LEADING INSECTS BY THE NOSE: PERSPECTIVES FOR THE APPLICATION OF SEMIOCHEMICALS

PLANT RESEARCH INTERNATIONAL

Semiochemicals

- What are semiochemicals?
- Practical applications?
- How to do research on semiochemicals?

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What are semiochemicals?

Attractive:
- Pheromones
- Host plant odours

Repellent:
-(non-host) odours
-Alarm pheromones

Important:
- Behaviour

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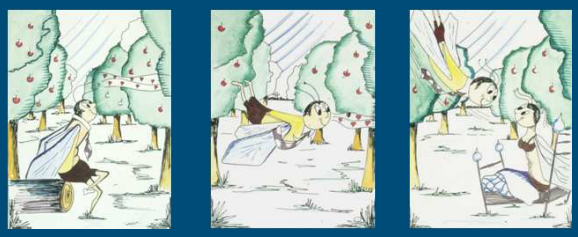
principle of sex pheromones



detecting source locating landing

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what are insect pheromones?

- odours (mostly attractants) emitted by insects
- exclusively emitted for communication between individuals of the same kind

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insect pheromones

- insect pheromones
  - alarm pheromones
    - aphids, ants
  - trail pheromones
    - ants, termites
  - aggregation/dispersion pheromones
    - weevils
  - sex pheromones
    - moths, beetles, etc. etc.

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composition insect pheromone

example of the component of a moth pheromone

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sex pheromones

> 500 pheromone references are available

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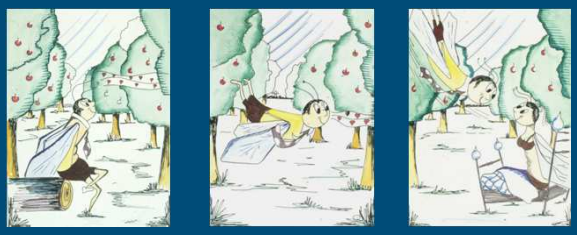
working mechanism

principles of sex pheromones



detecting source locating landing

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working mechanism

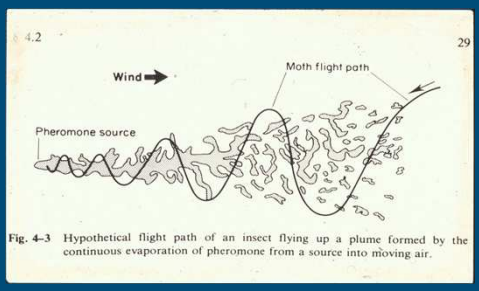


Fig. 4–3 Hypothetical flight path of an insect flying up a plume formed by the continuous evaporation of pheromone from a source into moving air.

PLANT RESEARCH INTERNATIONAL

Semiochemicals

- What are semiochemicals?
- Practical applications?
- How to do research on semiochemicals?

PLANT RESEARCH INTERNATIONAL

Application of semiochemicals

- monitoring
  - timing tool for pesticide application
  - identification tool
- mass trapping
  - trapping away the population
- mating disruption (sex-pheromones)
  - confusion of insects
- lure & kill (infect)
  - luring the insect towards a pesticide or pathogen
- push and pull
  - manipulate the distribution of insects
- Synergist
  - activate the insect

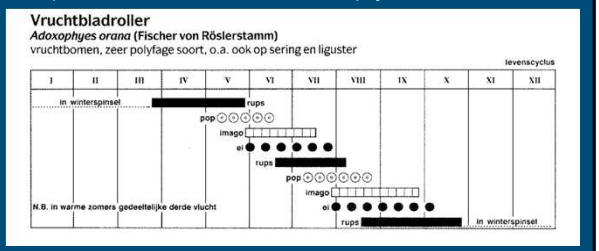
monitoring

monitoring (the past)

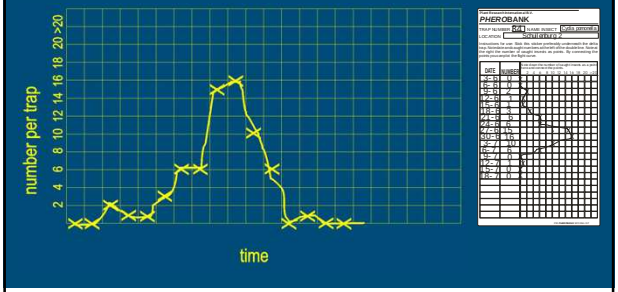
monitoring (nowadays) pheromone traps

pheromone traps to follow the life cycle

example: summerfruit tortrix moth *Adoxophyes orana*



monitoring pheromone traps



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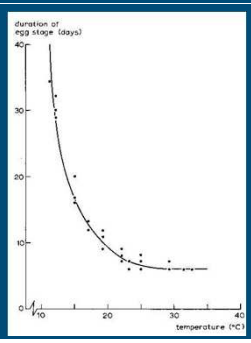
monitoring temperature sum



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monitoring

- factors influencing pheromone trap catches
  - trap type
  - pheromone dispenser type
  - purity and ratio of the pheromone components
  - trap maintenance
  - placement of the trap
  - density of traps

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monitoring examples in:

- amenity areas
- fruit growing
- green-houses
- arable crops
- golf links
- arboriculture
- …

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monitoring (amenity areas) chestnut leafminer

Reproduced with acknowledgement from
Entocare C.V., Wageningen, The Netherlands

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monitoring (fruit growing) funnel trap

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monitoring (fruit growing) transparant delta trap

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monitoring (green-houses) citrus mealy bug

gewasnieuws

POTPLANTEN

groene planten

LTO Groeiservice

Nieuwe feromoondop citruswolluis

Op seks beluste luis loopt in de val

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monitoring (green-house) *Duponchelia fovealis*

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monitoring (arable crops) wire worms

Agriotes lineatus
Agriotes obscurus

pest of potato, sugar beet, onion, lettuce, maize

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monitoring (arable crops) wireworms

Aanpak kniptorren werkt beter dan bestrijding ritnaalden

Vangst tellen in trechtervallen

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monitoring (golf links) garden chafer

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monitoring (golf links) garden chafer

Oosterhoutse Golfclub
25th May 2005

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monitoring (arboriculture) poplar (clearwing moth)

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mass trapping

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mass trapping

research on the possibility of mass trapping of *Symmetrischema tangolias* and *Scrobipalpuloides absoluta* in South America (Peru)

- larvae cause great losses of yield (up to 60%) in the growing of tomatoes and potatoes because of complete resistance against insecticides
- 30 pheromone traps per hectare can trap 40.000 moths a week and can reduce the damage with 75%

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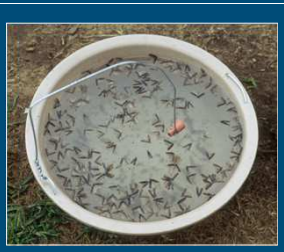
mass trapping

PLANT RESEARCH INTERNATIONAL

mass trapping water traps



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mass trapping *Rhynchophorus ferrugineus*

red palm weevil

up to 1000 mg pheromone
incorporated in a biodegradable matrix
last >45 days at 45°C day/35 °C night

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mass trapping

constraints in practice

- at least 95% of the males has to be caught before mating to induce reduction of the next generation
- generally too many expensive traps are required
- the application and maintenance of many traps is too expensive
- effectivity of traps should be higher than for monitoring

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mating disruption

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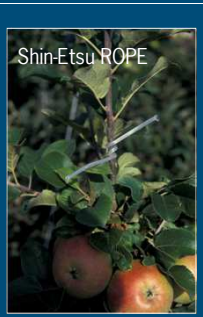
mating disruption

dispenser types



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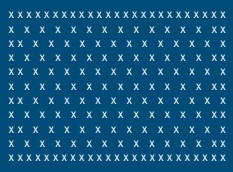
mating disruption — design



- 500 dispensers/ha
- extra border treatment
- adjacent orchards: zone of 25 meter extra treatment
- one application per year
- application immediately at the start of the flight

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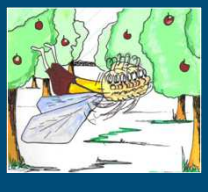
mating disruption — working mechanism

- disorientation of males
- peripheral adaptation of the male antennal receptors
- habituation of the cerebral nervous system in the male



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mating disruption — effect measurements

- pheromone-trap catches of male moths
- juice-trap catches of male- and female moths
- mating suppression in tethered females
- assessment of numbers of larvae/eggs
- assessment of damage

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mating disruption — research

recently executed research of the application of mating disruption in the Netherlands

- codling moth and leaf rollers (apple and pear orchards)
- apple clearwing moth (apple orchards)
- Turkish moth en Florida moth in greenhouses (sweet pepper and tomato)
- currant clearwing moth (red and white berry)

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mating disruption

- mating disruption against codling moth (*Cydia pomonella*) and several leaf roller species (*Adoxophyes orana, Archips podana* and *Pandemis heparana*)
- formulation: BASF RAK 3+4

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mating disruption

- results: crop damage is comparable with the damage in a standard insecticide treatment. Mating disruption against codling moth is registered in the Netherlands and is used by the majority of fruit growers

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mating disruption 3500 ha

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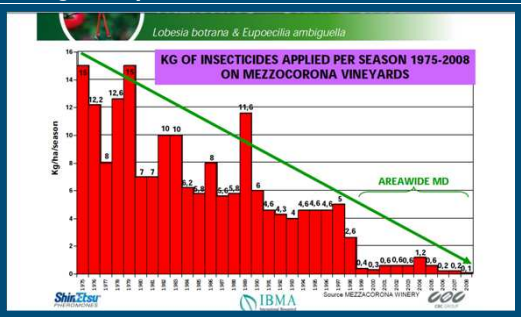
mating disruption



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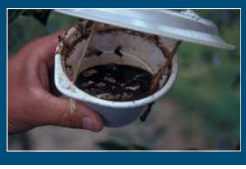
mating disruption

- mating disruption against apple clearwing moth (*Synanthedon myopaeformis*)
- formulation: Biocontrol twisted-rope



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mating disruption

- mating disruption against currant clearwing moth (*Synanthedon tipuliformis*) in red berry
- formulation: TNO/PRI


PLANT RESEARCH INTERNATIONAL

mating disruption

- mating disruption against currant clearwing moth (*Synanthedon tipuliformis*) in red berry
- formulation: TNO/PRI


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mating disruption

- mating disruption against Turkish moth (*Chrysodeixis chalcites*) and Florida moth (*Spodoptera exigua*) in greenhouses with sweet pepper and tomato
- formulation: TNO/PRI


PLANT RESEARCH INTERNATIONAL

mating disruption

- mating disruption against Turkish moth and Florida moth in greenhouses with sweet pepper and tomato

damage:

tethered female:

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mating disruption


PARINGSVERSTORING WERKT PERFECT

toegelaten toepassing in Nederland. In Amerika zijn inmiddels al vijfentwintig verschillende insectenferomonen voor deze bestrijdingsmethode toegestaan.

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mating disruption

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lure & kill

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lure & kill — working mechanism

pheromone +

insecticide

or

Insect pathogen

instead of bringing the pesticide to the insect (spraying) the insect is lured to the pesticide (pathogen)

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lure & kill — applications in:

- arable cropping
- arboriculture
- stock-breeding
- household use
- stored products
- fruit growing
- cotton growing (film)

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lure & kill — sweet potato weevil

attracting the insect…..

Sweetpotato weevil, Cuba

to the pathogen…

Beauveria bassiana

or to a killing device

pictures from INIVIT, 1995

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lure & kill — poplar clearwing moth

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lure & kill — stock-breeding

- lurectron Fly-bait (Denka):
- formulation: gel or powder
- attractant: muscalure (fly-pheromone)
- active ingredient: methomyl (1%)
- target insects: cattle flies

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lure& kill — household use

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lure & kill — fruit growing

- Bayer Appeal®
- formulation: gel
- attractant: codlemone (pheromone of the codling moth) (0.1%)
- active ingredient: Cyfluthrin (4%)
- target insect: codling moth (*Cydia pomonella*)

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lure & kill — fruit/vegetable growing

- product: Last Call™FF
- pest: fruitfly
- attractant: ginger oil
- insecticide: permethrin

producer: Insect Science (SA)

device: "Dead males don't mate"

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lure & kill — advantages

- substantial reduction of the use of insecticides
- formulation is not sprayed so substantial reduction of drift and human insecticide exposure
- formulation can be applied on the non-eatable parts of the crop, so the fruits remain free of residues
- as pheromones are species-specific beneficials are not attracted to the formulation so stay unharmed
- the required quantity of pheromone is much less compared to the amount used in mating disruption applications

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lure & kill — film

- crop: cotton
- insect: pink bollworm (*Pectinophora gossypiella*)
- formulation: CIBA Sirene®
- time of action: season long protection
- results: 30% more cotton yield and better quality than with a conventional treatment

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Semiochemicals

- What are semiochemicals?
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First: have your insect available...

- collection of larvae and/or eggs
- identification (do we have the right insect species)
- design the right mass rearing method
- sexing of the pupae

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collection of larvae

example: *Tuta absoluta* and *Symmetrischema tangolias*

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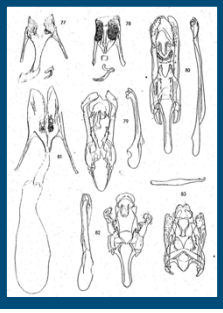
identification of the species



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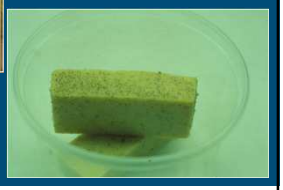
rearing method



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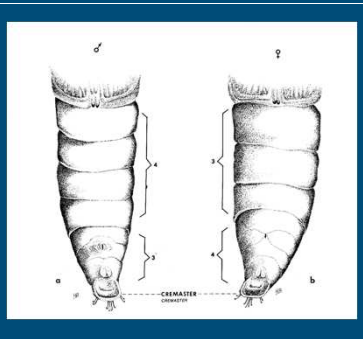
sexing of pupae



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Semiochemicals R&D

- 1. What odours do insects/plants produce?
- 2. What compounds do insects smell?
- 3. Are the compunds attractive or repellent?
- 4. Can we identify en synthesize the compounds?
- 5. How can we implement this in crop protection strategies?

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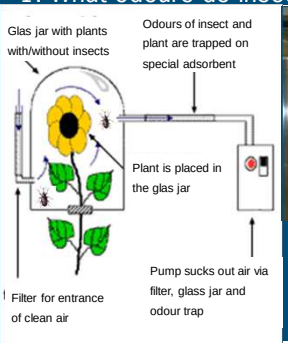
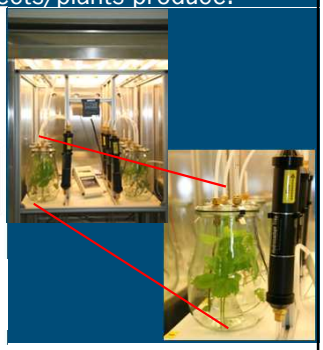
1. What odours do insects/plants produce?





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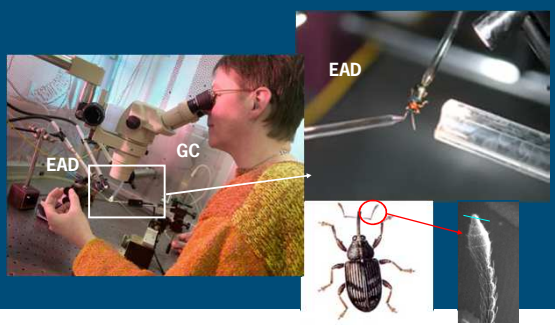
2. What odours can an insect smell?



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3. Attractive or repellent?



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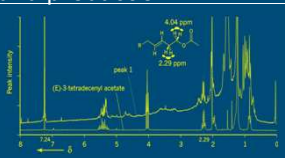
4. Analyses, synthesis and production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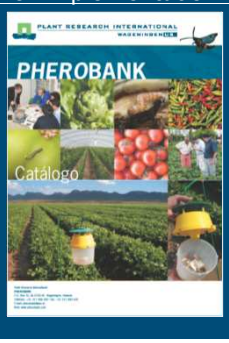
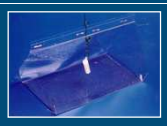
5. Implementation



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application of pheromones registration

- application of insect pheromones
  - monitoring
    - timing tool for pesticide application
    - identification tool
  - mass trapping
    - trapping away the population
  - mating disruption
    - confusion of insects
  - lure & kill (infect)
    - luring the insect towards a knock-down pesticide or pathogen

} registration required!

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other semiochemicals

- examples repellents:
  - *Resseliella oculiperda* in arboriculture
  - *Megaselia halterata* in mushroom culture
- example attractants (no pheromones):
  - *Frankliniella occidentalis*

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example repellent *Resseliella oculiperda*

- damage after grafting of fruit- and amenity trees

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example repellent *Resseliella oculiperda*

life cycle:

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example repellent *Resseliella oculiperda*

treatments:

- Flex-tape (untreated control)
- Flex-tape (impregnated with repellents)
- Buddy-tape (mechanical oviposition-barrier)

damage assessment after 3 weeks

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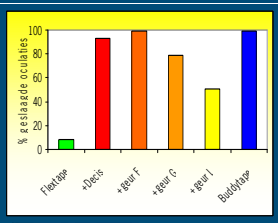
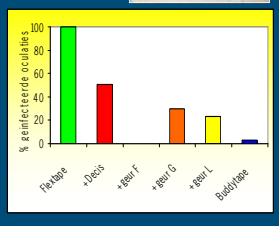
example repellent *Resseliella oculiperda*

results 2001
(fruit orchard)





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example repellent + toxic *Megaselia halterata*

- plant volatiles or components cause >90% reduction of the number of flies on laboratory and semi-practice scale
- side-effects on the fungal disease *Verticillium fungicola*
- no ill effects on the mushroom production

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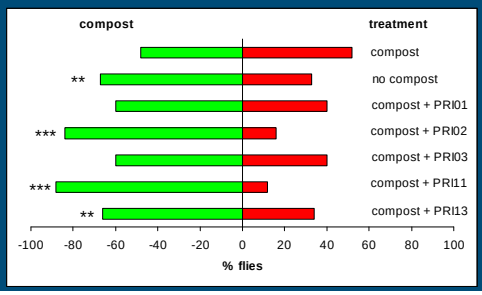
example repellent + toxic *Megaselia halterata*

plant volatiles repellent for *M. halterata*

PLANT RESEARCH INTERNATIONAL

example repellent + toxic *Megaselia halterata*

plant volatiles repellent for *M. halterata*



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example attractant *Frankliniella occidentalis*

- plant volatiles may increase the catches of *F. occidentalis* on blue and yellow sticky traps by 20x (greenhouse experiments 2005)
- possibilities for introduction in practice are in research

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attractant thrips

In 2007 the attractant for thrips was put on the market by Koppert B.V.

Product name: LUREM-TR

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- Thank you

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