PROMOTING INTERNATIONAL COLLABORATION FOR POTATO LATE BLIGHT DISEASE MANAGEMENT

K. V. Raman, Niklaus J. Grünwald and William E. Fry from Cornell University, USA, emphasize the need for international collaborative efforts in fighting potato blight and describe in particular one such project—the Cornell–Eastern Europe–Mexico (CEEM) project.

Introduction

The deadly plant pathogen that escaped from the rugged mountains of central Mexico in the 1840s caused the Irish Potato Famine (Niederhauser, 1956; Niederhauser, 1991; Fry and Goodwin, 1997). Potato late blight rotted the tubers of Ireland’s staple food in the field and in storage. Over 1 million people died and another 1.5 million fled the country (Large, 1940; Woodham-Smith, 1962; Bourke, 1964; Ó Gráda, 1997). The disease was caused by the microbial plant pathogen Phytophthora infestans (Mont.) de Bary (De Bary, 1873; De Bary, 1961). To date, late blight remains the world’s most devastating crop disease (Cooke, 1992; Fry and Goodwin, 1997; Cooke and Deahl, 1998).

New strains of the late blight pathogen have recently escaped from Mexico. Some of these exotic strains are far more aggressive than the descendants of those that triggered the Irish Potato Famine (Cooke and Deahl, 1998; Flier et al., 1998; Mizubuti and Fry, 1998).

Potato blight is particularly a threat to the Russian Federation and Eastern Europe, where potatoes are the “second bread”. The new strains of P. infestans have cut production by 15% in this region, where almost half of the world’s potatoes are grown. A “Russian Potato Famine” could be a greater world catastrophe than the Irish Potato Famine. The centre of origin for the pathogen that causes late blight is in central Mexico, where a highly diverse sexual population exists which features both mating types (A1 and A2) (Niederhauser, 1991; Fry et al., 1993; Fry and Goodwin, 1997). Until recently only one mating type of the late blight pathogen – the one that escaped from Mexico in the 1840s – was found worldwide (Fry et al., 1993). Sexual reproduction did not occur, because the compatible mating type was found only in Mexico. Thus the potato famine pathogen could only reproduce clonally, and could not adapt as rapidly to changes in the environment or to developments in agriculture.
A drought in 1976 caused a potato shortage in Europe and led to the introduction of deadly new late blight disease strains. The introduced A2 mating type was first detected in 1981 in Switzerland (Höhl and Iselin, 1984), and has subsequently been detected in most potato growing areas worldwide (Fry et al., 1993; Goodwin and Drenth, 1997). Europe imported 25,000 tons of potatoes from northern Mexico, where the A2 mating type of the late blight pathogen did not exist. Local farmers at that time could not provide the volume requested, and thus bought and shipped potatoes coming from Toluca (in central Mexico), which is considered to be the late blight pathogen's ancestral home. Thus, the A2 mating type reached Europe. In the early 1980s new metalaxyl-resistant strains of the late blight pathogen appeared. Retrospective analysis of late blight isolates using phenotypic, biochemical and DNA fingerprint markers, showed that increased levels of disease in Europe coincided with appearance of exotic pathogen strains (Fry and Goodwin, 1997). Disease control now relies on more frequent applications of fungicides (Fry and Goodwin, 1997). Reports indicate that new genotypes have now appeared in countries in Asia, Latin America, and Africa (Wei et al., 1999; Sengooba and Hakiza, 1999; Forbes et al., 1988; Koh et al., 1994; Ordoñez et al., 2000; Fry, unpublished results). As a consequence, the disease in these regions has become more severe.

The potential threat of this apparently renewed disease may lie in:

- the spread of new strains with increased fitness/aggressiveness
- an expanded capacity to produce oospores (sexual spores which enable long term survival in the absence of the host, and which may enable earlier epidemics)
- the shortage of chemicals and effective integrated control measures
- the lack of widely accepted, resistant commercial potato varieties.

Given this dire scenario, a rapid commitment to support research on the late blight disease, particularly by industrialized countries, is of the utmost importance for preventing a potential catastrophe.

**Economic impact of late blight in developing countries**

Late blight is poised to strike hardest at the millions of poor people who rely on potatoes but can least afford to buy expensive chemicals to keep the fungus in check. Hardest hit are potato producers in Africa, the Russian Federation and Eastern Europe. Almost all losses attributable to the disease in these regions are due to lost production. In Latin America the costs of fungicides are substantially more important, contributing to the total economic cost of the disease, not including the cost of environmental damage. Economists at the International Potato Center (CIP), in Lima, Peru estimate the overall annual cost of late blight in developing countries at $3.25 billion.

It is estimated that if the disease were controlled effectively through the use of stable, resistant varieties, the value of potato production would increase as much as 40-50% in many potato-producing countries and particularly in Sub-Saharan Africa, the Russian Federation and Eastern Europe. In other regions, especially Latin America and Asia, effective control through resistant varieties would result in significant reductions in the use of pesticides, thereby increasing farmer incomes.

The environmental “cost” of the use of fungicides is also of concern. While documented environmental ravages caused by fungicides are rare, it is prudent to limit the use of such chemicals in agriculture. In some agro-ecosystems of developing countries, applications of fungicide to suppress this disease approach 3-4 applications per week.

**The need for global research to control late blight**

Because of the gravity of the late blight problem many late blight control programs have been initiated all over the world and most of these will contribute to a sustainable solution. One of them is the Global Initiative on Late Blight (GILB) coordinated by the International Potato Center (CIP) [an international agricultural research centre supported by the Consultative Group on International Agricultural Research (CGIAR)]. The principal focus of GILB is to facilitate projects to develop sustainable programs to suppress the harmful effects of late blight. There is considerable emphasis to develop potato varieties with durable resistance (to all variants of the pathogen) that is appropriate for use in integrated disease programs in developing countries. However, Eastern Europe and Mexico are not yet involved in these initiatives.

In 1996, Cornell University started the Cornell-Eastern Europe-Mexico (CEEM) International Collaborative Project in Potato Late Blight Control with the general objective of lessening the problem of late blight through selected activities in Eastern Europe, Mexico and the USA. Specifically, CEEM aims at facilitating and conducting research on the biology/epidemiology and population genetics of the pathogen, especially in the highlands of central Mexico, as well as making available well adapted potato varieties resistant to late blight to Mexican, Eastern European, and North American scientists. CEEM is supported by Cornell University, an anonymous donor, and a network of international and national collaborators representing the private and public sectors. An Executive Committee of Cornell faculty provides the management and oversight, with help from an international panel of experts.

The College of Agriculture and Life Sciences (CALS) at Cornell University has a long-standing commitment to potato improvement and interest in issues related to world food production. It houses one of the largest concentrations of potato scientists in the world. There are experts in breeding for pest and disease resistance, biology and management of the late blight pathogen, physiology, molecular genetics, potato pests, and integrated pest management.

The Toluca Valley in the highlands of central Mexico, an
area representative of the center of origin of Phytophthora infestans, contains a pathogen population that is remarkably diverse and has been sexual for millennia. Until very recently, outside of Mexico, the pathogen had been reproducing only asexually and showed limited genetic variability. The Toluca Valley offers a unique site for evaluating the stability of late blight suppression programs (including plant resistances, cultural controls, biocontrols and fungicides) for potato programs around the world.

Eastern Europe is perhaps in greater need than any other region worldwide of establishing a stable, environmentally benign late blight management program. Economic difficulties following the reorganization of Newly Independent States and the erosion of the research base have made this region vulnerable to potato late blight epidemics. Although late blight in this region can be controlled with massive amounts of protectant fungicides, the economies of this region do not allow such expenditures. Thus knowledge of late blight epidemiology and the use of resistant potato cultivars are crucial.

CEEM recognizes the enormity of the late blight problem and realizes that the goals can be achieved only through a worldwide collaborative effort.

Activities of the CEEM project
- Facilitate the development and availability of improved potato germplasm with resistance to late blight
- Conduct basic research on the biology and life history of the late blight pathogen—and on the ways in which the pathogen survives and spreads
- Develop and evaluate disease management components for inclusion in an integrated pest management program
- Enhance the capacity of late blight research at Cornell University for scientists from Eastern Europe and Mexico and support graduate students from these regions

Partnerships within CEEM
CEEM has been designed to draw upon the best talents and resources of national institutions and scientists worldwide. An important goal of CEEM is to facilitate the sharing of information and biological materials/technology that might contribute to a solution of the late blight problem. The formation of CEEM is now fostering partnerships with the Mlochow Research Center of Poland’s Plant Breeding and Acclimatization Institute (IHAR), the largest agricultural institute in the country working on developing potato cultivars with durable resistance to late blight. In Russia, the N.I.Vavilov All-Russian Research Institute in the country working on developing potato cultivars with durable resistance to late blight, and support graduate students from these regions.

WEB SITES OF INTEREST
CEEM – http://www.cals.cornell.edu/dept/plantbreed/CEEM
CGIAR – http://www.cgiar.org/areas/potato.htm
CIP – http://www.cipotato.org/
GILB – http://cipotato.org/gilb.htm

DISEASE CONTROL

Looking to the future
New developments in the area of potato biotechnology now make it much easier to transform potatoes with genes of interest. Such new techniques should make it possible to insert disease resistance into popular potato varieties without jeopardizing their desirable qualities or their market share. As a result, geneticists will be able to respond more quickly to new stresses without having to go through the difficult process of rebuilding consumer acceptance.

There is also every reason to believe that developing country farmers will accept potato varieties with broad-based late blight resistance. Farmers in these regions will readily adopt potatoes that are less dependent on chemical sprays for insect pests and diseases. The adoption process will be much higher and quicker if resistance to late blight can be combined in well adapted susceptible potato varieties which are currently grown by farmers. The potato breeding

PREVIOUS PESTICIDE OUTLOOK ARTICLES ON POTATO BLIGHT


These articles give an excellent introduction to the potato blight, recent genetic changes in the fungus, and the development of new fungicides.
program at Cornell has released many new pest resistant varieties. A recent release, known as New York 121, is resistant to potato late blight as well as several other important diseases and pests. It is only through a solid understanding of the biology of this pathogen that we will be able to devise technologies and provide adequate education necessary to control this disease.

- Global and national initiatives, such as those being promoted by CEEM, GILB, PICTIPAPA and others will allow research and technology sharing and transfer to take place in a cost effective manner. Participants in such programs benefit in many ways, including:
  - global prioritization of research needs
  - improved possibilities for funding for program participants through recognition of the program by donor agencies
  - close interaction with, and knowledge of, other research teams within their area of specialization
  - opportunities for independent research projects (i.e., projects requiring interdisciplinary and complementary partnerships)
  - improved access to information and resources participation in program meetings and conferences

Global programs serve a valuable platform for universities and other public and private sector organizations to increase their involvement. Projects such as CEEM promote innovative and effective approaches to dealing with one of many global problems, and as a result considerable advantages are obtained by enhancing food security and environmental quality.

References


