1. IPM (Integrated Pest Management) in Greenhouses; History & Aims

Pierre M.J. Ramakers

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WHAT IS Integrated Pest Management ?

- IPM is control of pest (or diseases) with a combination of chemical and biological control agents
- components of IPM
  - pesticides
  - natural control
  - biological control *sensu strictu*

WHAT IS Integrated Pest Management ?

- IPM is thus NOT in contradiction with chemical control ...
- ... but is rather a chemical control strategy, that tries to control a pest (complex) without eliminating its natural enemies
- modern insecticides (f.e. IGR's) fit better in IPM schemes than broad spectrum biocides formerly used

WHY IPM ?

- pest resistance management
  - spider mite
  - leafminers, thrips, aphids
- control of secondary pests, lacking selective chemicals
- marketing
  - environmental labels (minimal damage to nature)
  - people's health

pioneers

Bert Bravenboer, Naaldwijk NL

- testing insecticides on both pest and natural enemies

"... an insecticide should be more toxic to the pest than to the key predator(s) with the largest possible difference between the respective LD_{50}'s ..."

introduction *Phytoseiulus persimilis* for spider mite control in cucumbers

pioneers

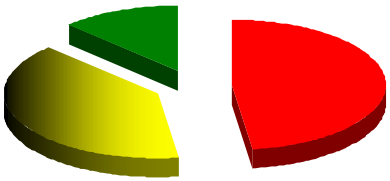
Joe Hussey, Littlehampton UK

- (re)introduction *Encarsia formosa* whitefly control
- initiator of the fungus *Verticillium lecanii* as a pathogen for whitefly
- ‘pest in first‘ concept
- ‘banker plant’ concept

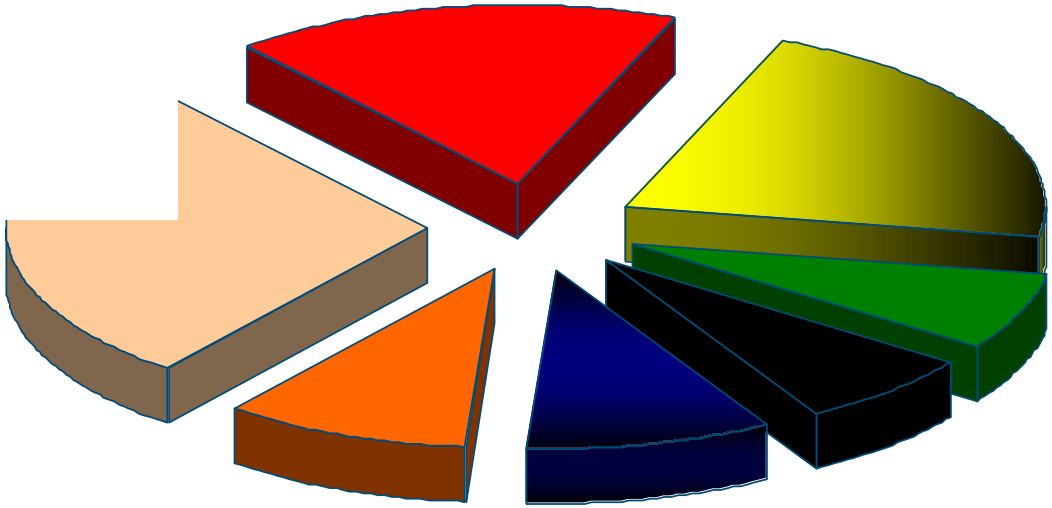
"... the field of integrated control can be successfully exploited only when there is a continuum of interest and involvement between research and extension workers and the growers on the nurseries where ideas are tested ..."

SELLING OF NATURAL ENEMIES IN THE NETHERLANDS

1984
ƒ 2.600.000



1992
ƒ 21.800.000



OLDEST IPM CROP

- cucumber IPM program
  - systemic fungicide dimethirimol => powdery mildew
  - predatory mite *Phytoseiulus persimilis* => spider mite
  - pirimicarb => aphids
  - hydrogen cyanide => whiteflies


LARGEST IPM CROP

LARGEST IPM CROP

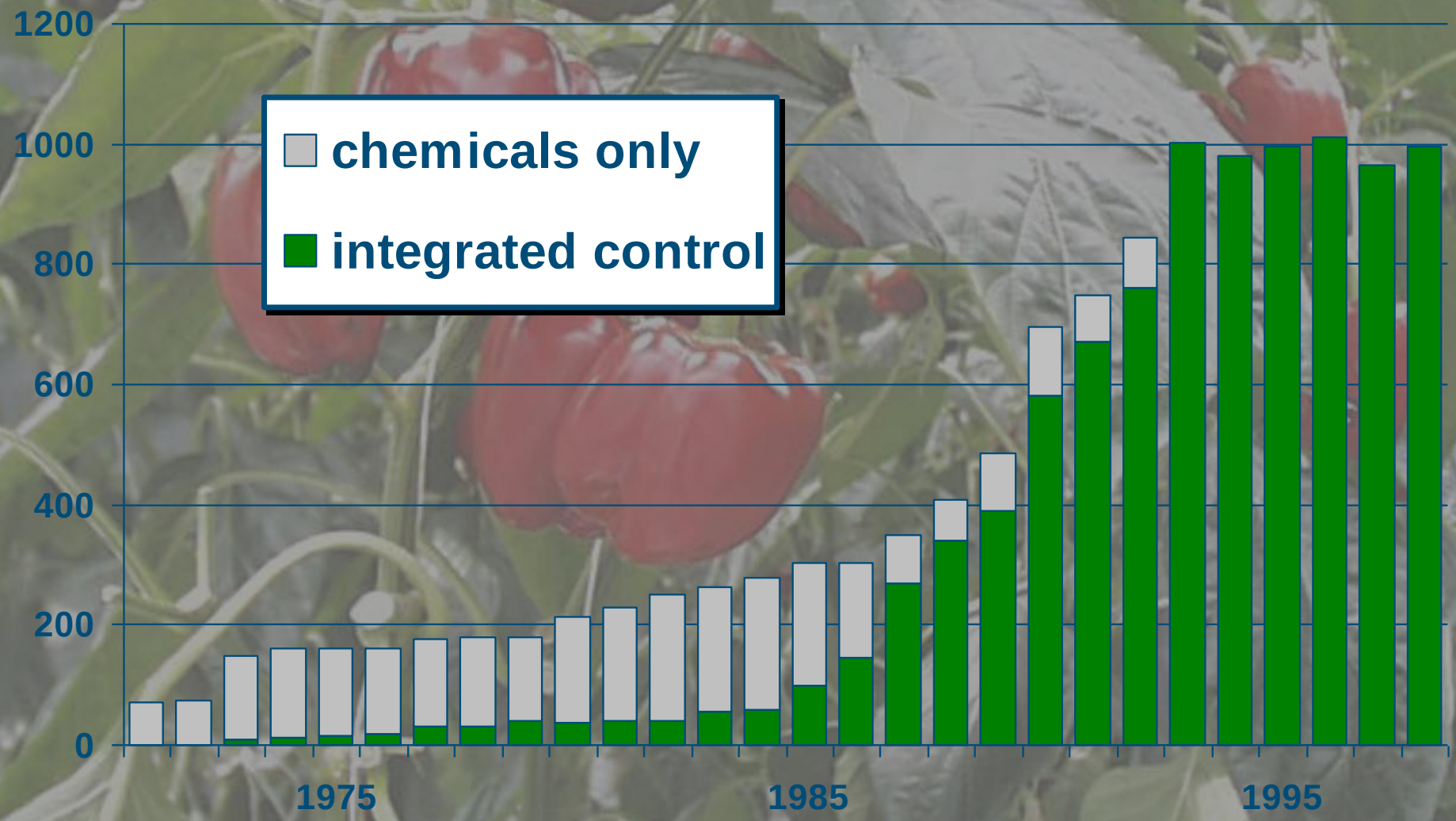
- tomato
  - high intrinsic resistance against pests
  - moderate hostplant for whitefly and aphids
  - whitefly control
    - 4 introductions of *Encarsia formosa*
    - corrections with Insect Growth Regulators
  - aphid control
    - banker plants with cereal aphids + parasitoids
    - corrections with systemic insecticides
  - natural control by leafminer parasitoids
    - occasional correction with cyromazine


MOST SUCCESSFUL IPM CROP

MOST SUCCESSFUL IPM CROP

- sweet pepper
  - bad host plant for whitefly
  - good hostplant for aphids
  - biological control of spider mites, thrips, aphids and Noctuids
  - natural control of leafminers and aphids
  - integrated control during about 90% of the season

acreage sweet pepper (ha)

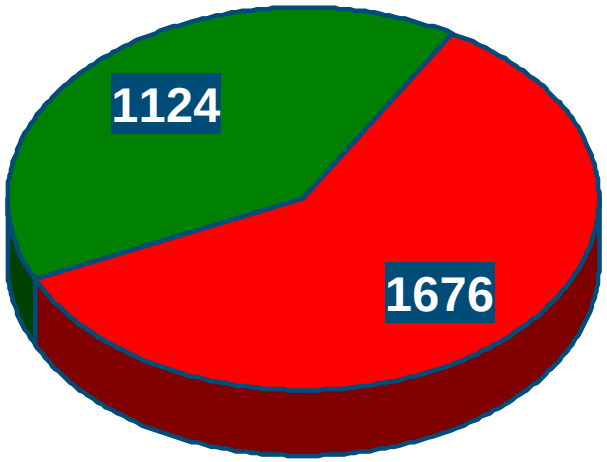


COSTS OF CROP PROTECTION PRODUCTS

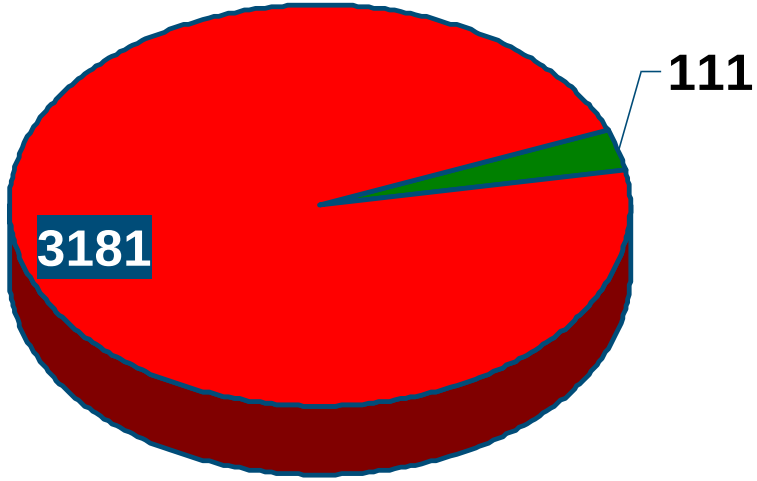
€ per hectare

- chemicals
- biologicals

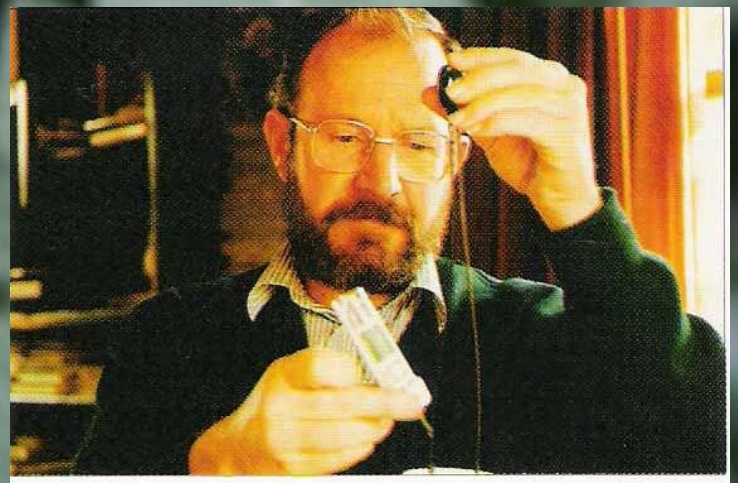
VEGETABLES



ORNAMENTALS

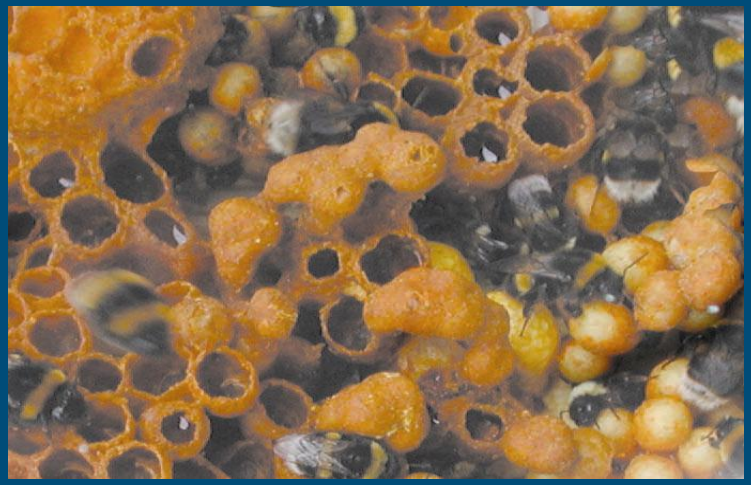


pioneers



Dr. Roland De Jonghe

BIOBEST
Bumblebees



MOTIVATIONS & CONCERNS

- consumers: safe food
- Ministery: sustainable agriculture
- environmentalists: minimal emission of chemicals to the environment
- quarantaine authorities: absence of insects
- trade channels: perfect quality
- supermarkets: IPM labels, Public Relations
- mass media: scandals
- everybody: cheap product

MOTIVATIONS & CONCERNS

focus on aspects close to a grower's mind

- pesticide resistance management
  - chemicals work better if seldom used
- technical merites of biocontrol agents
  - mobility => reaching difficult places
  - reproduction => persistent control
- health of workers => motivation
- biopollination (bumble bees in tomatoes)

HOW TO REDUCE RESIDUES ?

- inventarisation of the problematic chemicals
- supervised control
  - scouting
  - tresholds
- replacing insecticides
  - registration procedures
- (changing application techniques)
- developing IPM programs per crop
  - scouting & monitoring
  - monitoring pest AND natural enemies

- learn from similar areas (Almeria, Crete, Cesena, Canary Islands) …
- IPM programs are very specific
  - crop, variety
  - region, climate, season
  - initial pest density, pest immigration
  - market
  - available tools
  - available expertise
- … but do NOT copy
- => develop your own programs

1. IPM in Greenhouses; Tools & Strategies

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CHEMICAL TOOLS

- origine
  - synthetic
  - natural
    - mining
    - botanical
    - microbial
- mode of action
  - oral toxins and repellents
  - contact toxins
  - inhaling (vapours, smokes, aerosols)
  - systemic

BIOLOGICAL TOOLS

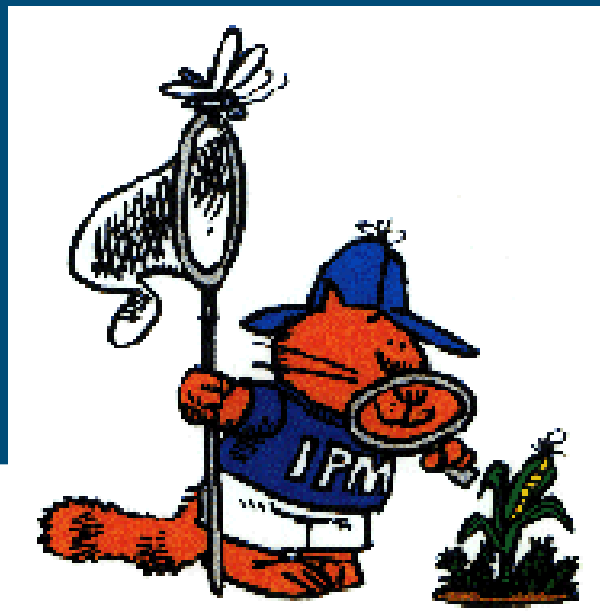
- parasitoids
  - Braconidae (*Dacnusa*, *Opius*, *Aphidius*, *Praon*)
  - Eulophidae (*Encarsia, Aphelinus*, *Diglyphus*)
- predators
  - Phytoseiidae (predatory mites)
- pathogens
  - fungi (*Verticillium*, *Paecilomyces*, *Beauveria*, *Metarhizium*, *Entomophthora*)
  - viruses (Nuclear PolyHedra Viruses)
  - bacteria (*Bacillus thuringiensis*)
  - nematodes (*Steinernema*, *Heterorhabditis*)

SCOUTING & MONITORING

- signalizing beginning of pest attack
  - recognition of early symptoms
- mapping hot spots
  - electronical or physical
- monitor populations
- keep record of data
  - observe trends (increases or declines)
  - compare one grower to another
  - compare one season (year) to another
- in case of IPM: include key natural enemies

TOOLS of IPM SCOUTS

- 5x magnifying glass with metrical scale
- insect pooter and collecting vials
- simple 40x microscope in your office
- traps
  - sticky colour traps (yellow, blue)
  - light traps
  - pheromone traps
- colour tags



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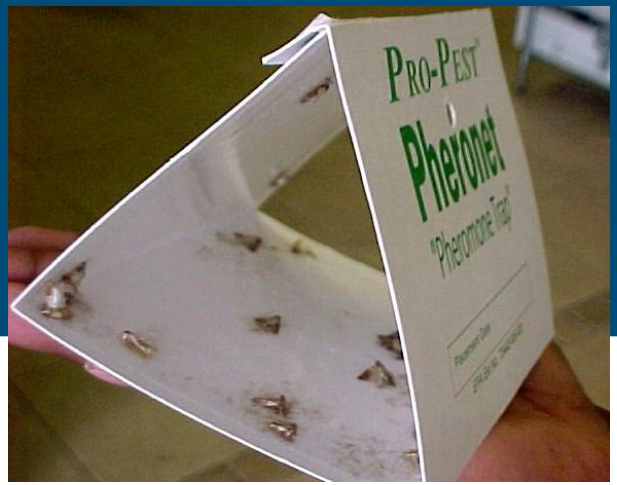
KOPPERT
BIOLOGICAL SYSTEMS


PRO-PEST
Pheronet

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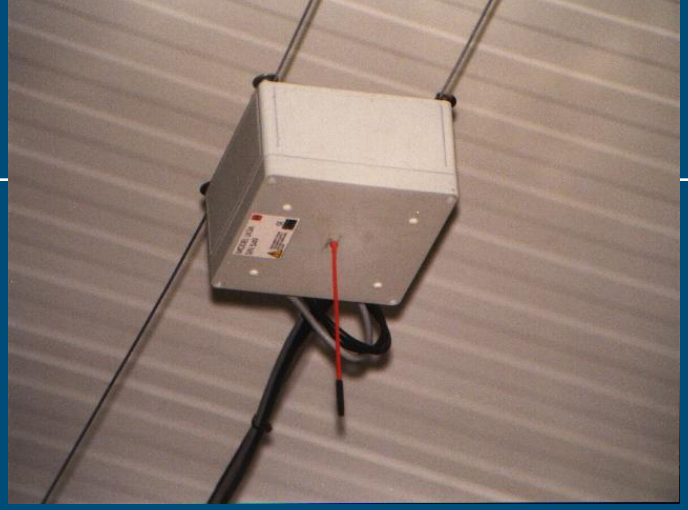


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DIAGNOSTICS

"… people fear new, unfamiliar, rare, exotic diseases

but most people die from very common diseases …"

DIAGNOSTICS

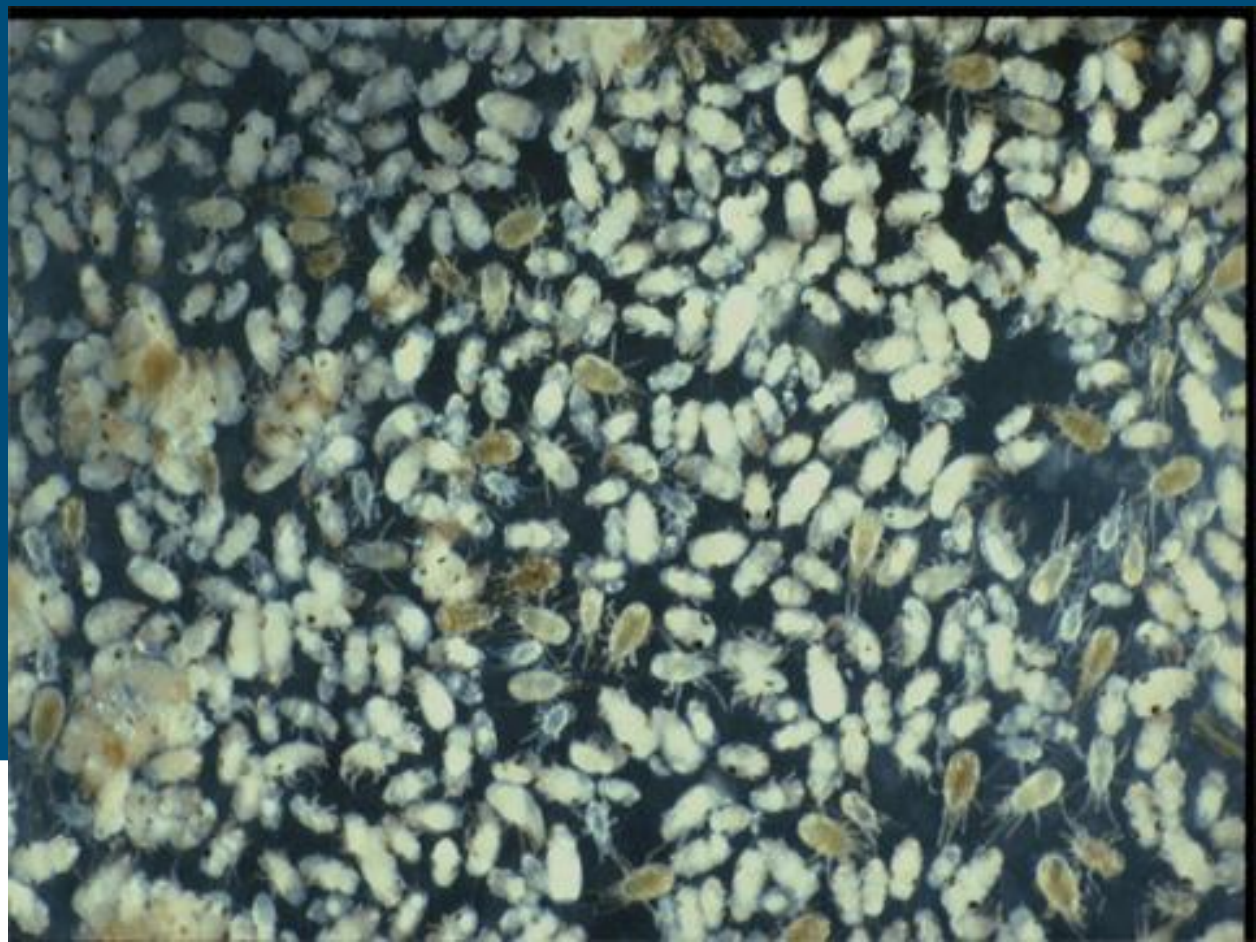
- there are millions of insect species in the world
- don't try to know them all!
- focus on ABUNDANT and IMPORTANT species
- use simple field guides for recognizing the most common species in your area
- growers don't expect you to be an entomologist, but a forecaster of population trends
- don't spend too much time on an occasional rare bug, but rely on back-up specialists

INTRODUCING NATURAL ENEMIES

- numbers / ha
  - should be pest related
  - actually cost related
    - fixed numbers + repairing sprays
- timing, frequency
  - single inoculative release
  - continuous inundative releases
- grid (release points / ha)
  - 25 / ha for very mobile species like *Braconidae*, *Syrphidae*, *Anthocoridae*
  - 500 / ha for slow flyers like *Aphelinus* and *Encarsia*
  - 4,000 / ha for walking predators (*Phytoseiidae*)

INTRODUCTION METHODS

- releasing massreared insects
  - eggs: (lacewings)
  - larvae / nymphs: lacewings, ladybird beetles
  - pupae / cocoons: *Encarsia, Cecidomyiidae*
  - adults: most hymenopterous parasitoids, field collected ladybeetles
  - (all) mobile instars: predatory bugs, predatory mites
- open rearing systems
  - CRS for *Amblyseius cucumeris*
- banker plants
  - barley seedlings with cereal aphids
  - castor bean with predatory mites



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WHAT IS A BANKER PLANT ?

PLANT + ~~PEST~~ + PREDATOR / PARASITOID

BANKER PLANTS

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BANKER PLANTS

IPM STRATEGIES

GREENHOUSE WHITEFLY

- wait for young larvae to be present (or assume so)
- release 2,500 adult *Encarsia* per ha
- TRADITIONAL: repeat after 2 weeks, 4x in total
- BETTER: release weekly, and continue until 80% parasitized
- repair local outbreaks by spraying top of plants with IGR's

IPM STRATEGIES

SPIDER MITES

- scout for leaf damage to find first colonies
- release high numbers of the predatory mite *Phytoseiulus persimilis* / ha around colonies
- optional: release low numbers of the predatory mite *Amblyseius californicus* in the rest of the greenhouse
- spray 'hot spots' with acaricides

- if you dare: try pest-in-first
- if you are very experienced: try desynchronised pest-in-first

IPM STRATEGIES

LEAFMINERS

- pest detection is relatively easy
- collect mines (with larvae) of the first generation
- establish rate of natural parasitisation
  - simple: alow pupae to hatch in a glass vial (for endoparasitoids only)
  - advanced: dissect leafminer larvae under a microscope for identifying parasitoid larvae
- if parasitoids are absent or rare, wait for the next generation and
  - introduce *Dacnusa sibirica* at low pest density
  - introduce *Diglyphus isaea* at moderate pest density
- repair unbalanced situations with a single spray of cyromazine

N.B. MOST GROWERS DON'T RELEASE ANYTHING

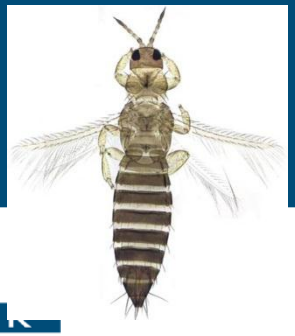
INTERFERING WITH CHEMICALS

- efficacy AND selectivity
- profile of the chemical
  - IGR's > traditional biocides
  - short activity > persistence
  - N.B. natural insecticides are NOT necessarily more specific than synthetic ones
- application method
  - systemic > spraying
  - spraying > dusting
  - aerial < > foliar
- selective timing
  - f.e. while parasitoids are pupating
- selective placing
  - f.e. top of plants against adult whiteflies or flower thrips
  - spot treatments

SPECIFIC MEDITERRANEAN

- interaction with outdoor fauna
- planting in summer / autumn
- extreme afternoon conditions
- impact of insect transmitted virus
  - TYLC by tobacco whitefly
  - TSWV by thrips

- more natural control ?
- longer interruption between crops



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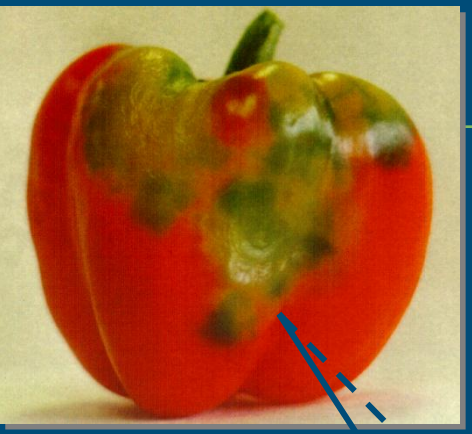
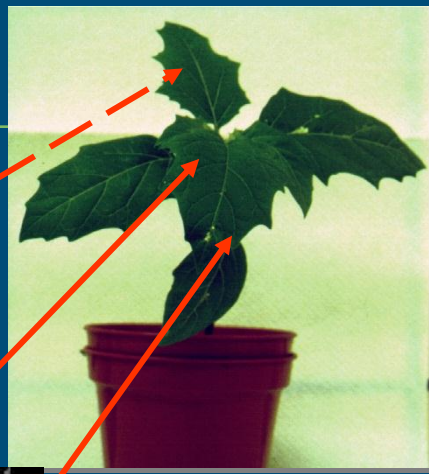
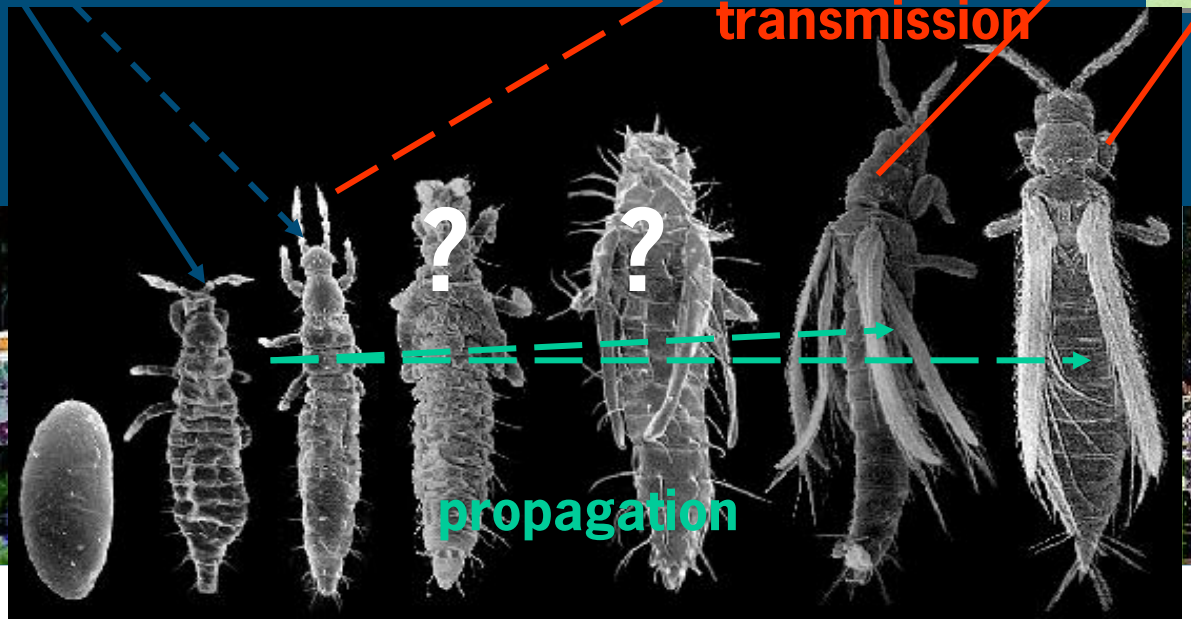
Institut für Zoologie der Universität Halle-Wittenberg
Lehr- und Forschungsbereich Entwicklungsbiologie
C. Delker, G. Moritz, P. Harm



Infection cycle





greenhouse whitefly, *Trialeurodes vaporariorum*, parasitized by *Encarsia formosa*

tobacco whitefly, *Bemisia tabaci*, parasitized by *Eretmocerus mundus*

IS BIOLOGICAL CONTROL OF WHITEFLIES RECOMMENDABLE IN THE PRESENCE OF TYLC VIRUS ?

RECOMMENDATIONS for IPM ADVISORS

- do not exclusively rely on what you've read in books …
- … but gather your own experience
- proceed step by step, don't jump
- take your growers serious
- incorporate their observations and experience …
- … but review their interpretations critically
- keep your information independent from
  - suppliers of chemicals
  - suppliers of biologicals
  - policy makers
  - representatives of the market chain
- => (some of) you may play a key role in future IPM programs