) Selection, formulation and application of essential oils

- Spearmint, peppermint, Thyme (savory leaf/thujanol), Tea tree, Chinese cinnamon tree, Clove tree
- Essential oil nano-emulsion (<200nm) with tween surfactants
- Design of a laboratory injection method
2) Phytotoxic properties of allelopathic compounds

- Inhibition of cell division and elongation
- Increases in cell membrane permeability
- Influence on respiration
- **Effect on plant photosynthesis**
Photosynthetic activity of injected trees

- Fluorimeter
- Maximum quantum efficiency of photosystem II (Fv/Fm)
- Infra-red gas analyser (IRGA)
- Net CO2 assimilation rate/net photosynthetic rate (A)

No significant impact on the photosynthesis apparatus
3) Volatile organic compound (VOC) profiles emitted and contained

- TDU-GC-MS/ DHS-GC-MS
- Up to ng per g of dried leaf
- Essential oil major compounds quantification + other compounds modifications

![Graphs showing changes in leaf content over time](image-url)
3) Volatile organic compound (VOC) profiles emitted and contained

- Principal component analysis (PCA) on the resulting profiles
- Variation in terpene and stress compounds indicates a significant reaction of the plant

<table>
<thead>
<tr>
<th>CP 3</th>
<th>CP 4</th>
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<tbody>
<tr>
<td>Caryophyllene</td>
<td>γ-Muurolone</td>
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<tr>
<td>(3E,7E)-4,8,12-Trimethyltrideca-1,3,7,11-tetraene</td>
<td>δ-Cadinene</td>
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<tr>
<td>Germacrene D</td>
<td>α-muurolone</td>
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<tr>
<td>Methyl salicylate</td>
<td>Non identif 12</td>
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<tr>
<td>β-Ocimene</td>
<td>Methyl salicylate</td>
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Biological test: Rosy apple aphid

- Clip-cage on injected trees
- Dysaphis plantaginea larvae in stage 2

Rosy apple aphid mortality curve

Significant death rate after 3 days of injection
What’s next?

- Field trials: effective?
- Effect on auxiliary insects?
- Impact on fruit production?
Take home message

- Demonstration of diffusion and occurrence in the plant tissues
- Demonstration of the physiological impact of these xenobiotics on the plant
- Demonstration of efficiency on the target insects
- Essential oils can be used in agricultural practices as bio-pesticides
Thank you very much for your attention!