

Systemic Approaches to Pest Management without Pesticides

-Biological control of insect pests with predators and parasitoids

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Introduction

Good agricultural practices, such as crop rotation and choice of cultivars, soil management as well as conservation biological control or vegetation management to conserve and augment natural enemies are key elements in keeping pest infestations at an acceptable level and a first priority as it provides the basic pest control. Still, this is not always sufficient, and additional control measures are needed. Inundative and inoculative biological control may provide the additional control needed. Finally as a last option, pheromone disruption, mass-trapping and use of organically approved pesticides (plant extracts, minerals) may be applied (Zehnder et al. 2007).

Systemic approaches requires biological research

Systemic approaches are needed to develop pest management without pesticides. Natural pest regulation is the result of abiotic and biotic factors affecting populations of insect pests. Studies at scales from organism over field to landscape are needed for understanding these mechanisms and to guide further research in developing sustainable and productive agroecosystems.

Biological insights are needed to develop pest management without pesticides. Examples of mechanisms that will guide the role of beneficial organisms are their response to abiotic factors, their prey preferences and their choice of oviposition sites. Arthropods development and activity is temperature dependent. The ability to develop and be active at low spring temperatures may determine the value of a predator for biocontrol under the climatic conditions of Northern Europe (Simonsen et al. 2009). Prey preferences, plant host preferences and habitat preferences will guide the seasonal distribution of natural enemies in and around the crop (Sigsgaard, 2010) and thus help identify the resources needed to keep and to augment beneficials in the agroecosystem.

Ecosystem services and ecological infrastructures

In an agroecosystem several species of pests and beneficials as well as 'neutral' species will be present, and a community of beneficials will provide pest control. A study in rice shows that as predator diversity increases biocontrol also increases (Sigsgaard, 2007). Several other studies have shown positive effects on biocontrol with increased predator biodiversity. It appears that where both predator, herbivore and plant diversity can influence biocontrol, a positive effect of increased predator biodiversity may be most likely (Aquilino et al., 2005).

Ecological infrastructures such as hedgerows and field margins can play an important role in conserving biodiversity and functional biodiversity (Boller et al 2004), and may play multipurpose roles in the agricultural production system apart from biocontrol also providing other ecosystem services as fuel and pollination (Porter et al. 2009).

Inundative and inoculative releases

Inundative releases can supplement conservation biological control in case of lack of / failure of insecticides. This will more often be relevant in high value crops as pear where mass-release of *A. nemoralis* nymphs consistently could reduce *Cacopsylla pyri* infestation (Sigsgaard et al., 2006). In a cropping system control more than one pest need to be considered. For example the use of pyrethrum against weevils and tortricids in strawberry production can negatively affect the use of predatory mites in this crop, making the development of alternative control strategies against weevils and tortricids desirable (Sigsgaard et al. *In prep.*).

Drivers and barriers for biological control

In low value crops, conservation biological control is preferred. The sale of inundative and inoculative biological control products against insect and mite pests in greenhouses in Denmark had reached a high level already ten years ago and has stayed high, but the sale in outdoor crops remains low and is to a high degree restricted to the use of *Bacillus thuringiensis* against lepidopterans in high value vegetable and fruit crops, and to the use of predatory mites in strawberries and of predatory bugs in pear. Historically, use of biological control has been guided by lack of pesticides, lack of effect of pesticides due to resistance, economy and societies wishes for better environment and health. It can be important for the development and expansion of IPM and organic production that certain chemicals are restricted or removed from the market. This has been demonstrated in several EU countries where pesticide use has been significantly reduced, such as in Denmark where the first pesticide action plan from 1986 led to a 40% reduction in sales by 1997, and the second action plan reduced the "Treatment frequency index"(TFI) from 2.5 to 2 in 2004. The third 'Pesticide action Plan' was put into work and stated that by 2009 the TFI should be reduced to 1.7, but in 2010 had risen back up to 2.3 (Sigsgaard et al. 2011).

Ongoing and new research activities

Ongoing and new research activities of relevance for systemic approaches to pest management without insecticide involving the zoology group at UCPH include among others 'Fruitgrowth – Novel organic solutions securing future growth' (2011-14), 'Softpest Multitrap -Management of strawberry blossom weevil and European tarnished plant bug in organic strawberry and raspberry using semiochemical traps' -a Core Organic II project (2012-14), 'Imbicont' Improved biological control for IPM in fruits and berries (mid 2012-15, in collaboration with partners in Brazil), Inbiosoil- Innovative biological products for soil pest control -an EU FP7 project (mid 2012-15) and ProGrOV - Productivity and Growth in Organic Value-chains (2011-15) (for ongoing projects in see Organic eprints (<http://www.orgprints.org/>)).

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