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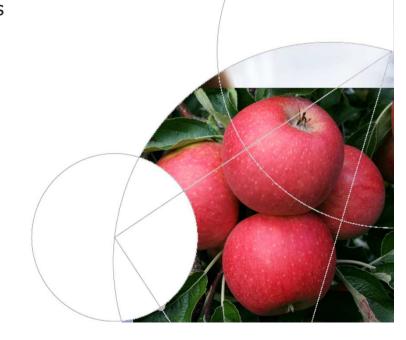


Present practice, on-going research and future potential for non-chemical pest management in fruit and berry production in Denmark

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Background

Denmark: 43.000 km²

67% of the area is cultivated, ca 60% with cereals

Strawberry is the major fresh berry crop with an area of ca. 1300 ha of which ca 63 ha organic (2009)

Apple is the major fresh fruit crop with an area of 1700 ha of which 16% in 2010 organic (highest in Europe)

Other important fruit and berry crops include black currant (1900 ha, 32 ha organic) sour cherry (1400 ha, ca 10 ha organic) Pear ca 400 ha

Red currant

Raspberry (30 ha, 2 ha organic)



Strawberry cultivation

- 6 -15 tons/ha. Tunnels 15-22 tons/ha.
- Cultivated as a 2-3 y crop
- Crop rotation
- Main harvest 20. June 20. July
 - Can be ca. 2 weeks earlier w. fibre/plastic covering
 - Tunnels can prolong the cultivation period







L. Sigsgaard, Slide 3

Pests in strawberry -present practice

•Spider mites and strawberry mites

•Strawberry weevil –Anthonomus rubi

•Strawberry tortricids -Acleris comariana

• Mirids – Lygus rugulipennis

Black vine weevil Otiorhynchus sp.

predatory mites / lower N level?

na (variety) - pyrethrum

B. thuringiensis

na

- pyrethrum

Nematodes (but expensive)

Entomopathenic nematodes (use?)

Pests found more in protected production /

Whiteflies

biocontrol agents available

Thrips

Mites

Aphids



Apple and pear

Pests

Aphids

Cydia pomonella

Other Tortricids

Geometrids

Noctuids

Fruit tree rsm *Panonychus ulmi*

*In Pear*Pear psyllid

Practice

na

Pheromone disruption

Virus

phermone disruption (Adox.

orana, P. heparana

(B. thuringiensis)

()

conserve pred mite

conserve +A. nemoralis



Response to abiotic factors

Effect of temperature / climate change on insects -pest and beneficials

Temperature effect on predators and parasitoids and EPF

Effect of winter conditions on pests & beneficials incl. codling moth - PhD project /Vucasinovic et al

Sigsgaard 2001, Simonsen et al 2009, 2010, Esbjerg & sigsgaard, subm.,



Response to biotic factors

Insect plant interactions

Prey preference and behaviour of natural enemies Field ecology of natural enemies Interactions between natural enemies and effect on herbivore

Mass release of *predators/ parasitoids/ microbial control*





Fruitgrowth - Novel organic solutions securing future growth.

UCPH, AU, SDU, Adv. Services, growers, industry

WP on pests and disease management

- Ecological infrastructures -codling moth control
- Inundative releases of *Trichogramma* spp to reduce codling moth
- Plant extracts to control apple sawfly (Klaus Paaske)
- Control of apple scab (Maren Korsgaard)













-24 August 2012

Biological control of tortricids and aphids in strawberry UCPH, AU, Adv. service

Cropping practice

- Effect of cropping practice on pest and natural enemies (parasitoids and fungi)

Sigsgaard et al submitted

Conservation biological control -floral strips

Sigsgaard et al. revision

Inundative biological control

-bioassays of predators and parasitoids against *Myzus ascalonicus*

Enkegaard et al revision

Strategic paper on BC in strawberry w. advisory service











EU FP7 project 2012-15

New formulations and technologies using microbiological control agents to control soil borne crop pests

Example in strawberry: Vine weevil

UCPH: Effect on environment, interaction/ side-effects with other BCA





Collaboration UCPH, Denmark- ESALQ-USP University, Brazil 2012-15

Focus crops: Strawberry, Apple, Citrus

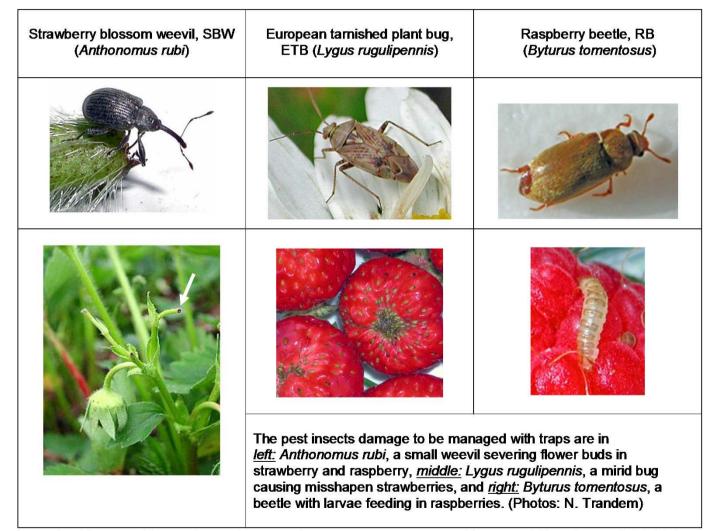
The ecology of entomopathogenic fungi and predators and their role and use in

- -conservation biological control
- -inundation biological control
- -inoculation biological control



CORE ORGANIC II: Softpest Multitrap 2012-14

Bioforsk Norway, KTH Sweden, KU-LIFE Denmark, EMR + U. Greewich, UK, Agroscope, CH, Latvian Plant Protection Res. C.





Ecosystem services - landscape ecology

Biological control and pollination

Landscape effects on wild bees – strawberry pollination





Ahrenfeldt et al., 2012 Porter et al 2009



Pests in strawberry, -Ongoing research summary

- •Spider mites and strawberry mites
 - -predatory mites
 - EPF diversity and bioassay + trophic interactions

Strawberry weevil -Anthonomus rubi

- -entomopathogenic fungi,
- -early warning/ mass trapping
- •Strawberry tortricids -Acleris comariana
 - -Bacillus thuringiensis,
 - -mechanical control
 - -conservation biological control
- Aphids

mass-release of beneficial insects

EPF diversity and bioassay + trophic interactions + conservation BC

- Mirids –*Lygus rugulipennis*
 - Mass-trapping
- Black vine weevil Otiorhynchus sp.
 - Entomopathogenic fungi
- Ecosystem services / landscape/ pollination





Pests in apple -ongoing research summary

Aphids

conservation biocontrol -biocontrol with immature anthocorids of potential Ecology and bioassay EPF, predators, parasitoids

Lepidoptera: Codling moth

Trichogramma biological control,

conservation biocontrol (flowerstrips, hedgerows)

Ecology, biocontrol predators

Hymenoptera

Operopthera brumata a major pest in organic - plant extracts

Mites: Ecology and bioassay EPF

Conservation BC, ecology of pests and natural enemies Ecosystem service/ landscape



Ongoing research other fruit and berry crops

Black currant

use of microbiological control/ oil/ soap/ pyrethrum/ mechanical control against lepidopteran pests winter moth, tortricids, *Lampronia capitella*

Raspberry mass trapping



Future potential

- Ecology / cropping system
- Basic ecological knowledge of organisms
- •interactions between crops/ field/ landscape and herbivores and their natural enemies for bioprospecting and for design of cropping systems
- •Scales from organism \rightarrow field \rightarrow landscape
- we see that pest problems can be less in organic (tortricid) knowing mechanisms behind can be a tool for improvement
- Prevention
- Variety / intercropping
- Conservation biological control –flower strip
- Distance between crops in time and space –crop rotation (strawberry)
- Other (ex. Sanitation)
- •Biological control identification of potential biocontrol agents

 Further development of rearing, application and use of BCA

 Use of multiple beneficials in combinations



Future potential continued

- How to handle complex systems
- •How to use beneficials together with other strategies
- Other control
- Mechanical control
- plant extracts
- mass trapping
- In cool climates not all years give problems (challenge). Mostly growers rely on naturally occurring beneficials
- •BC control in autumn targeting next year as a preventive treament further assessment required -could be promising

Control strategies need to be adopted to degree of cropping intensity open field ---- temporary protection (tunnel) -- permanent protection (tunnel) ---glasshouse