Crop protection in organic agriculture - a simple matter?

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ABSTRACT

Crop protection strategies in organic agriculture and horticulture aim to prevent pest, disease and weed problems through optimisation of the cropping system as a whole. Choice of crops and varieties within the rotation and use of appropriate husbandry practices are critical to the success of the system and direct curative action against pests and diseases is rarely necessary. Research is urgently needed to determine strategies for control of key pests and diseases in organic systems if UK organic agriculture is to expand to meet increasing consumer demand. This paper describes current prevention and control strategies for pests, diseases and weeds in UK organic agriculture and identifies problems that are currently limiting expansion of the industry.

CURRENT CROP PROTECTION STRATEGIES

Lack of effective, economic crop protection strategies is one of the key factors limiting expansion of UK organic agriculture, particularly where novel or horticultural crops are being considered as part of diversified rotations. Current strategies for weed, pest and disease control are described below.

Weed management

The main weed control strategies used in organic farming usually combine cultural or husbandry techniques with direct mechanical and thermal methods. Husbandry practices include: adjustment of soil conditions (e.g. by irrigation), various cultivation techniques, use of stale seedbeds, diverse crop rotations, pre-plant mulches for high value crops, and use of cultivars particularly suited for organic production. Mechanical and thermal intervention includes ridging-up in potatoes, inter-row cultivation in root crops and cereals, post-emergence harrowing to control weeds in cereal crops and heat treatment of weeds (infra-red or direct flaming) prior to crop emergence and in between rows.

Crops differ in their ability to compete with weeds. Some of these differences in competitive ability may be due to allelopathic properties of the crop (i.e. a capacity to release chemical compounds either directly or indirectly through microbial decomposition of residues, which suppress weed germination and growth in their vicinity). The inclusion of allelopathic plants in crop rotations may have the potential to aid weed control, but identification of the nature and magnitude of allelopathic effects of both traditional and novel break crops is required if opportunities for improved weed control in organic systems are to be fully exploited (Robson *et al.*). Potential biological control agents exist for some weed species, but European organic regulations do not, at present, permit the use of biological agents to control weeds.

Pest management

Pests are generally not a significant problem in organic systems, since healthy plants living in good soil with balanced nutrition are better able to resist pest attack. However, major pest damage is sometimes seen in organic crops, particularly in vegetables such as carrots and brassicas, which are very susceptible to damage from root flies. Pest problems can be particularly severe in large horticultural holdings, where several hectares of a single crop species may be grown. Pest control strategies in organic farming systems are mainly preventative rather than curative. The balance and management of cropped and uncropped areas, crop species and variety choice and the temporal and spatial pattern of the crop rotations used all aim to maintain a diverse population of beneficial organisms including competitors, parasites and predators of pests. Damaging populations of pests and pathogens are less likely to establish in soils that sustain high levels of beneficial organisms.

Break crop choice and rotation design can have a major impact on the incidence and severity of certain types of pest problems. The less mobile pests or those which have a specific or narrow host range are particularly susceptible to crop rotation. Highly mobile, often non-specific pests such as aphids are less affected, or unaffected by rotation design. Reactive treatments for pest outbreaks, including natural pesticides, are permitted under regulations for specific situations in organic systems, but cultural pest prevention techniques including the use of break crops within balanced rotations will remain the most important means for pest control in organic systems.

Disease management

Levels of soil borne pathogens and root disease are generally lower in organic systems than in conventional (van Bruggen 1995). Airborne pathogens do not generally cause serious problems in organic systems, but there are a few exceptions such as potato late blight and powdery/ downy mildews in vegetable and fruit crops.

The less mobile, soil-borne diseases such as rhizoctonia root rot and stem canker of potatoes and clubroot of brassicas can usually be adequately controlled through the use of balanced rotations, appropriate break crops and good soil husbandry. Not all soil borne pathogens are controlled adequately through crop rotation, for example, it is often difficult to control root-inhabiting pathogens that survive saprophytically in soil organic matter and exist for long periods in the absence of a host plant. These pathogens include *Pythium* spp., some *Fusarium* and *Phytophthora* spp. and *Sclerotium rolfsii*. Highly mobile, airborne pathogens are generally not controlled through crop rotation. In these cases, resistant species and varieties and cultural controls are used to minimise disease incidence and severity, for example, variety mixtures and intercropping are useful aids to foliar disease control (Theunissen, 1997; Wolfe 1985).

Direct disease control methods are rarely necessary in most organic crops, although some natural and plant extract-based fungicides are applied regularly to control foliar disease in some high value crops such as top fruit, grapes and vegetable transplants. Biological control of fungal diseases is permissible in organic systems, but few products are available because of difficulties in registration and the lack of cost-effective mass production. There are many new

products available in the UK and Europe which their manufacturers claim stimulate plants' own defenses to disease, but their efficacy and suitability for use in organic systems is rarely documented.

RESEARCH PRIORITIES

Research is urgently required to solve some of the more intractable weed, pest and disease problems in organic agriculture and to optimise farm system performance as a whole. Current research priorities are detailed in Table 1. There is considerable UK experience in cereal production within mixed organic systems and although much further work is required to optimise production methods, cereal production in such systems under current economic conditions is generally profitable. The real challenges may lie in the development of agronomically and economically successful stockless rotations in a range of soil types and rotations including more novel organic crops such as tree and soft fruits, vegetables, fibre, oil and biofuel crops. Work is also urgently required within all organic farm types to optimise nutrient use efficiency with a view to maximising crop health and minimising nutrient losses. The potential for composts and compost extracts as an aid to disease control and nutrient management requires detailed investigation for this reason.

There are a number of serious crop health problems limiting expansion of organic production of key crops in the UK. For some of these, such as late blight (potatoes), carrot fly (carrots), root flies (brassicas) and mildew (fruit crops) detailed biological and epidemiological studies are required in order to develop a greater understanding of the host/pest complex and to formulate control strategies. The UK climate and soils are ideal for production of a wide range of vegetable and fruit crops and research to solve major problems with these crops is vital if UK growers are to be able to take advantage of the high price premiums in the organic vegetable market.

Further work will always be required to optimise new prevention/control strategies within the farming system as a whole. Organic crop protection solutions can never be developed and implemented independently of the system. Work is also required to improve our understanding of the natural biological phenomena and cycles upon which successful organic farming depends. Only then can we learn how to enhance them in order to help prevent weed, pest and disease problems.

CONCLUSIONS

Crop protection in organic agriculture is not a simple matter. It depends on a thorough knowledge of the crops grown and their likely pests, pathogens and weeds. Successful organic crop protection strategies also rely on an understanding of the effects which local climate, topography, soils and all aspects of the production system are likely to have on crop performance and the possible host/pest complexes. Organic agriculture is rapidly expanding within the UK to include novel, edible, fibre and processing crops, diversified rotations and large scale stockless farming companies alongside traditional mixed organic farms. Many of the established strategies that have been developed to prevent and control weeds, pests and diseases in traditional organic systems have limited application in the more novel systems. Research is therefore urgently required to

optimise these strategies for use in novel organic systems and where necessary to develop new crop protection technologies, where pest, disease or weed problems are limiting expansion of the industry.

Table 1. Research priorities in organic crop protection

Problem	Research required on….
Weeds	Integrated control programmes for key weeds (esp. creeping thistle, docks, couch grass) [DEFRA projects OF0115T and work at ADAS Terrington have addressed the issue in part]
	Weed control in permanent pasture
	Weed control in cereals [DEFRA projects OF0145, OF0173 & OF0194 have addressed in part]
	Weed control in high value and novel crops
	Potential for the use of allelopathy as an aid to weed control
	The effect of weed control regimes on biodiversity (esp. macrofauna)
	The effect of weed control regimes on root systems, soil structure and the release of mineral nitrogen
Pests/ diseases	Biological control strategies for key pests/diseases (noted above)
	Use of bi-cropping, intercropping and varietal mixtures for pest and disease control
	Development of integrated organic cropping systems (mixed and stockless) to maximise crop health, optimise weed levels and minimise incidence and severity of pests and diseases
Pests	Slug control [DEFRA projects OF0137 & OF0158 have not yet solved the problem]
	Red clover nematode
	Carrot fly [partly addressed by DEFRA project OF0179]
	Root flies in brassicas
Diseases	Potato late blight [Now being addressed under DEFRA project OF0167 and an EU Framework V programme]
	Seed-borne disease in cereals, potatoes and horticultural crops
	Mildew control in cereals
	Disease prevention and control in top fruit
	Disease prevention and control in soft fruit
	Use of composts and compost extracts for disease prevention and control

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From: Powell et al. (eds), *UK Organic Research 2002: Proceedings of the COR Conference, 26-28th March 2002, Aberystwyth*, pp. 203-206.