MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

CSG 15

Research and Development

Final Project Report

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Research Policy and International Division, Final Reports Unit
MAFF, Area 6/01
1A Page Street, London SW1P 4PQ
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Project title	Exploiting semiochemicals for pest management in organic farming systems: study based on the literature and the experience of the authors
MAFF project code	**OF0188**
Contractor organisation and location	IACR-Rothamsted, Harpenden, Herts, AL5 2JQ, UK
Total MAFF project costs	£ 20,000
Project start date	01/01/00
Project end date	31/03/00

Executive summary (maximum 2 sides A4)

This study addresses the extent to which pest management systems can exploit semiochemicals (defined below) in ways acceptable to organic farming, and determines where the science base needs to be expanded to accommodate specific problems arising in an increasing organic farming sector. It considers whether current knowledge of semiochemical release from particular crop plants, herbs and wild plant species could be investigated further in relation to organic farming practice and identifies how strategies of multiple cropping, that exploit known semiochemical interactions, could be applied to key pest problems in organic production. Where such exploitation is not feasible, other strategies using semiochemicals including traps, extracts of natural products and nature-identical synthetic products are considered. Finally, general and specific directions in which research and development could facilitate greater penetration of the use of semiochemicals in crop protection for organic farming are identified.

Semiochemicals are natural products that, by acting as signals, regulate interactions between organisms e.g. plants and insects. Once the semiochemical interactions between a pest and its host plant have been elucidated they can be exploited to regulate the pest population, providing an alternative control strategy to conventional toxicants. The choice of approach by which the semiochemicals are deployed relates to three options, i.e. from a natural plant source, from an extract or as a nature identical synthetic product. However, even where the most natural situations of mixed cropping are used, the scientific basis of the interaction must be established for robustness and sustainability of the approach. A complete understanding of the process allows a risk assessment to be made of any problems that might ensue when exploiting natural systems in different configurations from those encountered naturally.

A major approach to using semiochemical based pest control is to exploit ways of repelling pests from crop plants and attracting them towards trap plantations. Deploying semiochemicals generated naturally by plants is

consistent with organic farming practice, where a range of mixed cropping techniques are employed already, which 'unconsciously' utilise semiochemical effects. Thus, the acceptance and use of systems exploiting aspects of semiochemical deployment demonstrate an emerging role in organic farming practices. However, as emphasised before, a comprehensive knowledge of the semiochemical interactions that underpin these techniques is vital if they are to be exploited fully.

Other pest control approaches compatible with organic farming, such as encouragement of beneficial species and the use of reflective surfaces in mulches, may not involve semiochemical effects, but could be exploited more beneficially by integration with semiochemical practices. Semiochemicals generated naturally by plants can be used to influence beneficial organisms as well as invertebrate pests. For example, plant defence chemicals, induced by pest or pathogen infestation, can affect the behaviour of pests and their natural enemies. Semiochemicals can be employed to maximise the impact of parasitic organisms that attack pest populations, for example in the management of refugia for maintaining and increasing populations of these beneficial organisms. In addition, the approach can be applied against other organisms antagonistic to agriculture besides invertebrate pests, for example in weed control, where signals interfering with weed germination can be exploited.

Extracts of natural products provide semiochemicals in a form that is familiar and acceptable to organic farming practice, where plant extracts are already used as toxicants or as semiochemical antifeedants and repellents. However, often the scientific basis for use of these materials is limited, and therefore, exploitation is also limited and can be unreliable. By understanding the composition and the mechanism of activity of semiochemicals, natural product extracts can be improved by selection of the best sources of natural materials and appropriate processes of extraction and formulation.

Many natural products, particularly pheromones (semiochemicals acting between members of the same species), can be synthesised as nature-identical and the synthetic forms are often indistinguishable from the natural form. Synthesis can be expensive, but where possible, starting materials should be obtained from natural renewable resources. Nature-identical synthetic pheromones are used widely in parts of the world, either deployed in traps for monitoring, mass trapping and lure and kill strategies or for direct pest control approaches such as mating disruption. In addition, manipulation of beneficial species with pheromones is being investigated and synthetic food-related attractants and oviposition attractants have also been developed for pests where pheromones are not available. Already some nature-identical synthetic semiochemicals have been accepted as compatible with organic farming practice. The registration of many sex and aggregation pheromones has been possible because they are nature-identical and are deployed away from the crop or on crop areas that are not consumed.

In most cases, semiochemicals, deployed alone, are not sufficiently robust to control pest populations directly. They are most effective when incorporated into strategies, such as the 'push-pull' strategy, that are integrated with other forms of pest control, e.g. pathogens, parasitoids and predators, mechanical barriers and resistant plant varieties. The integration of semiochemical approaches with other methods of pest population reduction will help prevent the development of pest resistance to the overall strategy. Since the integrated strategy comprises a number of components that affect different aspects of pest behaviour and development each component can be relatively ineffective when compared to conventional pesticides. However, this has the advantage of not selecting efficiently for resistance to any component of the strategy and thus contributes to the sustainability of the approach.

Recommendations

1) Develop a priority list of specific and general problems in organic production to be targeted by semiochemical methodologies in addition to known problems such as in carrot and lettuce production, aphids on a range of vegetable crops and for fruit pests.

2) Develop semiochemical based control methods suitable for 1) and for the targets already known.

3) Provide scientific input, where lacking, for 1 and 2.

4) Encourage greater diversification in organic cropping systems, including agroforestry, so as to exploit current knowledge of semiochemical based control and to pave the way for new interventions as the science develops.

5) Consider semiochemical attributes of non-crop plant inputs including mulches, weeds and multifunctional beneficial plants and the roles that they might play in organic systems.

6) Initiate organic plant breeding programmes, specifically to exploit natural semiochemical release where understood, for crop and companion plants.

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Scientific report (maximum 20 sides A4)

See attached document:-

Exploiting semiochemicals for pest management in organic farming systems: study based on the literature and the experience of the authors

J A Pickett, L J Wadhams, B J Pye, L E Smart and M Wolfe*

Biological Chemistry Division, IACR-Rothamsted, Harpenden, Herts., AL5 2JQ, U.K.
Elm Farm Research Centre, Hamstead Marshall, Newbury, Berkshire, RG20 0HR, U.K.*

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