Biological control of insect pests in outdoor crops

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Biological control in outdoor crops

Insecticides
Mating disruption

BCA

Conservation BC

Cultural practice

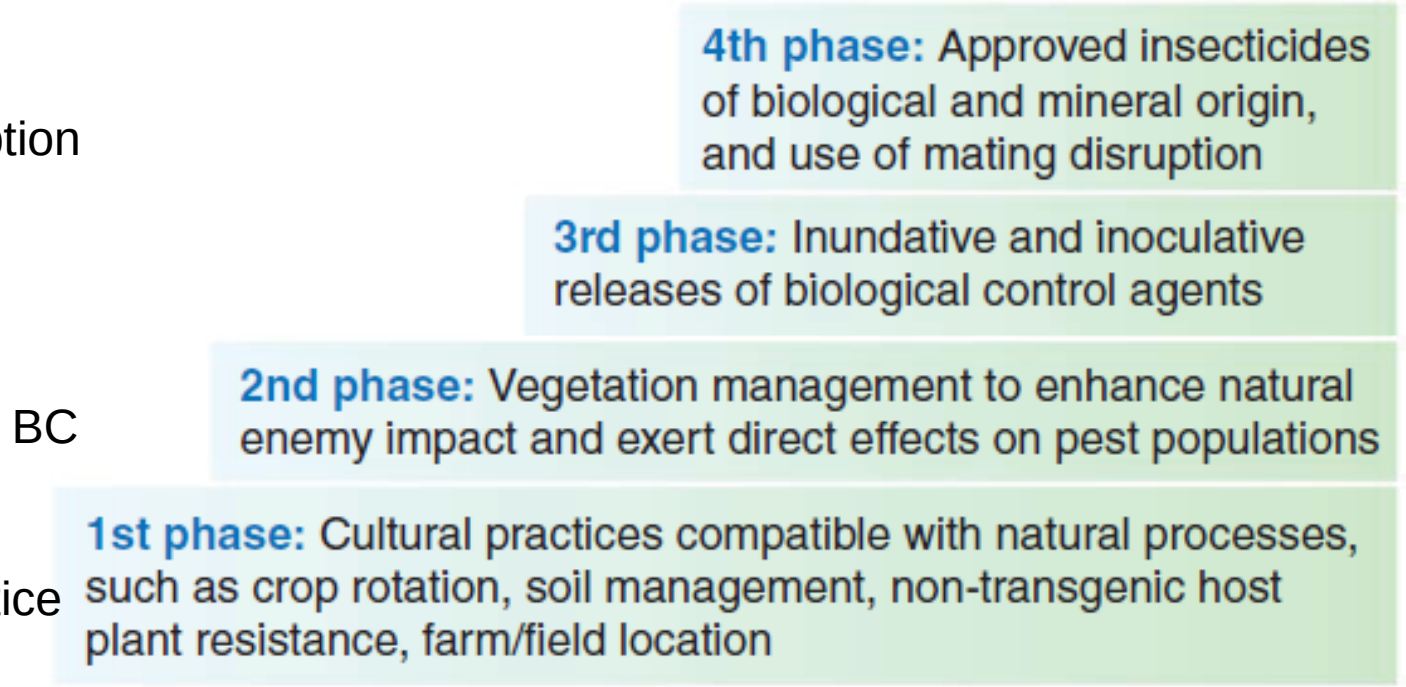


Figure 1

Diagrammatic representation of arthropod pest management strategies for organic crops. Priority is given to preventative strategies, which are considered first, followed by more direct measures if preventative strategies are not sufficient (data from Reference 165).

Zehnder et al 2006

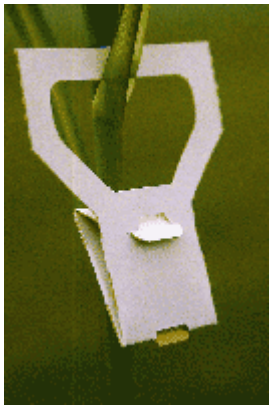
Most important augmentative biocontrol programmes in Europe

Crop	Pest	Natural enemy	Area under biological control in hectares/ Ref
maize	*Ostrinia nubilalis*	*Trichogramma brassicae*	100,000 / van Lenteren et al., 1992; Smith, 1996; Sigsgaard, 2006
orchards apple /pear	various	various	30,000 / Blommers, 1994; van Lenteren et al., 1992; Sigsgaard, 2006
greenhouses	many	many	50,000 / van Lenteren, 2000 Zheng et al. 2005
strawberries	*Tetranychus urticae*	*Phytoseiulus persimilis*	< 20,000 / Sigsgaard, 2006
vineyards	*Tetranychus urticae*	*Typhlodromus pyri* *Amblyseius andersoni*	40,000 / van Lenteren et al., 1992; Sigsgaard, 2006

IOBC Internet book, van Lenteren 2012

Control of European corn borer

- *Trichogramma brassica*
- Initial succes –then failure
- Changes in rearing successful
  - basic rearing on the true host under semi-natural conditions, while the factitious host was used to produce higher numbers for release



Fruit tree red spider mite

- Pesticide induced
- OP-resistant strains Introduced/re-introduced
- Few inoculations suffice

Photo: Nyrop, Cornell

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Changes in organisms for sale -2000 to 2011

	2000	2011	for outdoor use
Insect predators	18	(*Adalia, Anthocoris, Aphidoletes*) 14	1 --> 3
Parasitoids	*Trichogramma* sp., 20	*Trichogr., Aphidius* sp. 19	1 --> 2-3
Predatory mites	8	10	1 (+3 nurseries) -->5
Nematodes	*Heterorhabdites bacteriophora , Phasmarhabditis sp., Steinernema feltiae 3*	*Heterorhab. bacteriophora , Steinernema feltiae , S. kraussei, Phasmarhabditis sp., 4*	3 --> 4
Entomopathogenic fungi	*I fumosoroseus, Lecaniicillium lecanii 2*	*Beauveria bassiana, L. lecanii ((M. anisopliae)) 2*	2
Bacteria	*B thuringiensis* (2 var)	*B thuringiensis* (2 var)	2
Virus	*Agrotis segetum* granulovirus (AsGV) 1	Codling moth granulosis virus (CpGV) 1	1

Sigsgaard, Ørum, Eilenberg, 2011

Chemical and biological control in Danish horticulture

BC share

- On average 15%
- In greenhouse pot plants 30%
- In greenhouse vegetables 70%
- In field crops 2%

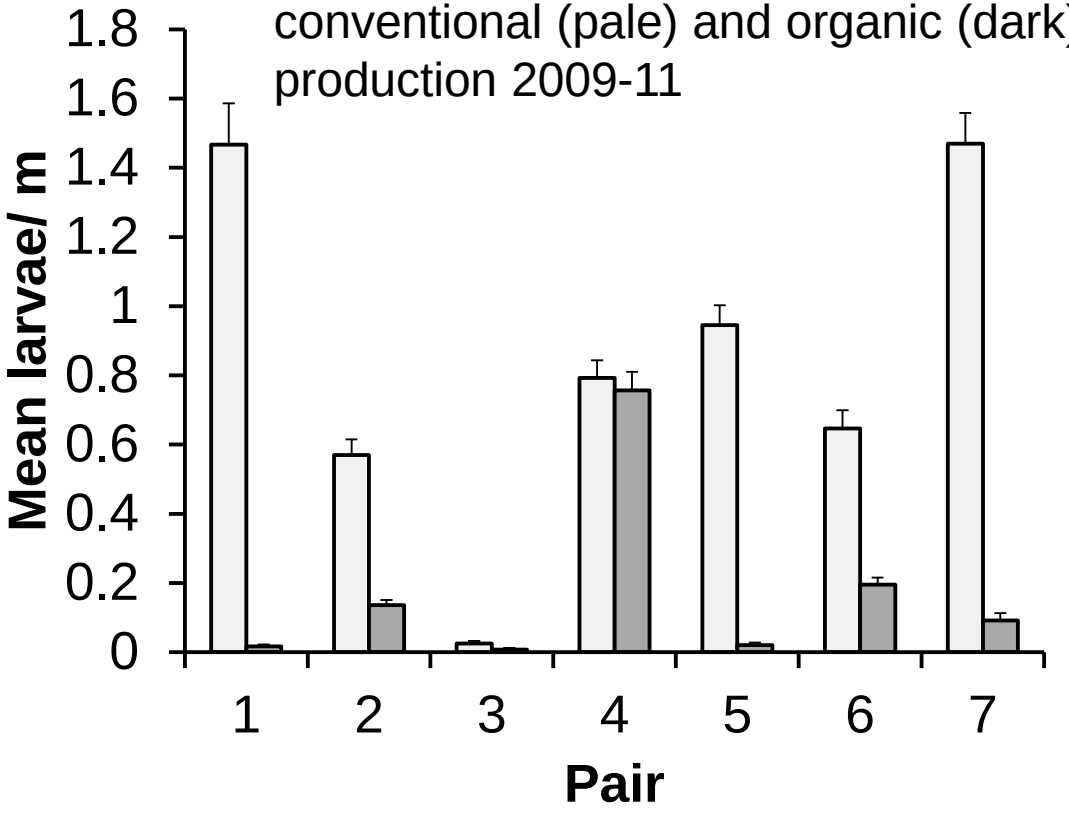
Sigsgaard, Ørum, Eilenberg 2011

Integrated BC of key pests in strawberries

- *Spider mites and strawberry mites*
  - *Acaricides*
  - *predatory mites*
- *Strawberry weevil –Anthonomus rubi*
  - *Pyrethroids*
  - *(entomopathogenic fungi)*
  - *(early warning/ (mass trapping)*
- *Strawberry tortricids –Acleris comariana*
  - *pyrethroids*
  - *Bacillus thuringiensis –against 2 gen*
  - *mechanical control –against 2 gen*
  - *conservation biological control*
  - *Cropping practice*

Cropping practice

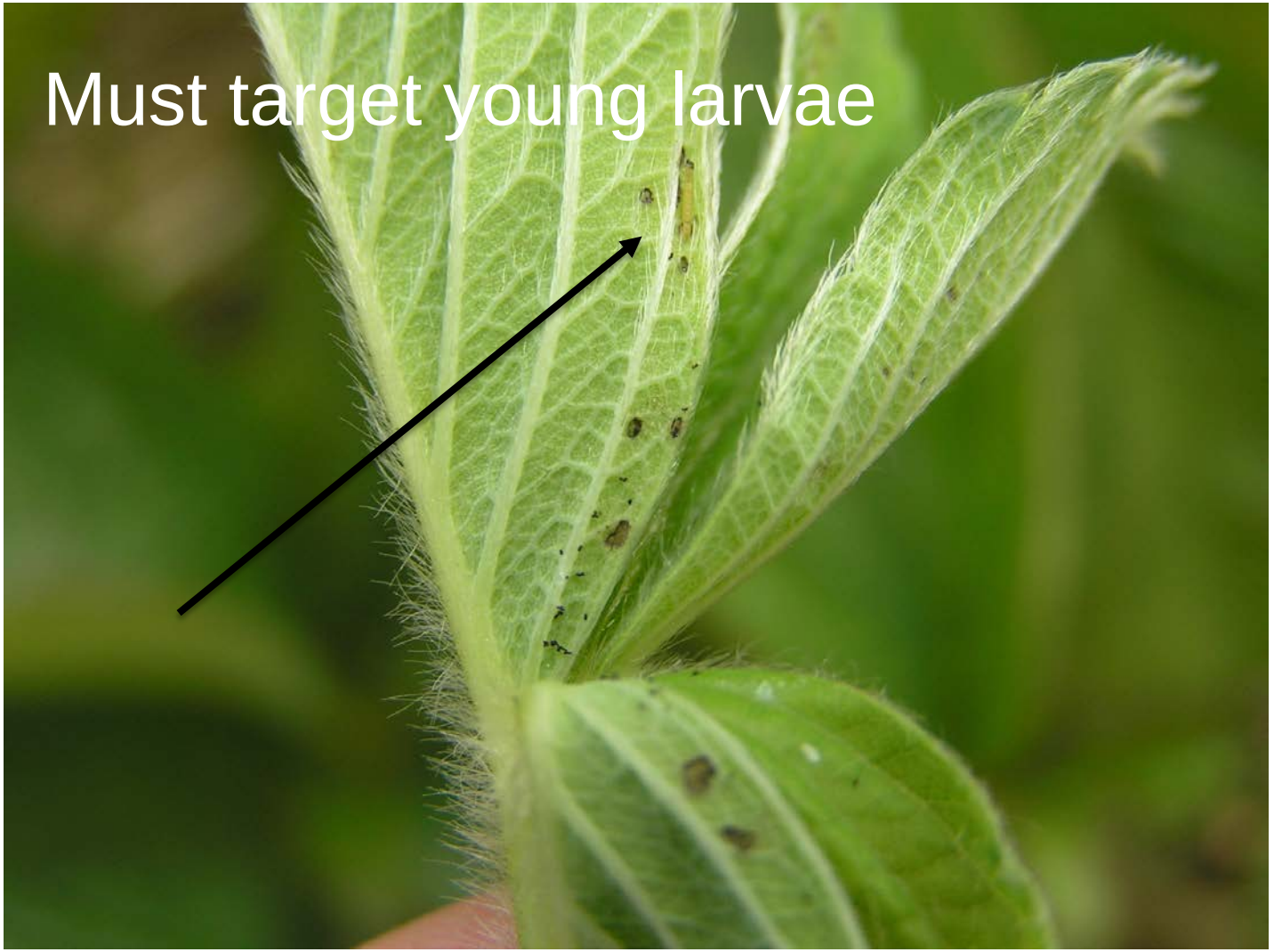
Acleris comariana larvae/m crop conventional (pale) and organic (dark) production 2009-11



Copidosoma –ca 20%
Other parasitoids higher in organic
Unknown mortality higher in organic

Sigsgaard et al 2013

BC with *B. thuringiensis*



Experiences from strawberry

•**Mites:** Outdoor predatory mite releases after harvest is used to some extent already –in tunnels also releases early -can be further developed

•**Strawberry weevil:** *Metarhizium anisopliae* give good control of *A. rubi* in lab –

•Early warning/ mass-trapping of *A. rubi* – 14 d earlier is timely for BC

•IBCA not available/ less relevant for this pest

•**Strawberry tortricid:** Organic cropping practice -> much lower tortricid infestation. Conservation BC some promise –flower strips

•*Bacillus thuringiensis* - tunnels in spring, outdoors late July (autumn-prophylactic)

•Mechanical control reduce *A. comariana*, comb with *B. thuringiensis* better result

IBCA: Copidosoma mass rearing? Trichogramma?, predators?

Use with conservation BC?

Increased area of protected and semi-protected berries

Easier transfer for greenhouse BCA as greenhouse pest complexes are found

BC in pear -Control of pear psyllid

- Avoid pesticides
- Conservation biocontrol
  - Flower strips can reduce infestation and augment *A. nemoralis*
    - *Winkler et al 2007*
- Inundative releases of Anthocorids
  - Kers et al. ’01 Adults 1200/ha -No control
  - Beninato & Morella ’00: Adults 1000 or 500 –no control
  - Fauvel ’93: Eggs –early control
  - Unruh ’94 Nymphs 3-5X
  - Faivre-D'Arcier et al. ‘01
    - 2.000-8000/ha at right time
  - Sigsgaard et al ’10
    - 40% reduction with 2 X 10-30 nymphs/tree

Experiences from Denmark

- Pesticide resistance -growers wish to avoid pesticides
- In small and scattered orchards as the Danish, mass-release of immature *A. nemoralis* yielded consistently good results
- Immature *A. nemoralis* not for sale -a few use release of adults
- Mostly growers rely on naturally occurring beneficials

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Challenges and options for outdoor BC

- Do we have BCA
  - are they adopted to outdoor climate
  - Release and field conditioning for BCA
- Biotic factors: plants, other arthropods in the agroecosystem.
- Interaction of BCA with natural BC and conservation BC
- Risk of non-target effects -focus on native BCAs for outdoor -BUT
- Economical cost
- Options for integrating BC with other control methods

Drivers and barriers for bc in outdoor crops

Conclusion

- Use of biological control is growing
- Trend will probably continue driven by
  - Future withdrawal of insecticides
  - Spread of certified IPM and organic production requiring alternatives
  - Consumer demands for unsprayed produce
- Reduced pesticide input can help conserve natural enemies

- **To move BC to outdoor crops –what can we do**
- Basic knowledge needed -Acess to BCAs adapted to outdoor/ semiprotected conditions
- How to handle complex systems
- Use of multiple beneficials in combinations/ with other strategies
- Contribute to new mindset: a single control measure rarely enough

Collaborate industry –reseachers -growers

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Thank you for your attention

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