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The effects of adjuvants on the wetting, foliar uptake and efficacy of agrochemicals

IPPS Conference 2017

Hans de Ruiter

Items presentation

- **What is an adjuvant?**
- **Brief introduction SURfaPLUS**
- **Examples** of adjuvant effects on performance PGR and an insecticide
- **Adjuvants**: mode of action and chemistry
- **Foliar uptake pesticides**: factors determining uptake
- **Benefits and risks adjuvants**

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Adjuvants in agrochemistry

- **Product that enhances the performance of a pesticide or a fertiliser without having a direct effect on the viability of the pest or the crop.**

- **Synonyms**
  - **Additives**
  - **Activators**

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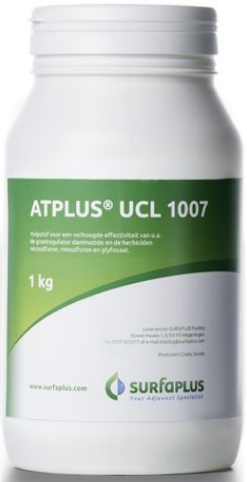
ADJUVANTS (NL)
Our products in NL

NEWS FOR SPECIALISTS
About adjuvants & formulations

ADJUVANTS INTERNATIONAL
Availability products outside NL

RESEARCH
R&D based products



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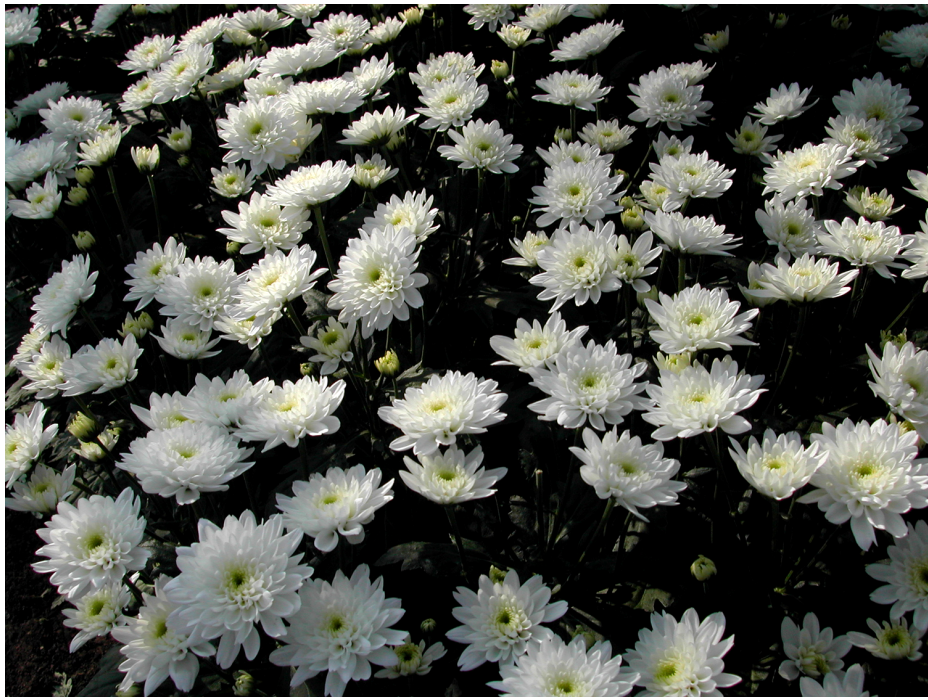
Variability in application rate of PGR daminozide

- Chrysanthemum cultivars
- Growth stage
- Climatic conditions in the greenhouse



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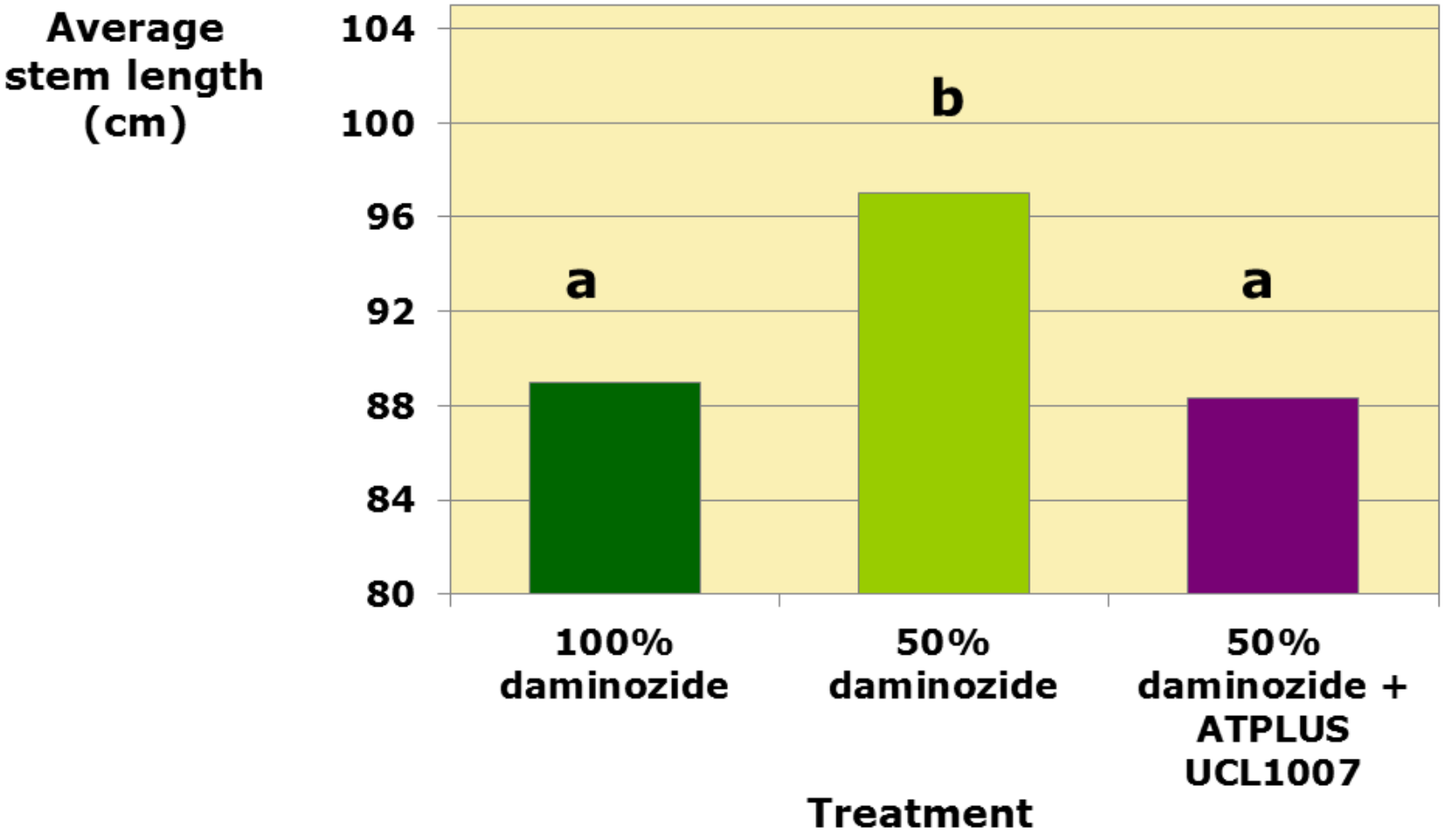
Effect of adjuvant on daminozide performance

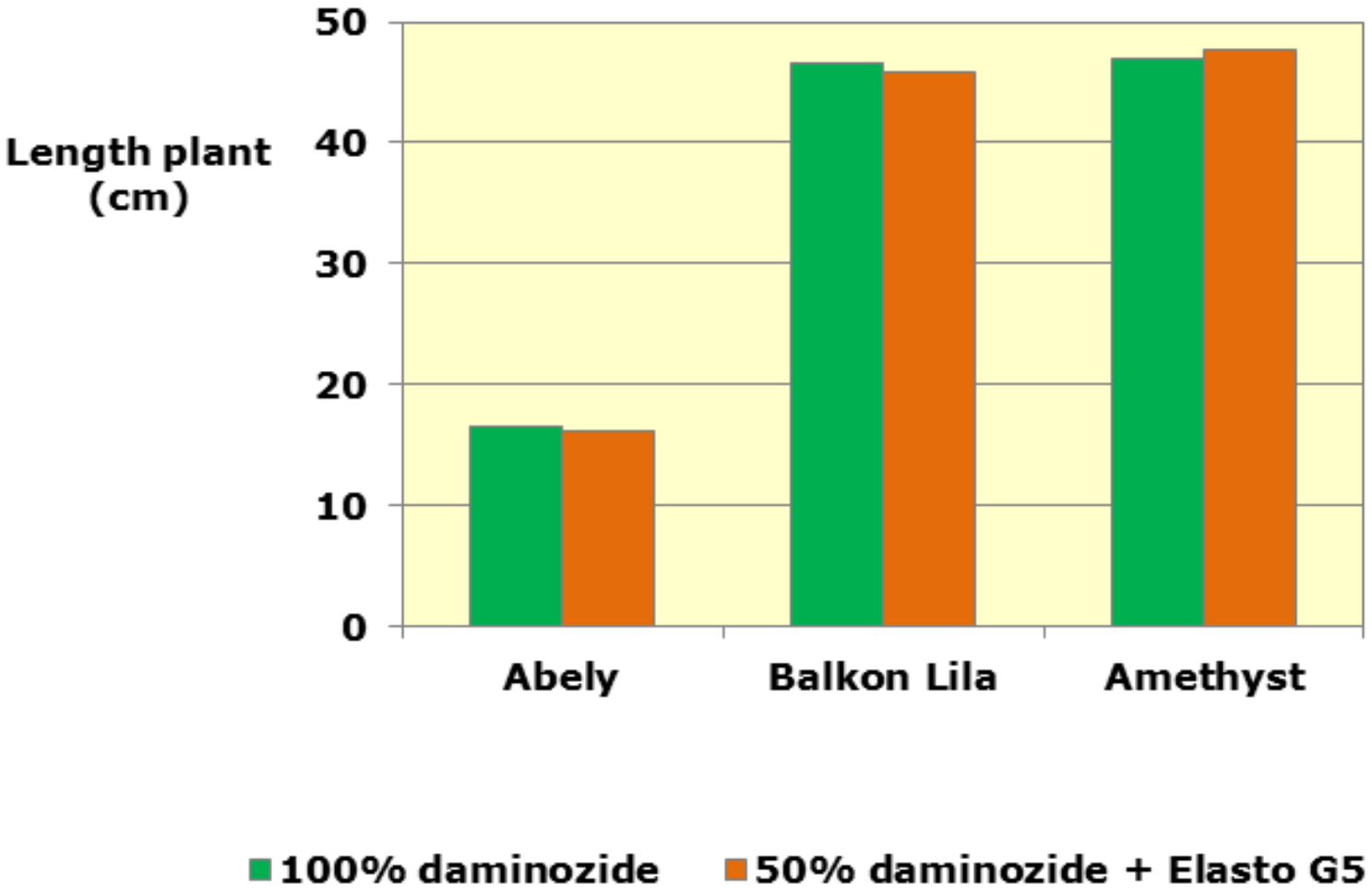


Cost reduction application 50% daminozide and ATPLUS, Netherlands

Standard daminozide rate=100% (g product/L)	Cost Reduction at 50% (€/1000 m²)	Cost reduction at 50% (% of normal costs)
2	2.90	11
3	9.40	24
4	15.90	31
5	22.40	34
6	28.90	37


3A

Effect of adjuvant on daminozide performance - Pelargonium



50% reduction daminozide with Elasto G5 tested & recommended with:

Hydrangea/Petunia/Verbena/Sutera/Campanula/SunflowerPlatycodon/Viola cornuta/Potted chrysanthemum

Chrysanthemum multi/Dahlia/Dahlietta/Solanum rantonnetii/Lavender/Pelargonium/Kalanchoe

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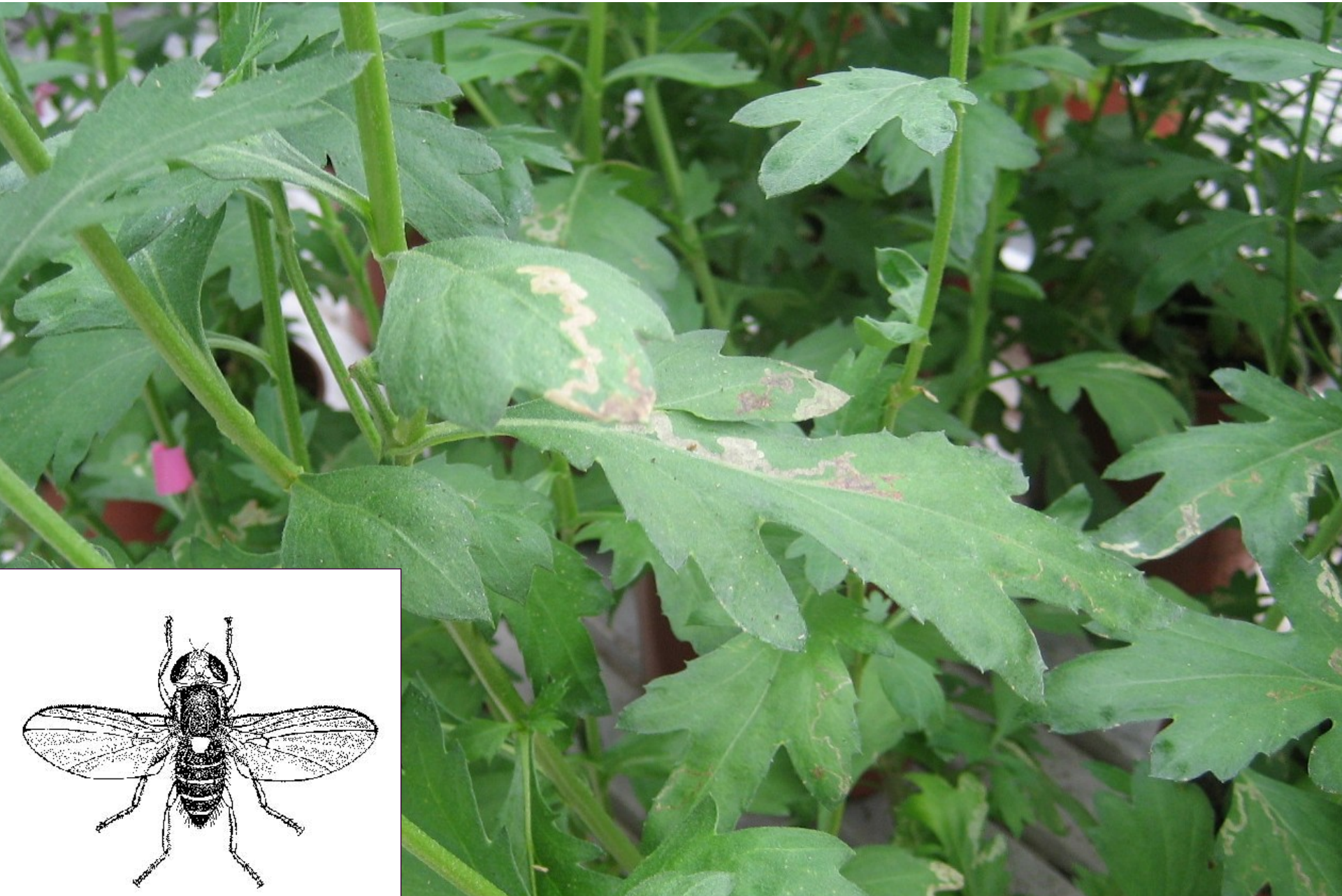
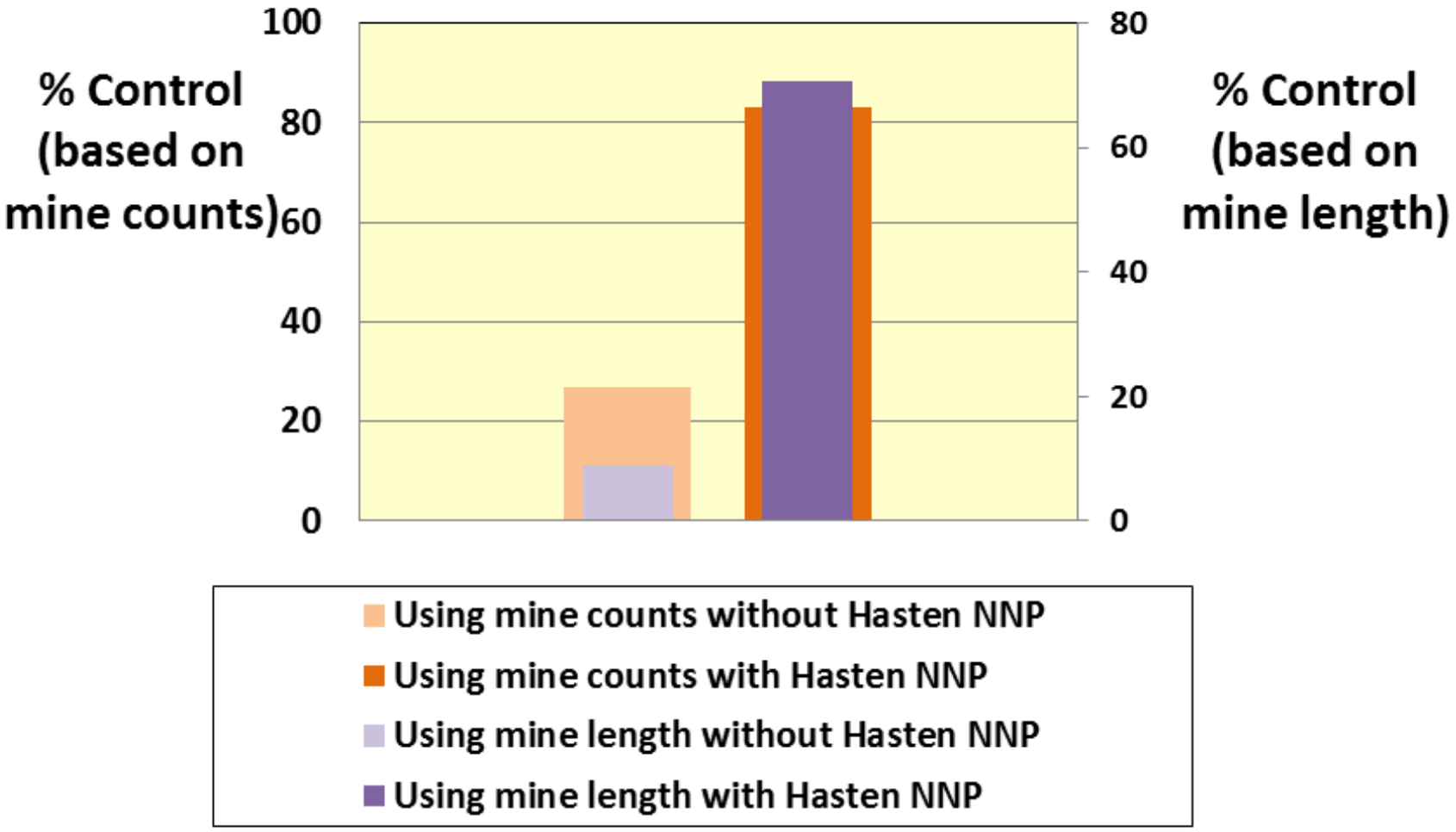
Cost reduction application Elasto G5 and 50% daminozide

Standard daminozide rate=100% (g product/L)	Cost Reduction at 50% (€/1000 m²)	Cost reduction at 50% (% of normal costs)
1	3.30	25
2	9.80	38
3	16.30	42
4	22.80	44
5	29.30	45
6	36.00	46

Esterified seed oil-abamectin-miner flies



Effect of esterified seed oil on performance of abamectin-miner flies

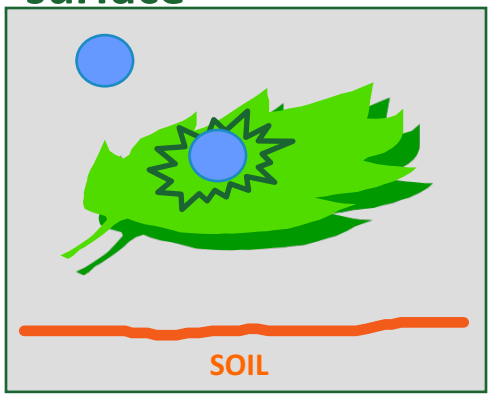


Way of a spray drop

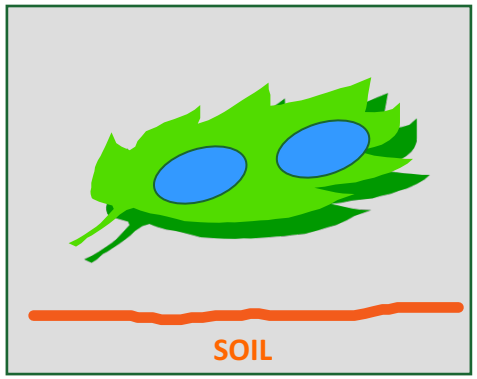
Drift

Goes into canopy

Bounces on leaf surface

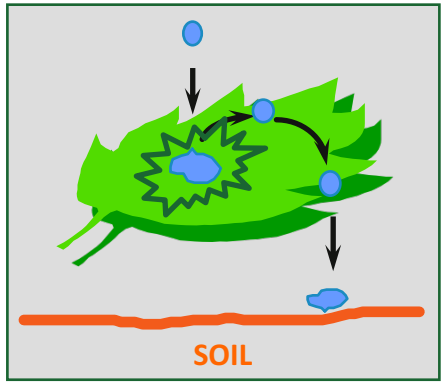


+Adjuvant



Retained, stays on leaf

Water



Bounces off

Source: Solvay

The fate of the a.i. step-by-step

1. Drops leave the nozzle (drift and volatilisation)
2. Drops land on the leaf (retained or bounces off)
3. Landed drop spread (yes, no, a little)
4. Contact a.i. with the pest and the crop
5. Uptake and transport (if any) into the pest and crop
6. Biological performance

Quite inefficient process; adjuvants increase efficiency

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1. Drift reduction

- **Name**: drift retardant
- **Classes**: oils, esterified seed oils, polymers [polyacrylamides, polyethylene- and propylene oxide, guar gum and other carbohydrates]
- **Effect**: less drops with diam.<100 µm

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2. Reduced emission during the drop flight and after landing

- **Name**: “anti-evaporant”
- **Classes**: oils, esterified seed oils, waxes
- **Mode of action**:
  - **Bigger drops reduce liquid/air interface**
  - **Active ingredient dissolves partly in the adjuvant and this can reduce emission**

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Effect of rapeseed oil on volatilisation of fungicide fluazinam (Shirlan)

- 30 minutes gently shaking at 50 °C
- Analysis fluazinam in air samples taken from the vials

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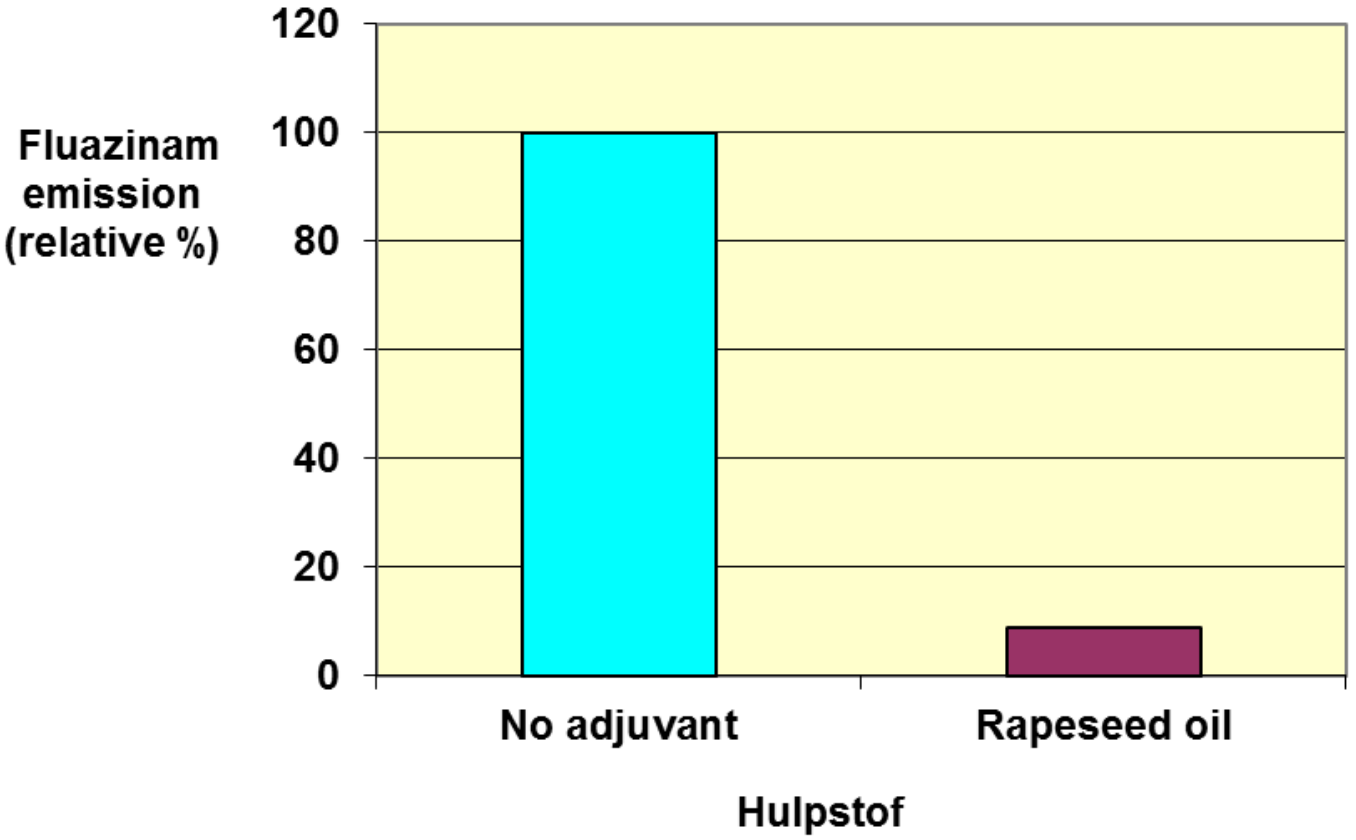
Effect of rapeseed oil on volatilisation of fungicide fluazinam (Shirlan)



De Ruiter *et al*, 2003
(PRI, IMAG, TNO)

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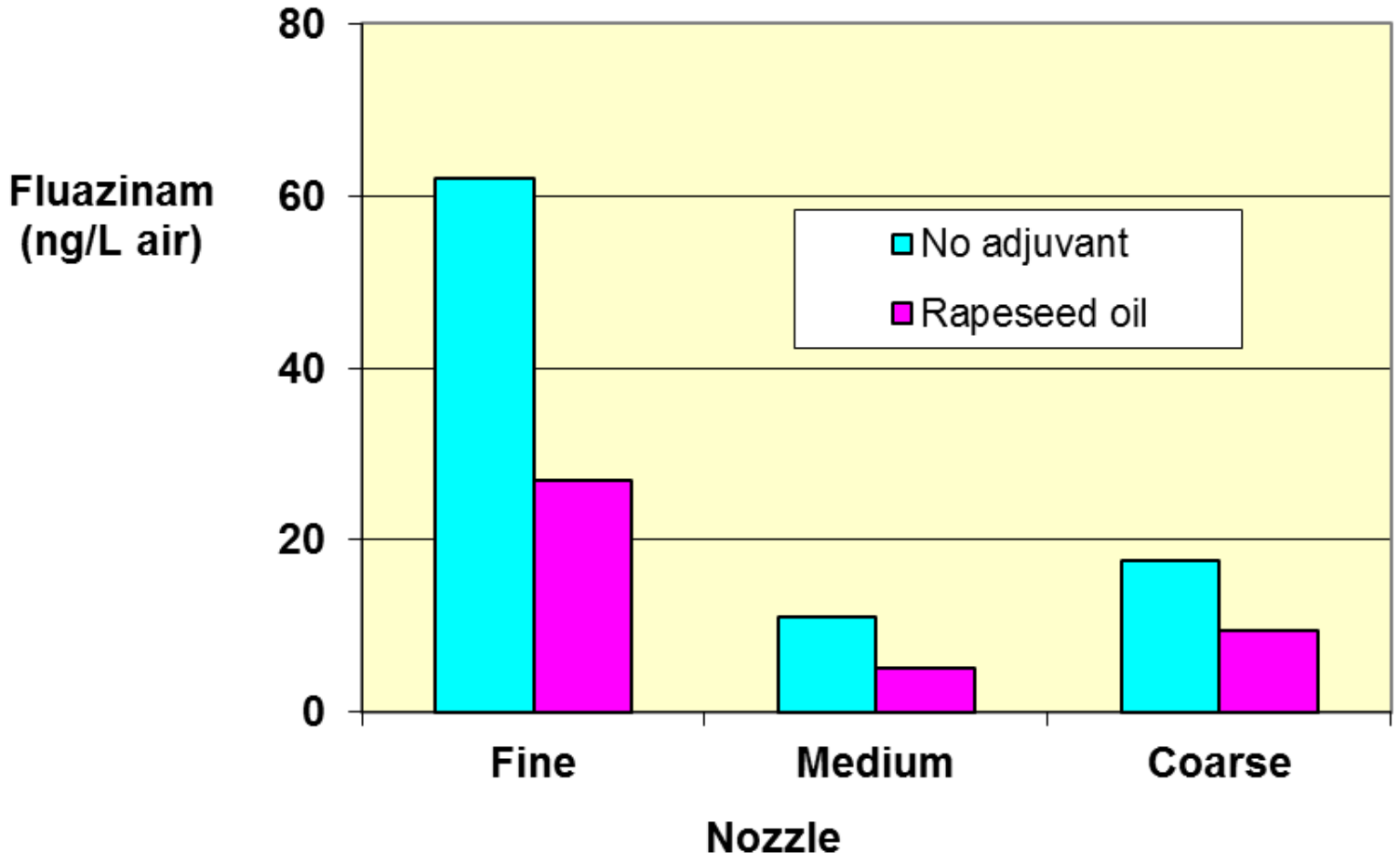
Effect of rapeseed oil on volatilisation of fungicide fluazinam (Shirlan)
Under realistic spray conditions



3. Drop retained on the leaf surface

- **Name**: Deposition aid or deposition agent
- **Classes**: surfactants, oils, esterified seed oils, polymers e.g. polyglycerol esters
- **Mode of action**:
  - **Lower surface tension the moment of landing**
  - **Lower (visco)elasticity**
  - **Absorption bounce energy by polymers**

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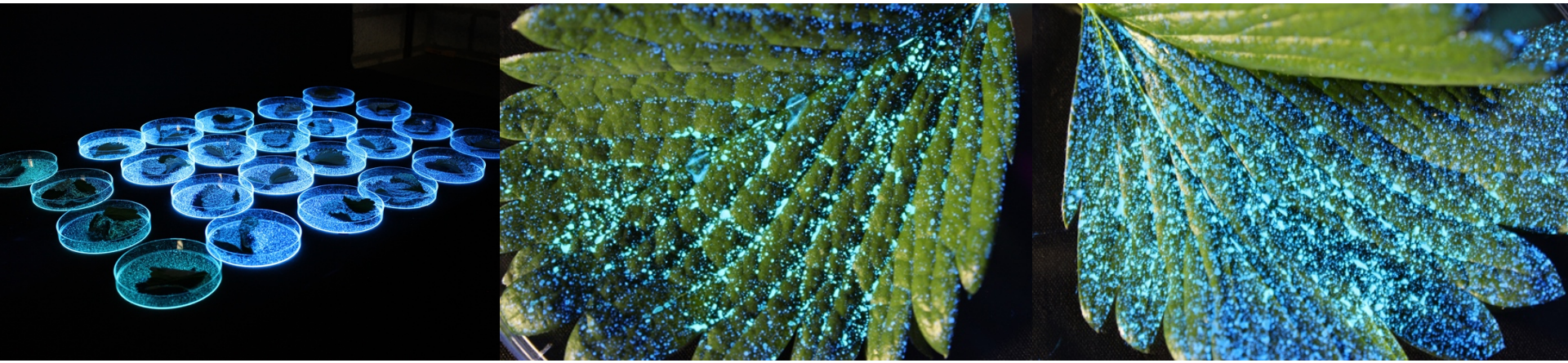
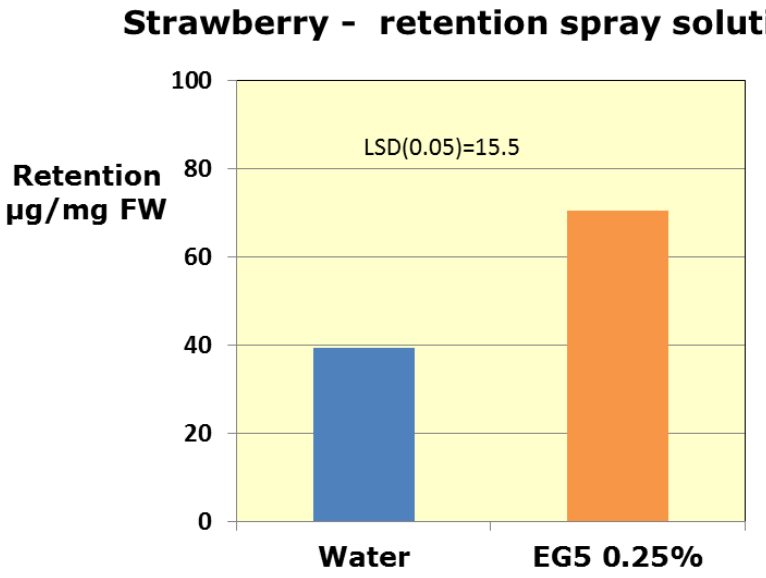
Effect of Elasto G5 on spray deposition strawberry



Water

Elasto G5 0.25%



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3. Improved spreading landed drop

- **Name**: wetter, super wetter
- **Classes**: surfactants, oils, esterified seed oils, polymers e.g. polyglycerol esters
- **Mode of action**:
  - **Lower surface tension**
  - **Adsorption of adjuvant to the leaf surface; less water repellent surface**

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4. Improved contact with pest and/or crop

- **Name**: sticker, sticking agent
- **Classes**: synthetic latex, polymers
- **Mode of action**:
  - **Sticks active ingredients to the surface**
  - **Often better spreading of landed drops as well**

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Nu-Film® P
Spreader Sticker

- Many products available (globally)
- Effects not always documented
- More scientific data needed

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5. Improved foliar uptake active ingredient

- **Name**: “penetrator”
- **Classes**: surfactants, oils, esterified seed oils, ammonium sulfate, urea, modified triglycerides, polymers e.g. polyglycerol esters.
- **Mode of action**:
  - **Dissolving active ingredient in drop residue**
  - **Increasing permeability of the wax layer; NOT DISSOLVING THE WAX LAYER**

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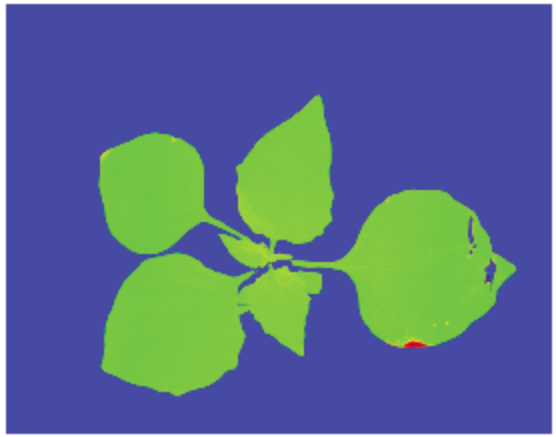
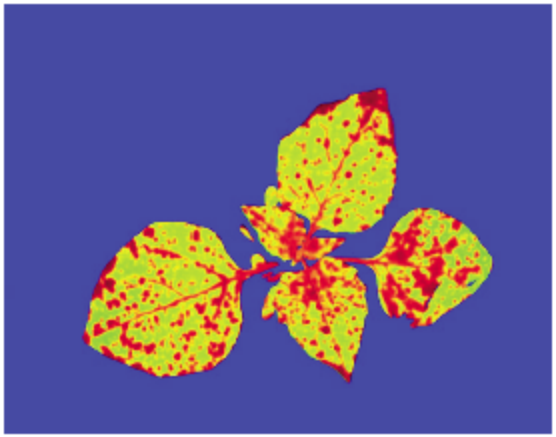
Effect esterified canola oil on the foliar uptake of bentazone into black nightshade

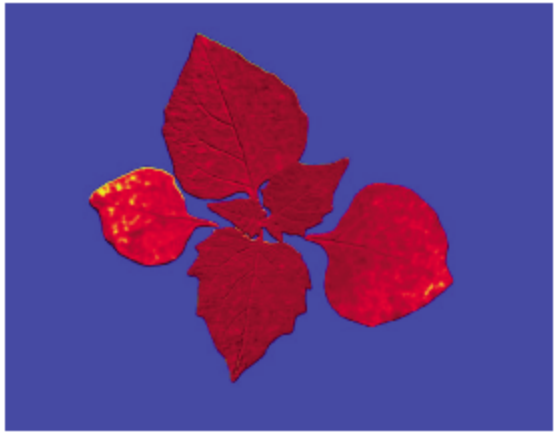
-via fluorescence imaging-



Untreated 4h



Bentazone 4h



Bentazone+Hasten 4h

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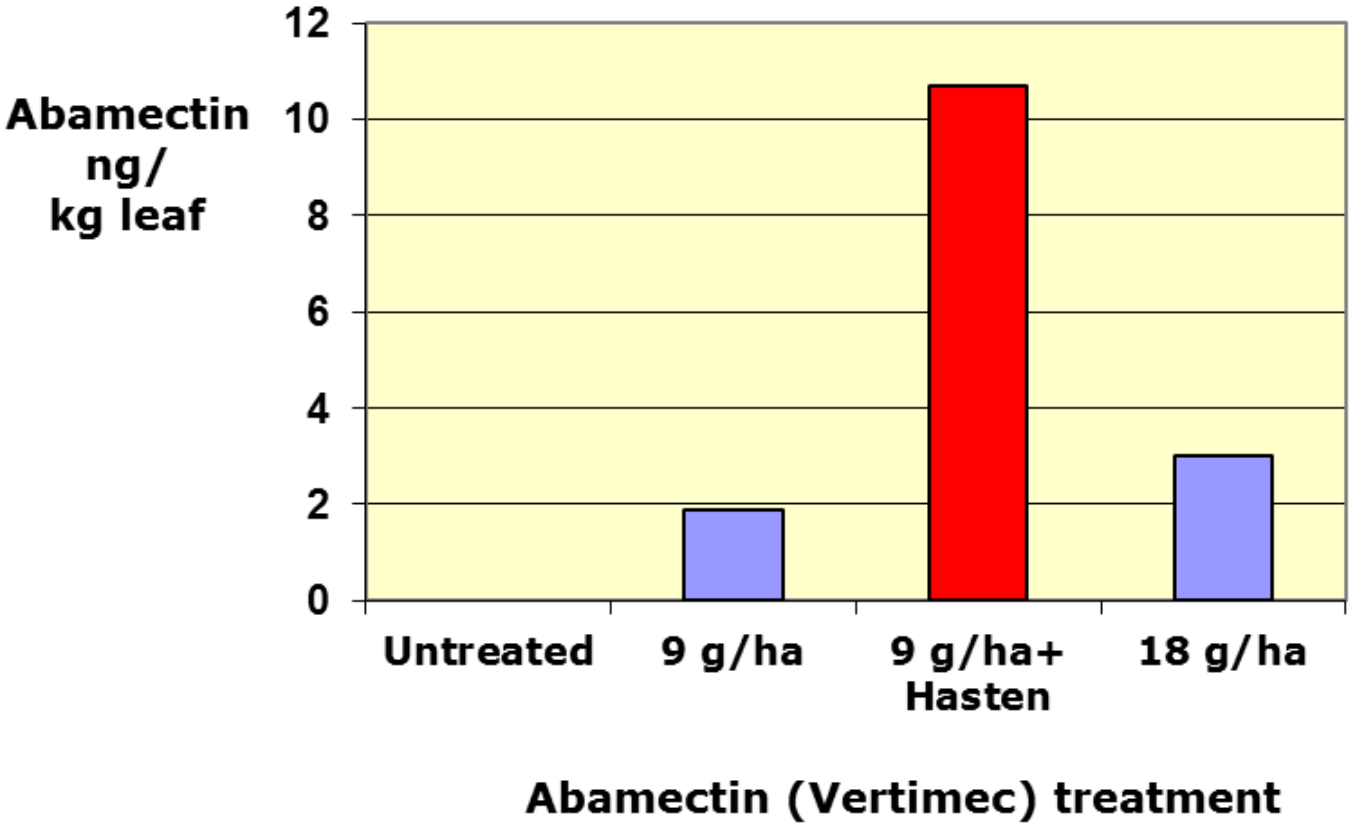
Effect of esterified seed oil on uptake abamectin

-chrysanthemum leaves sampled 48 h after spray application-

Delphy/TNO/SURfaPLUS



Adjuvant selection

- **Functions**: most adjuvants have more than one function
- **Route**: knowing the route (contact, translaminar, systemic) facilitates the choice of adjuvant
- **Chemistry a.i.:** knowing the physical-chemical properties of the a.i. facilitates the choice of adjuvant
- **Chemistry adjuvant**: knowing the adjuvant properties facilitates the choice of adjuvant

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Uptake active ingredients

- Literature survey
- 32 articles
- 22 active ingredients
- 100 (experimental) formulations
- 30 plant species

Bron: H. de Ruiter *et al.*– PRI 2004

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Uptake without adjuvants/formulations

- Generally **poor** uptake of a.i.'s
  - **Often < 50%**
  - **If ≥ 50% then after 20-70 hours**

- Uptake enhancing properties
  - **Liquid state in pure form; no crystals**
  - **Poor solubility in water allows passage of the wax layer and cell membrane**

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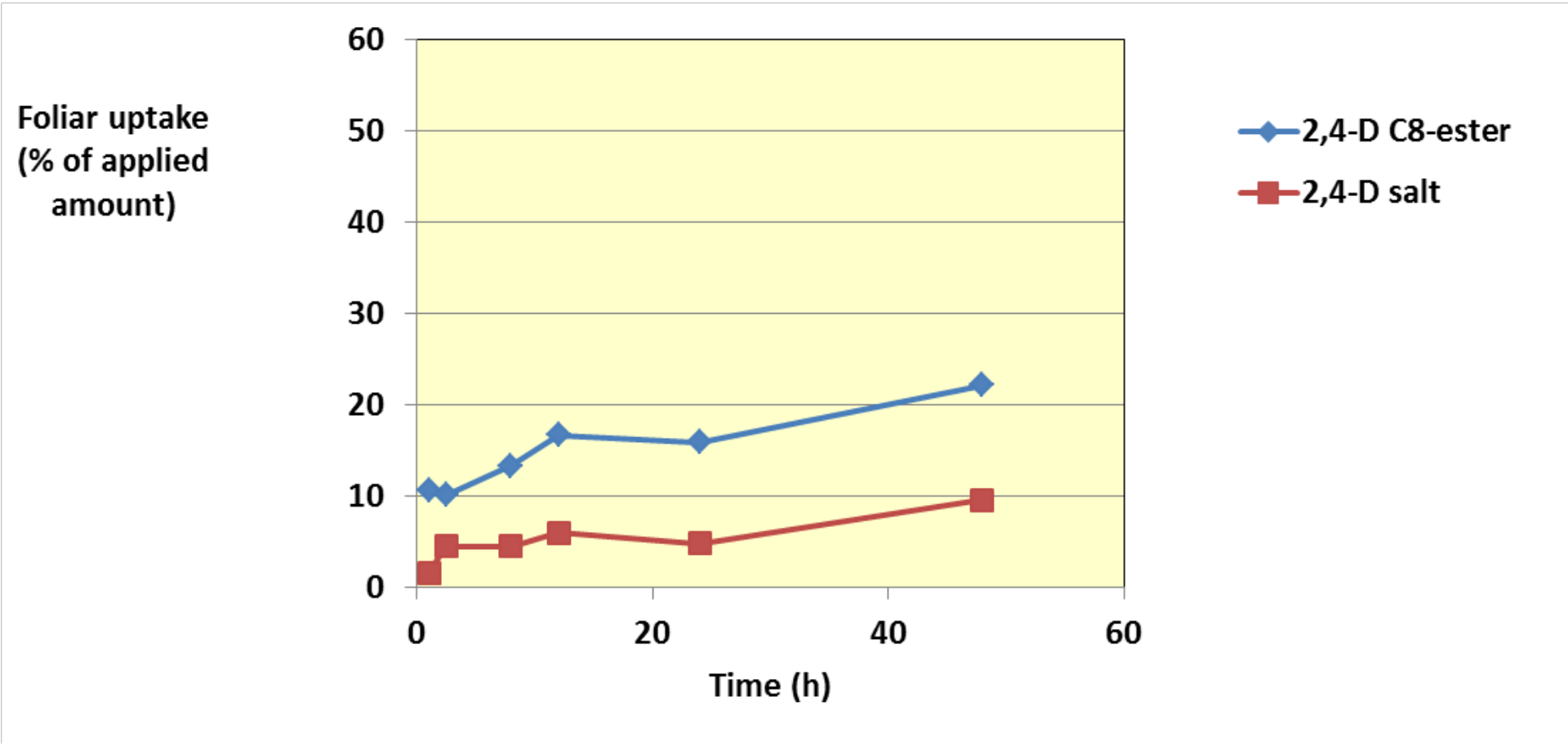
Uptake unformulated 2,4-D ester and 2,4-D salt

black nightshade



Data: de Ruiter et al. 1993

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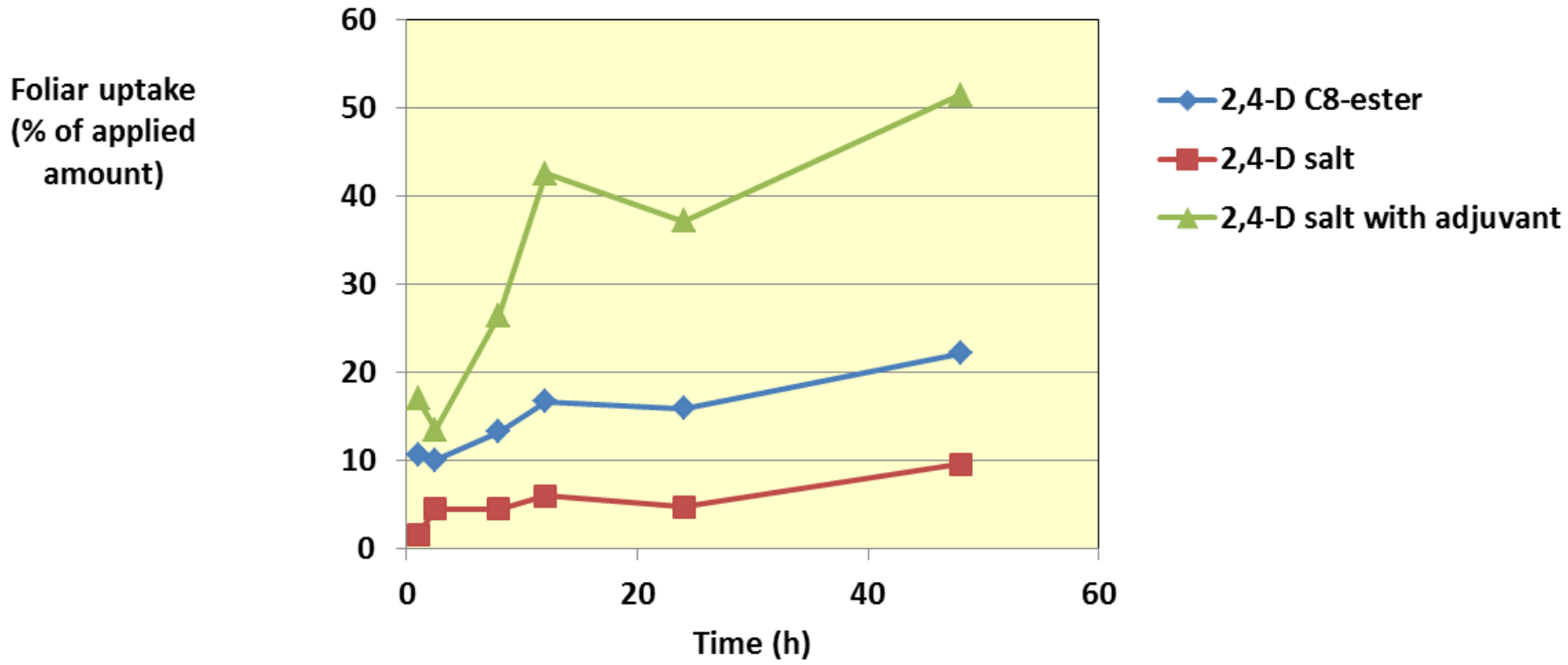
Effect of adjuvant on uptake of 2,4-D salt



Data: de Ruiter et al. 1993

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Properties adjuvants determine the choice for a certain adjuvant to increase uptake

- Adjuvant for water soluble a.i.'s (e.g. glyphosate, glufosinate)
  - Humectancy adjuvant results in solubility a.i. in "dried" drop deposit
  - Hydrophilic adjuvants enhances permeability of the wax layer for water soluble a.i.'s

- Adjuvant for a.i.'s poorly soluble in water (e.g. abamectin)
  - Dissolves a.i. in "dried"drop deposit; e.g. esterified seed oil
  - Makes the wax layer more permeable to lipophilic a.i.'s

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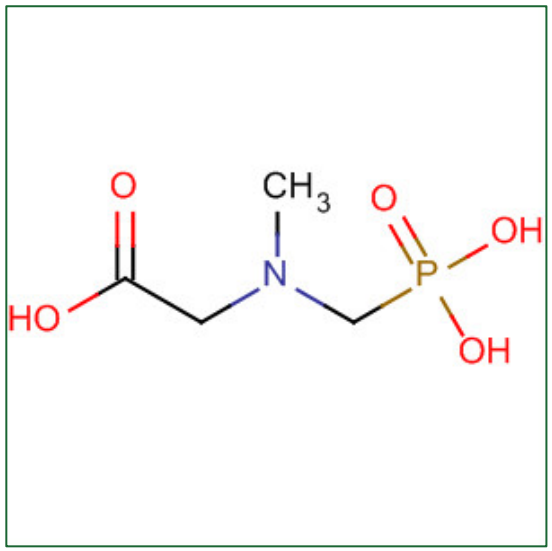
Example glyphosate salts

- Solid
- Very water soluble
- Foliar uptake only possible when solubilised
- Formulation ingredients are water and surfactants



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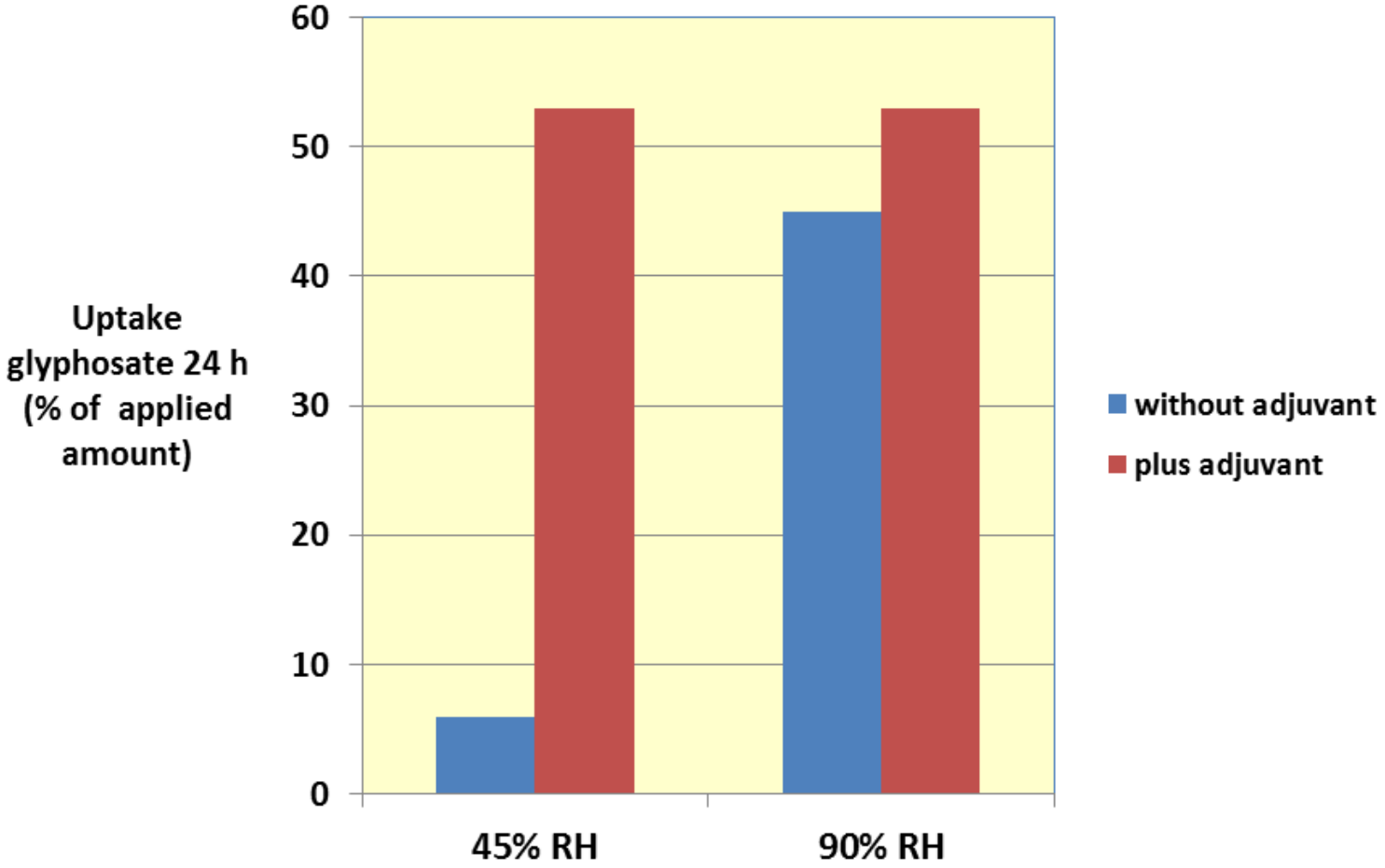
Effect of relative humidity and hydrophilic surfactant on glyphosate uptake

Black nightshade



Data: unpublished H. de Ruiter (PRI)

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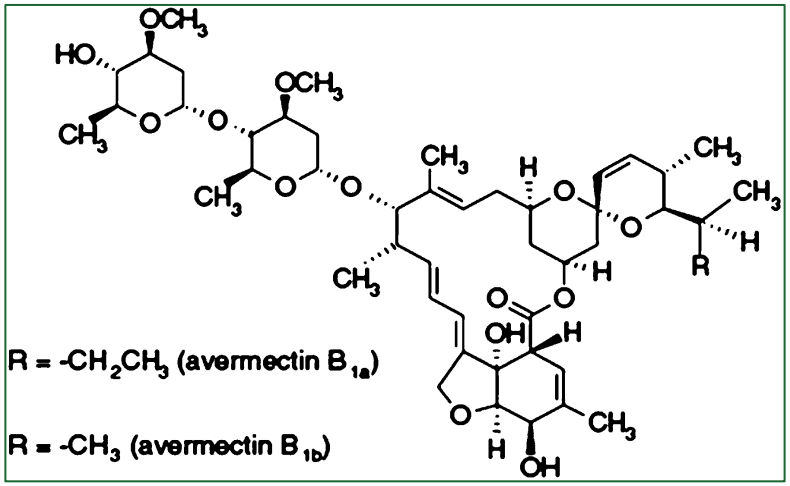
Example abamectin

- Solid
- Poorly soluble in water, soluble in organic solvents, e.g. esterified seed oil.
- Foliar uptake only possible after solubilisation
- Formulation ingredients cyclohexanol and emulsifiers (Vertimec EC)



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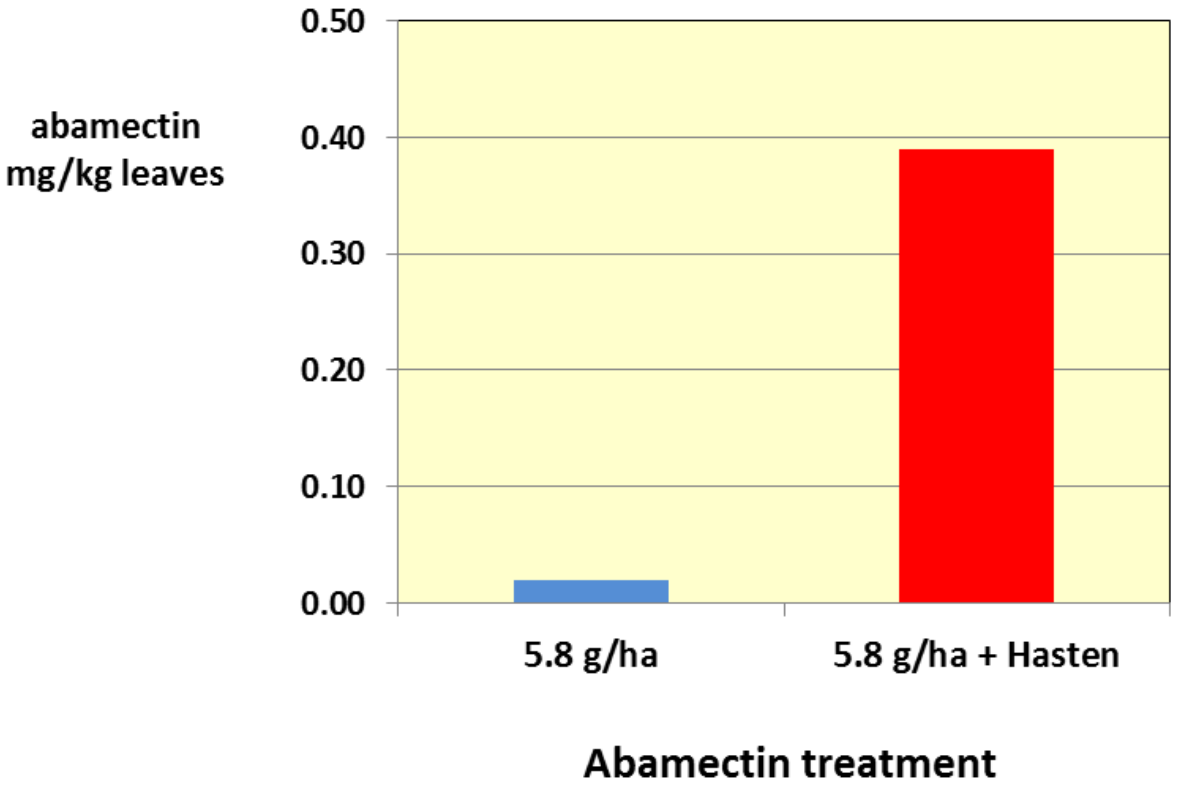
Effect of esterified seed oil on uptake abamectin –cucumber-

-Leaves sampled 24 h after application-

SURfaPLUS/Groen Agro Control



Solubilising active ingredient in adjuvant

- Demonstrated recently for tebucanozole (Folicur SC) and esterified seed oil with X-ray analysis
- Tebuconazole crystals dissolve in the adjuvant
- Therefore available for uptake into the leaves

Source: Webster *et al* 2016

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Benefits and risks adjuvants

Benefits:

- Better control of pests
- Reduction of pesticide use (per application or lower number of applications)
- Lower costs

Risks adjuvants:

- Phytotox when combined with “hard-to-the-crop” pesticides
- Using too “hard” adjuvants on sensitive crops

Always a pilot application at small scale when using the 1st time

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Availability SURfaPLUS products

- **Netherlands**
  - **Alle regular distributors and via www.surfaplus.com**
- **Denmark**
  - **Horticoop Scandinavia**
- **Germany**
  - **Under development with Syngenta and Royal Brinkman**
- **United Kingdom**
  - **Under development with Syngenta**
- **Other countries**
  - **Contact h.deruiter@surfaplus.com**

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Thanks for your attention!

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Update Xentarix test in paprika 2016

- En een opsomming is gauw gemaakt
- Met automatische bullets

- vervolg

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vvv

- En een opsomming is gauw gemaakt
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- enzovoorts