Development of a systems approach for the management of late blight (*Phytophthora infestans*) in organic potato production

Funder: EU (Project Ref: QLK5-CT-2000-01065 Blight MOP)

Lead Organisation: Tesco Centre for Organic Agriculture

Collaborators: **(1)** Tesco Centre for Organic Agriculture, University of Newcastle, UK; **(2)** Swiss Federal Research Station for Agroecology and Agriculture, Switzerland; **(3)** Institut National de la Recherche Agronomique, France; **(4)** Department of Ecological Plant Protection, University Gesamthochschule Kassel, Germany; **(5)** Elm Farm Research Centre, UK; **(6)** Danish Institute of Agricultural Sciences, Denmark; **(7)** Federal Biological Research Centre for Agriculture and Forestry, Germany; **(8)** Swiss Federal Research Station of Agroecology and Agriculture, Switzerland; **(9)** The Norwegian Centre for Ecological Agriculture, Norway; **(10)** Louis Bolk Instituut, The Netherlands; **(11)** Groupe de Recherche en Agriculture Biologique, France; **(12)** Plant Research International, The Netherlands; **(13)** Agricultural Economics Research Institute, The Netherlands.

Start Date & Duration: March 2001, 36 months for EFRC

Total EU contribution to EFRC: £95, 000

Overall Aim:

To develop a 'systems approach' for the management of late blight, allowing commercially viable production of organic potato crops without recourse to copper fungicides

Abstract of Research

Since 1882, when Alexis Millardet noticed the impact of copper ions on *Plasmopara viticola* infection of grapes, copper fungicides have been used against downy mildew diseases and potato late blight (caused by *Phytophthora infestans*). Copper fungicides continue to be a last resort for organic potato producers against late blight. However, the use of copper in EU organic production is under continuous review and further restrictions on its use were made in March 2002.

The aim of the Blight MOP project is to provide an integrated system approach against late blight to allow commercially viable production of organic potatoes without recourse to copper fungicides. The approach will be maximised for particular European regions and it is likely to integrate **(1)** variety resistance; **(2)** within-field diversification strategies; **(3)** agronomic strategies and **(4)** alternative treatments. The aim of Blight MOP is closely linked with the greater aim of EFRC of moving away from industrialised production models, with reliance on chemical intervention, towards ecological prevention of risk.

The focus of Elm Farm Research Centre's contribution to Blight MOP is the development of appropriate diversification strategies; this means understanding the ecological and epidemiological consequences of growing more than one variety or even species (e.g. potatoes and wheat) in the same field at the same time. It is hoped that synergism between diversification strategies, variety resistance, agronomic strategies and alternative treatments will provide a sustainable strategy of preventing late blight and stabilising yields in organic

production systems. EFRC's focus fits closely with the research agenda at EFRC of introducing functional biodiversity into cropping systems as a means of buffering growers against risk.

Position within EFRC Research Programme: Finite resource/genetic engineering.

Objectives

1. The assessment of the current socio-economic and management impacts of late blight in EU organic potato production systems.
2. The assessment of variety performance in organic production systems in different EU regions, in the context of local blight populations.
3. The development of within field diversification strategies to prevent/delay blight epidemics.
4. The optimisation of agronomic strategies for the management of late blight.
5. The development of alternatives to copper fungicides, which comply with organic farming standards.
6. The evaluation of novel application and formulation strategies for copper-free/alternative copper based treatments.
7. The integration and maximisation of the most appropriate component strategies into existing organic production systems, in different regions of the EU.

Project Progress

Objective 1. EFRC have delivered detailed survey data, collected from farms across the UK. EFRC have also contributed to the analysis of this data, which is now near completion.

Objective 3. EFRC have completed two years of successful field trials at Wakelyns Agroforestry. This work, combined with simulation modelling and an understanding of pathogen-plant-environment interactions, has progressed our understanding of (1) the epidemiology and ecology of potato variety mixtures; and (2) the costs and benefits associated with growing and marketing a potato variety mixture.

Ecology The yield to be expected from a potato variety mixture is a result of competitive interactions in the mixture. One variety will be more competitive than another, but the advantage to the more competitive variety almost always significantly outweighs any disadvantage to the less competitive variety. Mixtures offer better resource use efficiency at common cropping densities, but pure stands perform better than mixtures at very low cropping densities. A well-designed two-way variety mixture will yield greater than 5% better than its component pure stands, independent of any effects on disease or product quality. Potato variety mixtures seem particularly well placed to buffer against the many risks associated with monocultural production models, as illustrated by improved yield stability of mixtures through time and space and enhanced economic returns from variety mixtures by reducing the overall percentage of outgrades.

Epidemiology Potato variety mixtures provide a different epidemiological situation to that seen in small-grained cereals against mildew, bunts and smuts. This is mainly a result of large plant size, the importance of lesion expansion to disease progression and a fast rate of disease progress. We believe that potato variety mixtures make use of dilution and barrier effects (the mechanical effects of mixing varieties) rather than the more biological effects of induced resistance or other ecological interactions. This being the case, simulation studies have demonstrated the value of using almost immune hosts to restrict disease progression. Field studies have confirmed this result. In addition, the performance of potato variety mixtures against late blight improves greatly as we expand the area grown, this has been

illustrated by both simulation and field studies. These results also indicate the potential usefulness of a mosaic of potato varieties rather than an intimate mixture.

Diversification of potato varieties always makes biological sense and usually makes economic sense. It is the level of diversification that a grower is happy to adopt which is the key factor. Those smaller-scaled growers, marketing through farm shops or box schemes, may feel more comfortable with growing a variety mixture than larger scale growers. However, we believe that technological innovations on grading/packing lines ought to make variety mixtures an economically viable proposition for even the largest scale potato (not just organic) grower.

Expected Benefits

- Improved insight into the epidemiological consequences of diversifying potato varieties at different spatial scales. This should make a useful contribution to general theory about diversification of larger crop species against polycyclic air-borne diseases.

- Improved insight into the ecological consequences of diversifying potato varieties. This should make a useful contribution to understanding resource use efficiency in diversified cropping.

- EFRC's contribution towards the practical outcome of Blight MOP is to provide detailed understanding of one component of a systems approach against late blight. This systems approach is to be demonstrated to growers across Europe in model farming systems.

Output:

British Crop Protection Council (2002) 2 Papers, see attached.
IFOAM (2002) 1 paper, see attached
International Congress of Plant Pathology (2003) 1 paper.
Various talks and seminars, notably at Reading University and Pesticide Action Network.
Coverage in Farmer's Weekly and another article to appear in the next edition of 'The Furrow' magazine.
Various EFRC Bulletin articles.

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