



# ENDURE

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## Glossary

For a glossary of terms related to plant pathology we refer to an excellent glossary available at <http://www.inra.fr/hyp3/glossary.htm>

Partners in Potato Case :

WUR: Wageningen Universiteit & Researchcentrum (NL)  
INRA: Institut National de la Recherche Agronomique (F)  
ACTA: Association de Coordination Technique Agricole (F)  
AU: Aarhus University (DK)  
IHAR: Plant Breeding and Acclimatization Institute (PL)  
CNR: Consiglio Nazionale delle Ricerche (I)  
IBMA: International Biocontrol Manufacturers' Association

DSS: Decision Support System  
IPM: Integrated Pest management  
GILB: Global Initiative on Late Blight

## Summary

Late blight (caused by the pseudo-fungus *Phytophthora infestans*) is the most serious potato disease. A conservative minimum estimate of combined losses and costs of control (mainly fungicides) of potato late blight worldwide is 4 billion Euros per annum; half of this figure for Europe alone. More fungicide is applied to control blight than is used in any other crop.

Integrated management of potato late blight requires a combination of management techniques in order to keep disease levels low and at the same time maintain the quality of the environment.

EuroBlight is a European network of scientists and other specialists working on potato late and early blight. Since 2007 this network combines two previous networks originating from European Concerted Actions and has approximately 150 members.

An inventory was made among participating institutes in the ENDURE Potato Case for the facilities relevant for research on late and early blight (Table 1). Also the facilities of three research institutes in Scandinavia are presented (Table 2).

An inventory was made among participating institutes in the ENDURE Potato Case and partners of the EuroBlight network ([www.euroblight.net](http://www.euroblight.net)) for ongoing research projects related to *P. infestans* and *Alternaria*. The project title, a short description, the duration of the project and the responsible persons are presented in paragraphs 3.1-3.13. In table 3 an overview is presented of the projects in the different countries on various topics of the late blight and early blight problem.

A lot of work to identify relevant scientific issues with respect to host resistance, pathogen populations and integrated pest management is ongoing. Many relevant research projects are funded at the national level (Chapter 3) and the Potato Case participants and participants of the EuroBlight network have access to this research and also expertise in potato production systems and a wide range of other pests and diseases of potato. Most research projects are dealing with *P. infestans*, only some projects are ongoing on *Alternaria*. In addition, the facilities required to carry out cropping systems research for potato are available. For example, the participants in the Potato Case amongst many others, have excellent resources.

The EuroBlight networks consists of all the important scientists and specialists in potato pathology and it is recommended that this network would be ideally placed to identify gaps in the current knowledge, and importantly, gaps that must be filled in order to formulate a working and transferable strategy for the reduction in pesticide applications to potato. It is therefore recommended that to come to a better utilisation of research, the 4 subgroups of EuroBlight (DSS, fungicides, pathogen, host resistance) will use the information presented in this report to come to a better coordination of research programs and harmonised protocols.

# 1 Introduction

Late blight (caused by the pseudo-fungus *Phytophthora infestans*) is the most serious potato disease and, when first introduced into Europe in the 1840s, was responsible for the Irish Potato Famine. A conservative minimum estimate of combined losses and costs of control (mainly fungicides) of potato late blight worldwide is 4 billion Euros per annum; half of this figure for Europe alone. More fungicide is applied to control blight than is used in any other crop. Host resistance is available, but its practical application is currently limited: agronomic and market requirements place constraints on its use. In Eastern Europe, including all the pre-accession states, late blight is an even more serious problem. Many producers cannot afford the number of ‘routine’ sprays applied in W. Europe and typically spray only twice per annum. Consequently, larger losses are suffered; Poland can lose upwards of 20% of the potato crop directly to the disease in ‘bad’ years with 15-20% losses every year due to secondary rots in storage. As the agricultural economies in E. Europe align with those of W. Europe, the quantity of fungicides applied to the potato crop will increase substantially. Knowledge transfer regarding the integrated use of fungicides, decision support systems and the organisation of extension services is required from Western to Eastern Europe and *vice versa* the exchange of information on potato production systems based mainly on crop resistance with limited use of pesticides.

Changes in the world-wide *P. infestans* populations and the presence of both A1 and A2 mating types of the pathogen in Europe pose the risk of increased diversity, earlier disease epidemics and the rapid breakdown of host resistance.

Integrated management of potato late blight therefore requires a combination of management techniques in order to keep disease levels low and at the same time maintain the quality of the environment.

Important tools for integrated control include:

- Hygiene measures to keep the number of primary sources of inoculum low
- The use of cultivars with stable resistance for foliar and tuber blight
- Cultural practices such as early planting and moderate nitrogen fertilisation
- Targeting fungicides preventatively by using information on infection conditions based on weather data and disease pressure.

Decision Support Systems (DSS) are currently used to integrate and organise all the available information required for decisions to control late blight. The overall conclusion from the validation of DSS by EU.NET.ICP was that the use of a DSS combined good disease control with a reduction of fungicide input.

## **EU.NET.ICP (coordinated by Huub Schepers)**

This EU funded Concerted Action (1996-1999) ‘European Network for development of an integrated control strategy for potato late blight’ was commissioned to hold 4 workshops to discuss details of the most recent late blight epidemics in each country, and the latest research results regarding integrated control and decision support systems for late blight in potato. The enthusiasm of the participants and success in obtaining commercial sponsorship of the meetings has resulted in the continuation of this network (meetings were held in 2000, 2001, 2002, 2004, 2005). In 2005 the meeting was held in Estonia. The proceedings of these workshops are published as PPO-Special Reports and are also available at [www.euroblight.net](http://www.euroblight.net). At the most recent meeting there were 69 participants from 14 European countries and the USA.

**‘Eucablight’ – A Late Blight Network for Europe 2003-2006 (coordinated by Alison Lees, SCRI)**

The Eucablight concerted action incorporates the majority of late-blight research programmes from across Europe including many of those also active in EU.NET.ICP. A network of European scientists working on late blight resistance and *P. infestans* population biology in Europe (24 partners in 15 countries) has been established and links have been fostered to related research elsewhere in the world (Estonia, Czech Rep., Italy, USA, South America and Russia). Work is now under way to standardise methods for the characterisation of the pathogen and for determination of foliage and tuber blight resistance in potato germplasm and to make them universally accessible on the www. These techniques will be used to create databases of (a) European *P. infestans* isolates (to assess population structure and diversity at a continental level) and (b) potato germplasm characterised for foliage and tuber blight resistance. Results will be combined with existing knowledge on integrated control of late blight and the world-wide activities of the Global Initiative on Late Blight (GILB) to plan future strategies for the sustainable control of disease. Europe-wide standardisation of methodologies will generate truly comparable results and provide robust, reliable data on both the host and pathogen to help researchers combat this devastating disease.

**EuroBlight (coordinated by Alison Lees, Jens Gronbech Hansen & Huub Schepers)**

EuroBlight is a European network of scientists and other specialists working on potato late and early blight that continues to meet every 12-18 months. Since 2007 this network combines the two previous networks originating from European Concerted Actions and has approximately 150 members.

## 2 Research facilities

An inventory was made among participating institutes in the ENDURE Potato Case for the facilities relevant for research on late and early blight (Table 1). Also the facilities of three research institutes in Scandinavia are presented (Table 2).

Table 1. Research facilities of members of Potato Case.

Facilities	WUR (NL)	INRA (F)	ACTA (F)	AU (DK)	IHAR (PL)	CNR (I)
Trial fields <sup>1</sup>	*	*	*	*	*	2 rented fields but no equipment available
Growth chambers	*	*		*	*	2
Greenhouses	*	*		*	*	1
Laboratories						
*Mycology	*	*	*	*	*	1
*Molecular biology	*	*		*	*	1
*Biochemistry	*	*				1
Potato storage rooms	*	*		*	*	One cold room (4 C)

<sup>1</sup> including field trial spray equipment

Table 2. Research facilities of research institutes in Scandinavia

Facilities	Bioforsk (N)	SLU (S)	MTT (FIN)
Trial fields <sup>1</sup>	*	*	*
Growth chambers	*	*	*
Greenhouses	*	*	*
Laboratories			
*Mycology	*	*	*
*Molecular biology	*	*	*
*Biochemistry			
Potato storage rooms	*		

<sup>1</sup> including field trial spray equipment



### 3 National Research projects related to *P. infestans* and *Alternaria*

An inventory was made among participating institutes in the ENDURE Potato Case and partners of the EuroBlight network ([www.euroblight.net](http://www.euroblight.net)) for ongoing research projects related to *P. infestans* and *Alternaria*. The project title, a short description, the duration of the project and the responsible persons are presented in paragraphs 3.1-3.13. In table 3 an overview is presented of the projects in the different countries on various topics of the late blight and early blight problem. It must be realized that the list of projects is not complete. Some countries are not represented in the list below although we know that projects in these countries are ongoing. Also the list of projects in countries that are represented is not always complete. Unfortunately some researchers did not respond to our request for information. We however believe that the projects in this list cover the majority of projects in Europe on this subject.

#### 3.1 Denmark

Project title	Description	Status
DSS and fungicide reduction - REFUKA	Funded by the Danish Ministry of the Environment. Epidemiological studies about sporangia formation, liberation, survival and infection. Development of new methods to improve the weather forecasting data especially for relative humidity in collaboration with the Danish Meteorological Institute. Test of improved DSS in field trials	<b>Duration:</b> 2004-2007 <b>Responsible:</b> Bent Nielsen & Jens G. Hansen
Resistance of potato varieties	Screening of Danish potato varieties for foliar resistance to <i>P. infestans</i> (Eucablight protocol)	<b>Duration:</b> 2007 <b>Responsible:</b> Bent J. Nielsen
Improving decision support for control of late blight	Improving and updating information and tools about late blight control in Planteinfo	<b>Duration:</b> 2007 <b>Responsible:</b> Jens G. Hansen
Test of new fungicides	Field experiments with new fungicides for controlling late blight and early blight as part of fungicide registration in Denmark. Also different control strategies integrating fungicide timing, dose and intervals with variety resistance aiming at optimizing fungicide use in potato.	<b>Duration:</b> Continuously <b>Responsible:</b> Bent J. Nielsen
Spray technique in potato	Field experiments with different spray techniques and spray systems aiming at optimising the effect of late blight fungicides	<b>Duration:</b> Continuously <b>Responsible:</b> Peter Kryger Jensen and Bent J. Nielsen
Production and survival of oospores, II	Experiments in field and greenhouse with influence of cover crops, soil temperature and humidity on survival of oospores.	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Sabine Ravnskov

Production and survival of oospores, I	Effect of different control and desiccation methods on production and survival of oospores in leaves and soil	<b>Duration:</b> 2007 <b>Responsible:</b> Sabine Ravnskov
European Network for the Durable Exploitation of crop protection strategies(ENDURE)	European project. Project SA4: Provide a central European point of reference for extending recommendations and providing advice on low input practices for crop protection as developed in different countries. Project RA1: Potato case study	<b>Duration:</b> 2007-2008 <b>Responsible:</b> Bent J. Nielsen(for DK)

### 3.2 Norway

Project title	Description	Status
Late blight epidemiology and forecasting	Improve the current forecasting system on the Internet. Studies on control strategies, early infections and on oospore formation and survival are included.	<b>Duration:</b> 1998-2008 <b>Responsible:</b> Arne Hermansen
Integrated Pest management - Vietnam	<i>P. infestans</i> , epidemiology and control strategy experiments in Vietnam	<b>Duration:</b> 2005-2007 <b>Responsible:</b> Trond Hofsvang/Arne Hermansen
Potato quality and haulm killing	Infection potential of <i>P. infestans</i> at different leaf infection levels and haulm killing methods	<b>Duration:</b> 2003-2007 <b>Responsible:</b> Eldrid L. Molteberg/Arne Hermansen
Test of new fungicides	Field experiments regarding approval test of new compounds for the control of late blight	<b>Duration:</b> Continuously <b>Responsible:</b> Arne Hermansen

### 3.3 Sweden

Project title	Description	Status
Pre-sprouting of potato	Development of new techniques for pre-sprouting potato	<b>Duration:</b> 2005-2007 <b>Responsible:</b> Jannie Hagman/Björn Andersson
Potato late blight in Nicaragua	Population study <i>P. infestans</i> in Nicaragua	<b>Duration:</b> 2006 - ? <b>Responsible:</b> Jonathan Yuen
Stay-green	Multidisciplinary study of how to increase Swedish (starch) potato yield levels	<b>Duration:</b> 2003-? <b>Responsible:</b> Lars Wiik

Biocontrol of <i>P. infestans</i>	Microorganisms and plant extracts as alternatives to chemical control of late blight	<b>Duration:</b> ? <b>Responsible:</b> Sadhna Alström
Plant breeding	Breeding for late blight resistance in potato	<b>Duration:</b> ? <b>Responsible:</b> Kerstin Olsson
Significance of <i>Alternaria</i> spp on potato in Sweden	Development and evaluation of early blight control strategies. Population study of <i>Alternaria</i> spp	<b>Duration:</b> 2005-2007 <b>Responsible:</b> Björn Andersson/Lars Wiik
Test of new fungicides	Field experiments regarding approval test of new compounds for the control of late blight	<b>Duration:</b> Continuously <b>Responsible:</b> Lars Wiik

### 3.4 Finland

Project title	Description	Status
Blight Management	Improve the current monitoring and forecasting system on the Internet. Studies on control strategies, early infections and on oospore formation and survival are included, publication of old data	<b>Duration:</b> 2006-2008 <b>Responsible:</b> Asko Hannukkala, Ari Lehtinen & Marika Rastas
Improving late blight management in North-Western Russia	Monitoring blight population in Russia and Finland	<b>Duration:</b> 2006-2007 <b>Responsible:</b> Asko Hannukkala
Tests of new fungicides	Field experiments regarding approval of new compounds for potato late blight control	<b>Duration:</b> Continuously <b>Responsible:</b> Peppi Laine & Asko Hannukkala
Resistance of potato varieties	Official variety trials	<b>Duration:</b> Continuously <b>Responsible:</b> Asko Hannukkala

### 3.5 Poland

Project title	Description	Status
Analysis of variability in reaction of potato cultivars to fungal	Assessment of potato variety resistance to LB (field trials, laboratory tests, cooperation with Baltic countries and Denmark - variety observation in Internet).	<b>Duration:</b> Continuously <b>Responsible:</b> Józefa Kapsa

and bacterial diseases

Influence of plant-pathogen-environment interaction on variability of fungal and bacterial potato pathogens	Epidemiology and biology of <i>Phytophthora infestans</i> (sources of infection, stem blight problems, resistance of <i>P. i.</i> populations to phenylamides). Building of <i>P. i.</i> monitoring-net for Poland available via Internet.	<b>Duration:</b> Continuously <b>Responsible:</b> Józefa Kapsa
The improvement of evaluation methods for resistance to potato late blight and tuber rot	Biology of <i>Phytophthora infestans</i> , monitoring <i>P. i.</i> population and search on storage methods of <i>P. i.</i> isolates. Development of methods for testing resistance of potato against <i>P. i.</i> and research on tuber resistance to <i>P. i.</i>	<b>Duration:</b> 1996- <b>Responsible:</b> Renata Lebecka
Analysing of various factors affected protection effectiveness against fungal and bacterial potato pathogens	Development of integrated strategies for potato crops protection (late and early blight control, tuber protection programs and studies on stem blight control). State trials testing efficacy of new compounds before registration in Poland (State Certification).	<b>Duration:</b> Continuously <b>Responsible:</b> Józefa Kapsa
Collecting and maintaining of potato pathogens	Collecting, characterising and maintaining of <i>Phytophthora infestans</i> isolates.	<b>Duration:</b> Continuously <b>Responsible:</b> Renata Lebecka
Identification of parental lines suitable for breeding potatoes outstanding in some quality and resistance characters	Parental line breeding focused on combination of resistance to <i>Phytophthora infestans</i> and earliness.	<b>Duration:</b> 2002-2007 <b>Responsible:</b> Ewa Zimnoch-Guzowska
Stability of resistance to late blight of Polish potato cultivars	Screening of Polish potato cultivars for foliar and tuber resistance to <i>P. infestans</i> (Eucablight protocol)	<b>Duration:</b> Continuously <b>Responsible:</b> Beata Tatarowska
Studies on new tetraploid sources of resistance to <i>P. infestans</i>	Searching for new sources of resistance and introduction to tetraploid potato	<b>Duration:</b> Continuously <b>Responsible:</b> Beata Tatarowska
BIOEXPLOIT	Development of standardised and representative collections of fungal and oomycete isolates. Phenotyping mono-QTL lines and core collections with a representative collection of <i>P. infestans</i> . Introduction of the new sources of resistance to <i>P. infestans</i> into 2x and 4x breeding pool via backcrosses to <i>S. tuberosum</i> and selection using PCR markers	<b>Duration:</b> 2005-2008 <b>Responsible:</b> Ewa Zimnoch-Guzowska
Introduction of resistance genes to	Introgression of new sources of resistance to <i>P. infestans</i> from <i>S. michoacanum</i> via somatic	<b>Duration:</b> 2007-2010

*Phytophthora infestans* from *Solanum michoacanum* into cultivated potato *S. tuberosum* and development of PCR markers for their selection

hybridization and development of markers for selection purposes

**Responsible:**  
Ewa Zimnoch-Guzowska

Production and molecular analysis of interspecific somatic hybrids of *Solanum* as a new source of resistance to *Phytophthora infestans* for cultivated potato

Introgression of *S. villosum* and *S. scabrum*, donors of resistance to *P. infestans* to *S. tuberosum* via somatic hybridisation

**Duration:**  
2007-2010  
**Responsible:**  
Bernard Wielgat

### 3.6 Slovakia

Project title	Description	Status
New fungicides in control of late blight	Field trials for evaluation of new compounds for the control of late blight; comparing the efficacy of fungicides in the control of late blight on foliage using DSS	<b>Duration:</b> Continuously <b>Responsible:</b> Ján Heldák & Andrea Galliková

### 3.7 Germany

Project title	Description	Status
Production of potato genotypes with combined resistance to virus and <i>Phytophthora</i> by use of biotechnological methods	The goal of the project is to create potato genotypes with combined resistances to virus, aphids and <i>Phytophthora</i> by using conventional and biotechnological methods as well as to study the resistance mechanisms.	<b>Duration:</b> 1997- <b>Responsible:</b> R. Thieme
Epidemiology of latent infected tubers	Epidemiology within potato fields especially under the influence of latently infected seed potatoes as the infection start point and its further course during vegetation	<b>Duration:</b> ? <b>Responsible:</b> Michael Zellner
What soil conditions are optimal for primary infections	Influence of the soil consistence and soil moisture in respect to the severity of the primary infections (i.e. stem <i>Phytophthora</i> )	<b>Duration:</b> ? <b>Responsible:</b> Michael Zellner
Inclusion of latent infected potatoes into prognosis models	Development of prognosis models to forecast the infection development when latently infected seed tubers are the source of infection	<b>Duration:</b> ? <b>Responsible:</b> Michael Zellner

Can tuber dressings influence the primary infection	Influence of a potato seed dressing on the primary infections of <i>P. infestans</i> . Application of systemic and contact fungicides	<b>Duration:</b> ? <b>Responsible:</b> Michael Zellner
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### 3.8 Austria

Project title	Description	Status
Enhancement of horizontal and vertical late blight resistance of potato through the use of diverse resistance genes	Aims include to widen the genetic base of blight resistance, to prepare for molecular marker aided selection, and to obtain a genetic profile of <i>P. infestans</i> populations in Austria.	<b>Duration:</b> Continuously <b>Responsible:</b> Felix Fuchs

### 3.9 Hungary

Project title	Description	Status
Conventional resistance-breeding based on the use of R-gene carrying genotypes	work in co-operation with Plant Protection Research Institute of Hungarian Academy of Sciences (PPRI). In this co-operation PPRI investigates the pathogen itself while PRC investigates mainly the resistance of potato genotypes to late blight	<b>Duration:</b> ? <b>Responsible:</b> Zsolt Polgar

### 3.10 The Netherlands

Project title	Description	Status
Control of <i>P. infestans</i>	Research into the possibilities to combine an effective control of late blight with a low level of environmental side effects. In 7 field trials the possibilities to reduce dose rates in resistant cvs are tested under practical disease pressure conditions	<b>Duration:</b> 2007-2009 <b>Responsible:</b> Huub Schepers
Formulate control strategy	Using recent research results an up-to-date control strategy for late blight is formulated and communicated to advisors and growers	<b>Duration:</b> 2007-2009 <b>Responsible:</b> Huub Schepers
Site specific removal of volunteer potatoes	Develop sensing and weeding tools and an automated vehicle prototype for precise and effective control of volunteer potatoes with low inputs of labour, energy and chemicals	<b>Duration:</b> 2004-2009 <b>Responsible:</b> Ard Nieuwenhuizen
Stability of fungicide resistance	Mutants tolerant to mefenoxam en cyazofamid will be tested for loss of fitness. The projects aims at gaining insight in the evolution and stability of resistance	<b>Duration:</b> 2003-2007 <b>Responsible:</b> Rolf Hoekstra

Monitoring virulence Early warning with respect to newly occurring

and fungicide resistance	virulences and fungicide resistance. Isolates will be documented and added to the collection	2007-2009 <b>Responsible:</b> Geert Kessel
Infection risks	Project will deliver a complete set of tools to calculate (1) spore production on sources (2) spore travel to targets (3) spore survival during transport in the atmosphere (4) infection chance in target crops	<b>Duration:</b> 2007-2009 <b>Responsible:</b> Geert Kessel
Epidemiology of tuber blight	Projects aims to deliver a set of decision support rules specifically designed to prevent tuber infection. These rules are evaluated in field trials	<b>Duration:</b> 2007-2009 <b>Responsible:</b> Geert Kessel
Functional characterization of R-genes with effectors	To identify new R-genes in Solanum species and functional characterization and cloning using effectors.	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Edwin van der Vossen
Tuber blight resistance	Investigate the effects on tuber resistance of resistance genes that are effective in the foliage and investigate whether specific tuber resistance genes are present in potato cvs expressing high levels of tuber blight resistance.	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Ronald Hutten
Introgression breeding of potato	Prebreeding project to supply the Dutch potato breeders with tuber bearing lines that are crossable with tetraploid potato varieties	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Ronald Hutten
Nonhost resistance	Gain insight in the genetical basis of nonhost resistance in Arabidopsis and investigate whether such genes can contribute to a sustainable solution of the late blight problem	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Edwin van der Vossen
Resistance mechanisms	Classification of Phytophthora R-genes on basis of molecular mechanism of action. It is foreseen that this information, besides resistance spectrum and effector recognition, will become an important criterion for selection of R-genes in the future	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Edwin van der Vossen
Identification of virulence targets	This project aims at investigating the role of virulence targets in the Phytophthora-potato interaction. Virulence factors interact with Avirulence factors and R-proteins which play an important role in the compatible and incompatible interactions.	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Francine Govers & Edwin van der Vossen
Molecular targets for control of Phytophthora	Determine the biological function and mode of action of a number of specific Phytophthora genes. Search for possibilities to disturb the activity of these genes	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Francine Govers
Effector variation in the Dutch Phytophthora population	Development of a DNA-based diagnostic technique to monitor the presence of (new) R-genes in the Dutch <i>P. infestans</i> population	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Francine Govers

Monitor the environmental side effects of control strategies	Every year the environmental points of fungicides used to control <i>P. infestans</i> are measured and compared with the situation in the reference years 1996-1998	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Ben Kimmann
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Critical period warning system	During the whole potato growing season all potato growers receive a message by phone, SMS or fax when a critical weather period is forecasted in their region	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Ben Kimmann
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### 3.11 Ireland

Project title	Description	Status
Strategies for the control of Late Blight	Determining: the current distribution of metalaxyl resistance; the prevalence of different physiological races; the distribution and frequency of A2 mating type within the Irish population of <i>Phytophthora infestans</i> . Comparing the efficacy of new and established fungicide programmes in the control of foliage and tuber blight using routine and decision support system based application programmes.	<b>Duration:</b> -2007 <b>Responsible:</b> Leslie Dowley

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### 3.12 United Kingdom

Project title	Description	Status
Late Blight resistant cultivars	Development of late blight resistant organic cultivars	<b>Duration:</b> 2002- <b>Responsible:</b> David Shaw
Fight against Blight	Analysis of UK blight isolates from BPC 'Fight against Blight' campaign, for phenotypic and genotypic characteristics	<b>Duration:</b> 2003- <b>Responsible:</b> David Shaw
A survey of Great Britain blight populations	British Potato Council funded project to examine changes in the structure of the Great Britain <i>P. infestans</i> population with particular emphasis on frequency of the A2 mating type, the nature of the primary inoculum and the production and survival of oospores under Great Britain conditions	<b>Duration:</b> 2006-2008 <b>Responsible:</b> David Cooke together with SRT, ADAS, SAC & CSL
Optimising disease control	Optimising control of potato late blight with effective use of fungicides and cultivars for conventional and reduced input systems	<b>Duration:</b> 2004-2009 <b>Responsible:</b> Louise Cooke
Competitive selection in <i>P. infestans</i>	PhD studentships to examine competitive selection of <i>P. infestans</i> in the US and Northern Ireland	<b>Duration:</b> 2002-2007 <b>Responsible:</b> Gillian Young, Louise Cooke & Willie Kirk

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UK Blight Forum	British Potato Council Initiative to bring together UK	<b>Duration:</b>
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	blight researchers and industry to inform them of latest UK and European research and Eucablight progress.	2003- <b>Responsible:</b> Alison Lees
Tetraploid Genetics	Genetics of cultivated tetraploid potatoes	<b>Duration:</b> Ongoing <b>Responsible:</b> John Bradshaw
Diploid Genetics	Genetics of cultivated diploid potatoes	<b>Duration:</b> Ongoing <b>Responsible:</b> John Bradshaw
<i>P. infestans</i> structural genomics	SEERAD fellowship to combine physical, genetic and transcriptional maps of <i>P. infestans</i>	<b>Duration:</b> 2002-2007 <b>Responsible:</b> Steve Whisson
<i>P. infestans</i> functional genomics	SEERAD fellowship and 1 SEERAD-BBSRC grant to develop high-throughput systems (including RNAi) for analyzing the functions of <i>P. infestans</i> genes	<b>Duration:</b> 2002-2007 <b>Responsible:</b> Steve Whisson
Identification of <i>P. infestans</i> genes involved in establishing infection	Two SEERAD-BBSRC grants to use transcriptional profiling methods to identify <i>P. infestans</i> genes that are up-regulated during pre-infection stages	<b>Duration:</b> 2002-2007 <b>Responsible:</b> Paul Birch & Steve Whisson
Identification and characterisation of avirulence genes	SEERAD fellowship, SEERAD-BBSRC grant and EU grant to use physical mapping, association genetics and linkage disequilibrium to identify candidate Avr genes that are subsequently functionally characterised	<b>Duration:</b> 1998-2008 <b>Responsible:</b> Paul Birch & Steve Whisson
Characterisation of the functions of key effector genes in <i>P. infestans</i>	PhD project and two SEERAD-BBSRC grants to investigate the roles of key pathogenicity genes in establishing infection, biotrophy and necrotrophy in <i>P. infestans</i>	<b>Duration:</b> 2001-2007 <b>Responsible:</b> Paul Birch & Steve Whisson

### 3.13 France

Project title	Description	Status
Adaptation of <i>P. infestans</i> to cvs with partial resistance to late blight	To investigate the adaptive response of <i>P. infestans</i> to cultivars with different levels of partial resistance and model this evolution based on biological data and theoretical background	<b>Duration:</b> 1998-2007 <b>Responsible:</b> Didier Andrivon
Online DSS	Development and diffusion of an online DSS for late blight control	<b>Duration:</b> Continuously <b>Responsible:</b> D. Gaucher
Foliar resistance	Field test of foliar blight resistance according to	<b>Duration:</b>

	EUCABLIGHT methods, including Black's differentials	Continuously <b>Responsible:</b> D. Ellissèche, JM Abiven, C. Chatot, F. Aurousseau, S. Duvauchelle & D. Gaucher
BioEXPLOIT	EU Integrated Project - Development of new, improved resistance progenitors for LB resistance through phenotyping and marker identification	<b>Duration:</b> 2005-2009 <b>Responsible:</b> JE Chauvin, V. Lefebvre, D. Andrivon
<i>P. infestans</i> population survey in French potato growing regions	Monitoring of <i>P. infestans</i> populations for mating type, fungicide resistance and virulence	<b>Duration:</b> Continuously <b>Responsible:</b> Serge Duvauchelle
New resistance sources for LB in Solanum species	Screening of tuber-bearing Solanum species for LB resistance	<b>Duration:</b> 2003 - <b>Responsible:</b> Jean-Eric Chauvin
Evolutionary ecology	Evolutionary ecology of <i>P. infestans</i>	<b>Duration:</b> 2007-2010 <b>Responsible:</b> Didier Andrivon

Table 3. Number of projects ongoing in the different countries on various topics of the late and early blight problem.

Topic	DK	N	S	FIN	PL	SK	D	AU	HU	NL	IRL	UK	F
Decision Support Systems	1	1					1				1		1
Epidemiology	2	1			1		2			3		1	1
Population biology & genomics			1	1	2					5	1	6	2
Variety resistance	1		1	1	8		1	1	1	5		2	3
Fungicides	2	1	1	1	1	1	1						
IPM	1	1		1	1					4	1	1	
Organic strategies			1										
Alternaria			1		1								
EuroBlight	1	1	1	1	1	1	1	1	1	1	1	1	1

## 4 Discussion & Recommendations

A lot of work to identify relevant scientific issues with respect to host resistance, pathogen populations and integrated pest management is ongoing. Many relevant research projects are funded at the national level (Chapter 3) and the Potato Case participants and participants of the EuroBlight network have access to this research and also expertise in potato production systems and a wide range of other pests and diseases of potato. Most research projects are dealing with *P. infestans*, only some projects are ongoing on *Alternaria*. In addition, the facilities required to carry out cropping systems research for potato are available. For example, the participants in the Potato Case (Table1) amongst many others (Table 2), have excellent resources (e.g climate chambers, semi-field facilities, rain simulators etc.) These facilities are also available within agrochemical companies connected to the EuroBlight network.

The Eucablight project has collated, harmonised and disseminated methods for the phenotypic and genotypic characterisation of the pathogen and for host resistance. In addition, existing and newly generated data has been collected using a data entry tool specifically designed for the purpose. This data is held in databases, facilitating analysis of the pooled data on a European scale. In the EU.NET.ICP network, a harmonised protocol was developed to validate DSS for control of late blight in different European Countries. Also the fungicide characteristics (to be included in the DSS) are rated according to harmonised protocols for testing the effectiveness and mode of action.

Both projects are now combined in EuroBlight and deliver experience in modelling, testing candidate strategies and software tool technology. Whilst collectively, EuroBlight participants have experience with a wide range of potato pests (fungal, bacterial and nematode) and would envisage that these were built into an integrated disease management programme, a concentration of effort towards the control of late blight (and early blight) will result in the best contribution to a reduction of chemical input in potatoes.

It will be important to ensure that the lessons learned from the proposed potato-late blight model are applicable to other potato pest problems and also across crops (for example cereals and grapes). There must be inter-disciplinary and inter-crop dialogue to deliver a true European IPM strategy.

The EuroBlight networks consists of all the important scientists and specialists in potato pathology and it is recommended that this network would be ideally placed to identify gaps in the current knowledge, and importantly, gaps that must be filled in order to formulate a working and transferable strategy for the reduction in pesticide applications to potato. It is therefore recommended that to come to a better utilisation of research, the 4 subgroups of EuroBlight (DSS, fungicides, pathogen, host resistance) will use the information presented in this report to come to a better coordination of research programs and harmonised protocols.