Agrifood Research Working papers 142

MTT

New and old pathogens of potato in changing climate

Asko Hannukkala and Marjo Segerstedt (eds.)

Plant Production

Agrifood Research Working papers 142
51 pages

New and old pathogens of potato in changing climate

Proceedings of the EAPR Pathology Section seminar, 2.-6th of July 2007, Hattula, Finland

Asko Hannukkala and Marjo Segerstedt (eds.)

MTT Agrifood Research Finland

ISBN 978-952-487-112-9 (Printed version)
ISBN 978-952-487-113-6 (Electronic version)
ISSN 1458-509X(Printed version)
ISSN 1458-5103(Electronic version)
www.mtt.fi/mtts/pdf/mtts142.pdf

Asko Hannukkala and Marjo Segerstedt (eds.)
Publisher
MTT Agrifood Research Finland
Distribution and sale
MTT Agrifood Research Finland, Information Management
FI-31600 Jokioinen, Finland, phone +358 3 4188 2327
julkaisut@mtt.fi
Printing house
Tampereen Yliopistopaino Juvenes Print Oy
Photographer
Asko Hannukkala

Alkusanat

Euroopan Perunatutkijoiden Yhdistys (EAPR, The European Association for Potato Research) on vuonna 1957 perustettu järjestö, johon kuuluu perunatutkijoita ja tutkimuksesta kiinnostuneita alan toimijoita. Yhdistyksen kotisivu löytyy linkistä http://www.eapr.net. Yhdistys kustantaa Potato Research nimistä tieteellistä aikakausilehteä, jossa julkaistaan perunaan liittyviä tutkimustuloksia, kokooma-artikkeleita ja muita yleistä kiinnostusta herättäviä kirjoituksia.

EAPR:n tärkein tiedonvaihto on alusta saakka tapahtunut tieteenalapohjaisissa jaostoissa. Yhdistyksessä on seitsemän jaostoa: Perunanviljely, jalostus ja lajikkeet, tekniikka, patologia, fysiologia, käyttölaatu ja virologia. Jaostot kokoontuvat säännöllisesti tutkimusongelmien ja –tulosten merkeissä. Edellinen patologiajaoston seminaari oli Lillessä, Ranskassa vuonna 2004. Edellisessä patologiajaoston kokouksessa Bilbaossa, Espanjassa kesällä 2005 jaoston puheenjohtaja tri Jozefa Kapsa valtuutettiin järjestämään seuraava seminaari Suomessa. Asko Hannukkala lupautui vastaamaan seminaarin käytännön järjestelyistä.

Seminaarin teemaksi valittiin ”Uudet ja vanhat perunan taudit muuttuvassa ilmastossa”, koska Euroopan perunaruttopopulaation muutoksista on viime vuosina julkaistu paljon uutta tutkimustietoa. Myös aiemmin Euroopassa harvinaiset taudinaiheuttajat, kuten *Erwinia chrysanthemi,* ovat aivan viime vuosina yleistyneet hälyttävästi pohjoisillakin viljelyalueilla. Ilmastonmuutoksen vaikutusten arviointi sopii erityisen hyvin Suomessa käsiteltäväksi aiheeksi, koska ennustettu ilmaston lämpeneminen suosii monia kasvintuhoojia, joita ei vielä esiinny pohjoisessa ilmastossa.

Suomen Akatemian myöntämä avustus kokouksen järjestämiseen on mahdollistanut useiden kansainvälisten asiantuntijoiden kutsumisen luennoimaan seminaarissa. MTT Maa- ja Elintarviketalouden tutkimuskeskus ja monet peruna-alan yritykset ovat antaneet seminaarin järjestelytoimikunnalle merkittävästi henkistä ja aineellista tukea.

Jokioinen kesäkuussa 2007

Järjestelytoimikunnan puolesta

Asko Hannukkala

Vanhempi tutkija

MTT, Kasvinsuojelu

Preface

The European Association for Potato Research (EAPR) is an organization, formally constituted in 1957, consisting of people working in, or with an interest in, potato research, http://www.eapr.net. The Association publishes a journal "Potato Research", which includes original scientific contributions on both fundamental and applied research on potatoes, review articles and topics of general interest.

Over the intervening period since the founding of EAPR the Association has been very much enhanced by the activities of the Sections which have performed the invaluable function of promoting the interchange of knowledge within specific disciplines. The Association has seven sections: agronomy, breeding and varietal assessment, engineering, pathology, physiology, utilization, and virology. The sections meet regularly to discuss problems and research results. The previous Pathology Section meeting was organized in Lille, France in 2004. At the latest Pathology section meeting in Bilbao, Spain in 2005 the chair person of the section, Dr. Jozefa Kapsa, was authorized to organize the next seminar and meeting in Finland in collaboration with the local organizer Asko Hannukkala.

The theme of the seminar 'New and old pathogens of potato in changing climate' was chosen, because changes in the populations of potato late-blight pathogen have been reported throughout Europe and elsewhere. Also, pathogens such as *Erwinia chrysanthemi,* previously rare in Europe have recently spread into Northern potato production regions. Speculation on the effects of climate change to potato diseases is especially appropriate in Finland, where the predicted climate warming favours many pests not currently present in a cool climate.

Support granted by the Academy of Finland made it possible to invite several international experts on potato pathology as key-note speakers to the seminar. MTT, Agrifood Research Finland as well as companies in the potato sector have given extensive support to the organizing team.

Jokioinen June 2007

On behalf of the organizing team

Asko Hannukkala

Senior Scientist

MTT, Plant Protection

Organizers and sponsors

European Association for Potato Research

Agrifood Research Finland

Tärkkelysteollisuusyhdistys ry Association for Starch Industry (sponsor)

Berner Ltd (sponsor)

Syngenta, Finland (sponsor)

Finnish Seed Potato Centre Ltd (sponsor)

Chips, Finland (sponsor)

Northern Seed Potato (sponsor)

Contents

Abstracts

Posters

Climate change, scenarios and their impact on potato diseases

Timo Kaukoranta

MTT Agrifood Research Finland, Horticulture, FI-31600 Jokioinen, Finland,timo.kaukoranta@mtt.fi

Abstract

Since 1970's Europe has warmed rapidly, more than observed globally. The warming may partially result from inherent variation of climate but its rate and geographical distribution fits the expected pattern of global climate change. The observed rate of warming is comparable to the expected rate in the next decades. Over the 21st century climate is expected to become gradually milder and more humid in Northern Europe and hotter and more arid in the South; Central Europe is becoming warmer with more extreme weather events; CO_2 concentration continues to rise steadily. Global climate scenarios suggest that warming until mid-century is already largely determined and only after mid-century the outcome of climate change could be significantly affected by policy decisions and economic development.

In some areas in Europe the warming in the past 30 years is so large that trends of seasonal temperature parameters are discernible. If statistics on pest occurrence or multiplication rate exist in these areas, it may be possible to attribute statistically part or all of the changes in pest dynamics to the observed climatic changes.

Regional climate scenarios extend knowledge of the climate to future decades and provide daily weather data for modelling pest dynamics in future conditions. Repeating model runs over years gives an estimate of a probability distribution of pest risk. If pest risk is cumulative over years or shows lag after a climate threshold has been crossed, each of individual runs requires special consideration in setting initial values or climate data over several years. It is possible to generate hourly weather data for any particular site and period in future, which allows simulation of future local epidemics. However, these data represent only one possible set of climate conditions and it is difficult to explore the entire range of climate conditions.

Another way of representing climate is to compute the combined distribution of climate parameters – e.g. number of rain days, daily minimum temperature, and daily temperature range – in future by extrapolating statistically from past climate data or from the daily output of regional climate models. If observed pest response to climate can be related to these parameters, the model can be used for deriving estimates of change of pest risk as climate changes.

All predictions of future pest risk are conditional to the assumption that pest response to climate and interactions with host, soil, and surrounding environment are stable. Knowing that this assumption cannot always be true it seems useless to extend pest risk predictions beyond a few decades. Yet, over a few decades climatic variation can be larger than the general warming trend in any particular region. This makes it difficult to reach results that would be valuable for potato industry and supporting research. The value of studying the effect of climate change on potato pests lies in detecting ongoing changes of pest risks and understanding their origin, which is useful for planning pest control under the current climate.

Index words: Climate change, disease, regional climate scenario

Evolving populations of the potato late blight pathogen *Phytophthora infestans* – does climate change matter?

Didier Andrivon[1)], Björn Andersson[2)], Asko Hannukkala[3)], Arne Hermansen[4)] & Jens G. Hansen[5)]

[1)]INRA, Agrocampus Rennes, UMR1099 BiO3P (Biology of Organisms and Populations applied to Plant Protection), Domaine de la Motte, BP 35327, F-35653 Le Rheu Cedex, France, Didier.Andrivon@rennes.inra.fr
[2)]Swedish University of Agricultural Sciences, Department of Forest Mycology and Pathology, Plant Pathology, PO Box 7026, S-750 07 Uppsala, Sweden, bjorn.andersson@mykopat.slu.se
[3)]MTT Agrifood Research Finland, Plant Production Research, FI-31600 Jokioinen, Finland, asko.hannukkala@mtt.fi
[4)]Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division, Hogskoleveien 7 N-1432 As, Norway, arne.hermansen@bioforsk.no
[5)]Aarhus University; Research Centre Foulum, Dept. of Agroecology and Environment, Blichers Allé 20, P.O. BOX 50 DK-8830 Tjele, JensG.Hansen@agrsci.dk

Abstract

Global warming and correlative changes in local and mesoclimatic conditions are now widely accepted as one of the striking features of the last few decades. These changes are forecasted to persist well into the 21st century, and have already been held responsible for major changes in the distribution of plant and animal species, pathogen prevalence, and pest biodiversity. However, we still lack a comprehensive understanding of the ways climate change might affect major plant diseases, although speculation as to their implication in epidemiological and evolutionary changes have been raised.

This paper will focus on potato late blight, a major disease, caused by the oomycete *Phytophthora infestans*. This pathosystem is well suited to investigate climate change issues, because 1) the pathogen is strongly dependent on climatic factors (mainly temperature and moisture duration) for infection and sporulation, 2) the pathogen has been present in Europe since more than a century and a half, and its epidemics are closely monitored in most European countries, 3) the pathogen and its hosts (potato and tomato) are widely distributed in Europe, over a large range of latitudes and longitudes, 4) the population structures of the pathogen have undergone dramatic changes over the past 30 years following a secondary introduction from the American continent, and 5) both phenotypic and molecular tools are available to follow the evolutionary and adaptive changes in these populations. We will address three main questions, for which data are either already available or urgently needed:

1- initiation of epidemics - are they earlier, and if yes, how much of it is due to changes in climate? A recent paper, exploiting long –term surveys of late blight incidence and correlations with climatic and agronomic data in Finland shows that the first detection of late blight outbreaks is now approximately one month earlier than it was 20 years ago, and that the occurrence of late blight outbreaks in the northern parts of the country is considerably more frequent now than it was in the past. This is convincing evidence that climate change is important as a driver for earlier and/or more severe epidemics in regions previously not highly conducive to late blight.

2- aggressiveness changes - are these related to new climatic conditions, or at least do current climatic conditions favour different strains than the 'classical ones'? There is scattered evidence, both direct and indirect, that current populations of P. infestans might be able to thrive at lower threshold temperatures. However, these data are still insufficient to conclude that populations have adapted to more variable climates. Recent work also showed that aggressiveness might have increased as a consequence of adaptation to prevailing cultivars, with no climatic driver required.

3- oospore distribution and climate zones. Because oospores are resting organs, it is plausible that they will be found more often in areas with either short crop cycles and/or extreme seasons (winter or summer). A preliminary exploitation of the data collected within the EUCABLIGHT database suggests a correlation between frozen soil conditions and the presence of oospore problems. However, populations with both mating types are now becoming common also in temperate, Atlantic regions such as northern France or the UK, so cold seasons are certainly not the only factor favouring the survival of mixed populations.

Potato late blight populations: migration, selection and chance?

Louise R. Cooke[1,2)], G.K. Young[2,3)], J.M. Thompson[2)], William W. Kirk[3)], Kenneth L. Deahl[4)] & Leslie J. Dowley[5)]

[1)]Applied Plant Science Division, Agri-Food and Biosciences Institute, Newforge Lane, Belfast, BT9 5PX, UK, louise.cooke@afbini.gov.uk
[2)]Department of Applied Plant Science, Queen's University of Belfast, Newforge Lane, Belfast, BT9 5PX, UK
[3)]Plant Pathology Department, Michigan State University, East Lansing, MI, 48824 USA, kirkw@msu.edu
[4)]USDA, ARS, PSI, Vegetable Laboratory, Beltsville, MD 20705, USA, Ken.Deahl@ARS.USDA.GOV
[5)]Crops Research Department, Oak Park Research Centre, Carlow, Republic of Ireland, Leslie.Dowley@teagasc.ie.

Abstract

Since the 1970s, new genotypes of *Phytophthora infestans* introduced into many parts of the world have almost completely displaced the old, A1 clonal lineage. Despite introductions of both mating types, in many regions this has not resulted in sexually-recombinant populations becoming established, but in the evolution of new, but largely clonal populations. These may comprise several major clonal genotypes and sometimes undergo periodic upheavals when new fit genotypes appear by migration, infrequent recombination or other mechanisms. For example, the *P. infestans* population in Ireland consists of a number of clones all of the A1 mating type: A2 mating type strains, although introduced in the 1980s, do not appear, so far, to have become widely established in the population and are rarely detected. The population in Great Britain also appears clonal, but is currently undergoing major changes. In Taiwan, displacement of the old US-1 population took place within 2 years, but the new population is also A1 and clonal. In the USA, although numerous A1 and A2 genotypes have appeared since the early 1990s, only a limited number have been perpetuated. At present, in the eastern and mid-western states, the US-8 genotype, which first appeared in the mid 1990s, is dominant, but US-11 is the main genotype isolated from potato and tomato from Washington, Oregon, and Alaska, while US-14 and variants occur on both potato and tomato in Florida. There is currently evidence of the appearance of new genotypes in parts of the US, but it remains to be seen if these will displace existing ones. Thus, in some regions (e.g. Taiwan), the new genotypes belonged to only a single mating type, but in others, even where multiple genotypes of both mating types were introduced, only a few have been perpetuated.

What mechanisms are involved? Field trials in Northern Ireland and Michigan using multiple potato cultivars and *P. infestans* genotypes showed that extreme selection occurred within the *P. infestans* populations at both locations. In Northern Ireland, there was a strong influence of cultivar; different genotypes dominated infection of different cultivars. Selection was partly due to aggressiveness to specific cultivars, but this did not fully explain the extreme selection in the field, other factors such as direct competition during the infection process may also play a role. In the US, the US-8 genotype proved the most aggressive and also dominated infection of all cultivars in the field: other genotypes were rarely detected. Additional selection occurs during the tuber phase. Studies in Belfast demonstrated that the cultivar influences which genotypes infect tubers; even where multiple genotypes have colonised foliage, few infect tubers. Over the winter, some genotypes may be lost by tuber rotting. A further bottle-neck occurs when epidemics are initiated by surviving infected tubers: field trials showed that when tubers inoculated with different genotypes were planted, generally only one successfully initiated foliar infection.

Finally, the extreme efficiency of asexual reproduction in *P. infestans*, compared with the sexual cycle, must be important in perpetuating clonal genotypes in regions where tuber infection is frequent and infected tubers can survive the winter. However, none of these factors seems sufficient to explain why sexually-recombinant populations have apparently become established in some parts of Europe, including the Netherlands, Poland and the Nordic countries, yet, in many other regions, sexual recombination seems to be very infrequent or even absent. Barriers to successful recombination and perpetuation of sexual progeny may well be important: these merit further investigation. Above all, chance may play a crucial role, particularly in terms of the introduction and survival of new, fit genotypes of *P. infestans* by man, its principal vector.

Index words: Phytophthora infestans

Tracking *P. infestans* populations via molecular fingerprinting and a comprehensive isolate database

David E. L. Cooke[1)], Alison K. Lees[1)], Jens Grønbech Hansen[2)], Poul Lassen[2)], Björn Andersson[3)] & József Bakonyi[4)]

[1)]SCRI, Invergowrie, Dundee DD2 5DA, United Kingdom, david.cooke@scri.ac.uk
[2)]University of Aarhus, Faculty of Agricultural Sciences, Dept. of Agroecology and Environment, Blichers Allé 20, P.O. BOX 50, DK-8830, Tjele, Denmark
[3)]Swedish University of Agricultural Sciences, PO Box 7026, SE-75007 Uppsala, Sweden
[4)]Hungarian Academy of Sciences, Herman Ottó u. 15, H-1022 Budapest, Hungary

Abstract

Potato late blight control is challenging even in a stable environment. Understanding and, furthermore, predicting how the pathogen will respond to a given set of agronomic and environmental conditions is a key element of successful disease management. It is clear that blight control represents a moving target. Disease incidence and severity and the efficacy of control measures are not easy to predict and depend on several factors. Long and short-term changes in climatic conditions will clearly have a significant impact and changes in active ingredients for chemical control, potato varieties and agronomic practices will similarly influence the disease. Overlying this are changes in the pathogen population that may either be occurring in response to, or independently from, the other factors. Fluxes in *P. infestans* populations have been described and there is an ever-expanding weight of literature documenting such change. However, until recently much of the population monitoring has been on a local scale and wider comparisons, over longer timescales, with meaningful sample sizes, have been challenging. The EU-funded EUCABLIGHT project has changed this via the assembly of a comprehensive database on almost 17,000 isolates of *P. infestans* from 21 European countries. A key element of the database is novel SSR fingerprint data that, for the first time, is allowing an objective picture of the pathogen population structure on a European scale. Overviews of the data and more detailed insights into local populations using SSR data will be presented and discussed.

Index words: SSR, microsatellites, Eucablight,

Potato late blight in the Netherlands, a thing of the past? New frontiers in resistance breeding and disease management

Geert J.T. Kessel[1)], Piet M. Boonekamp[2)] & Anton J. Haverkort[3)]

[1)]Plant Research International, Biointeractions & Plant Health, P.O.Box 16, 6700 AA Wageningen, the Netherlands, Geert.Kessel@WUR.NL
[2)]Plant Research International, Biointeractions & Plant Health, P.O.Box 16, 6700 AA Wageningen, the Netherlands, Piet.Boonekamp@WUR.NL
[3)]Plant Research International, Agrosystems Research, P.O.Box 16, 6700 AA Wageningen, the Netherlands, Anton.Haverkort@WUR.NL

Abstract

Potato late blight, caused by the oomycete *Phytophthora infestans*, has a long history as a major problem in potato cultivation. Host resistance was introduced and overcome and a new, more versatile and aggressive, pathogen population was introduced into the Netherlands an Europe leading to a situation in which potato late blight is almost exclusively controlled through an intensive use of fungicides. A growing societal concern about the chemical inputs into the food production chain, has inspired two research programmes specifically targeted at potato late blight:

- the "Umbrella Plan Phytophthora" (*P. infestans* biology, ecology and late blight management) and
- DuRPh, Healthy potato production: development of durable Phytophthora resistance applying GMO methods

The Umbrella plan Phytophthora was initialised in 2003 aiming to reduce the environmental impact of late blight control by 75% within 10 years. In a unique management structure the program is funded by the Dutch Ministry of Agriculture, Nature and Food Quality but management is in the hands of the Dutch potato industry. Research within the umbrella plan is structured in 3 themes and a toolbox in which results are evaluated for their practical value. The MasterPlan Phytophthora, a growers initiative, then communicates the results to the Dutch potato growers. This integrated approach has already yielded a significant reduction of the environmental impact due to late blight control.

DuRPh, initialised in 2006, is using GMO methodology to detect, clone and marker free transfer major resistance genes to existing varieties. Societal benefits comprise reduced costs of control, an improved environment and a boost to fundamental research. The cisgene approach using only potato genes combined with marker free transformation may contribute to public acceptance of GMO food. The program serves as a proof of principle for the application of GMO techniques and their results for breeding and disease control purposes. Examples of some of the questions studied are: How can the detection efficiency of major (R-) genes in wild species, subsequent isolation and stacking of these genes in existing varieties be improved? How do we develop adequate resistance management strategies for the temporal and spatial deployment of major genes? How to study societal resistance and acceptance mechanisms regarding this specific GMO (marker free and cisgene) approach?

The programme integrates related projects, is pre-competitive and its results will be published. Co-operation with the Dutch breeding industry will be sought actively as well as EU FP7 co-funding.

Index words: potato late blight, Phytophthora infestans, disease management, resistance, GMO

Climatic trends and potato late blight risk in the upper Great Lakes region of the USA

Kathleen M. Baker[1)], William W. Kirk[2)], Jeffrey M. Stein[2)] & Jeffrey A. Andresen[3)]

[1)]Department of Geography, Western Michigan University, Kalamazoo, MI, USA
[2)]Plant Pathology Department, Michigan State University, East Lansing, MI, 48824 USA, kirkw@msu.edu
[3)]Department of Geography, Michigan State University, East Lansing, MI, USA.

Abstract

Concern in the agricultural community over observed and projected climate change has prompted numerous studies on the possible implications for crop yields. However, relatively little work has focused on disease management. In the upper Great Lakes region of the United States, late blight (*Phytophthora infestans*) of potato (*Solanum tuberosum*) is a temporally sporadic disease, occurring only when microclimate conditions within the canopy are favorable and inoculum is present. This and other studies indicate that historical climatological trends in the upper Great Lakes region have resulted in warmer and wetter growing season conditions, as well as local increases in precipitation totals and in the frequency of days with precipitation. Consequently, the risk of potato late blight is increasing. Historical trends in hourly weather variables and potato late blight risk as expressed by a modified Wallin disease severity value index were analyzed at seven regional weather stations from 1948–99. All sites showed significant trends in at least one of the risk estimates. While late blight risk was greatest at all locations in August, periods of increasing risk occurred across the region particularly during July. The increases in disease risk appeared to be associated with upward trends in dry bulb and dew point temperature at nearly all of the stations, especially during July and August. Increased risk of potato late blight has implications for extension agents and commercial horticulturists that include increased emphasis on grower education and application of integrated disease management techniques.

Application of the SNP-analysis for characterisation of *Phytophthora infestans*-isolates

Frank Niepold

Federal Biological Research Centre for Agriculture and Forestry (BBA), Institute for Plant Protection in Field Crops and Grassland, 38104 Braunschweig, Messeweg 11-12, Germany

Abstract

Using the single nucleotid polymorphism (SNP) method *P. infestans* could be easily characterised. *P. infestans*-isolates collected in the period from 2000 to 2004 did show a continuous change of the chromosomal area used for the SNP analysis. At the end of the survey only 25% of the isolates corresponded with the original DNA sequence (230 bp fragment). Since a non-coding DNA region was used for the SNP analysis, genetic changes could easier be found within the surveyed period. For monitoring the genetic changes of *P. infestans*-isolates a host change was performed (potato-tomato respectively black nightshade). Parts of the surveyed *P. infestans* isolates showed a stable SNP-fragment of the proper size, being independently from the host change. The other part of the isolates did not only show visual microscopic differences in the sporangia but also in the detection of the 230 bp SNP-fragment. Since it is not plausible that in a highly variable gene a fast change via point mutation can occur that fast, it is assumed that in that case a population mixture was surveyed. Therefore, a stress in the form of a host change might favour the one or other *P. infestans*-isolate exhibiting a change in the SNP-fragment. When the *P. infestans* isolates grown on different hosts were re-inoculated onto their potato hosts, the acquired change in the SNP-pattern was kept.

Temporal population genetic dynamics of *Phytophthora infestans* in Great Britain

Jiasui Zhan[1)], Alison K. Lees[1)], David Shaw[2)] & David E.L. Cooke[1)]

[1)]SCRI, Invergowrie, Dundee, DD2 5DA, UK, jzhan@scri.ac.uk
[2)]Sarvari Research Trust, Siambra Gwynion, Llandygai, Bangor, LL57 4BG, UK

Abstract

Knowledge on temporal population genetic dynamics and the genetic mechanisms driving these dynamics are important in order to understand the evolutionary potentials of plant pathogens over changing environments. We sampled more than 1400 isolates of *Phytophthora infestans* from Great Britain between 2003 and 2006 and assayed these isolates with 11 molecular markers (SSR) and a phenotypic trait (mating type). We found a significant change in the population genetic structure of the GB population of *P. infestans* over the four years: 1) the frequency of the A2 phenotype increased from less than 0.1 in 2003 to more than 0.5 in 2006; 2) only five out of more than 140 genotypes were detected in all four years and a new genotype, which was first detected in 2005, accounted of more than a quarter of the 2006 population; 3) allele frequency in the majority of the 11 SSR loci changed significantly across the survey years and there was evidence of directional increases in genetic differentiation over time. Further analysis revealed that the hypothesis of Hardy-Weinberg equilibrium was rejected in all four populations, suggesting that *P. infestans* in GB exists in a non-random, or asexual state. The implication of our findings in the adaptation of *P. infestans* to changing environments will be discussed.

Index words: Phytophthora infestans, population genetic dynamics, Great Britain, SSR, mating type

The evolution of *Phytophthora infestans* in France (Mating type, Metalaxyl resistance)

Delphine Detourne, Ludovic Dubois & Serge Duvauchelle

Plant Protection Service, BP 47 – 62750 Loos-en-Gohelle, France, serge.duvauchelle@agriculture.gouv.fr

Abstract
Since 1993, more than 1400 samples have been tested to determine the mating type and the mefenoxam resistance. Since 2004, an evolution of the population is observed.

I – Mating type in North of France
Before 2003 only 14 samples (by 783) have A2 strains in 1997 (11 in garden, 3 in fields).
In 2003: 7 samples (4 on dumps, 3 in fields) have A2 strains: 6 % of the monitoring
In 2004: 30 % of the sample are A2 (20 % of the fields visited)
In 2005: 41 % of the sample are A2 (39 % of the fields visited)
In 2006: 74 % of the sample are A2 (79 % of the fields visited)

These A2 strains are observed in 81 % of the fields in Nord Pas-de-Calais, 89 % in Picardie, 96 % in Champagne Ardenne, 35 % in Normandy.

Mating type in others regions
The results are different:
- Brittany:
  - before 2005: only one or two A2
  - 2005: 4 % of the sample are A2
  - 2006: 43 samples, 9 % of A2, 10 % of fields with A2
- Aquataine:
  - before 2005: the number of sample is very low
  - 2005: 6 % of A2
  - 2006: 8 samples, 25 % A2, 25 % offields
- Alsace:
  - 2005: 68 % A2
  - 2006: 58 % A2

Conclusion: The number of A2 increases, particularly in North of France, the evolution is different according the regions.

II – Metalaxyl resistance
North of France:
- 2004: 28 % resistants (on dumps 13 %, 37 % fields)
- 2005: 34 % resistants (on dumps 34 %, 65 % fields)
- 2007: only 7 samples on dumps (the 7 of June): 100 % resistants

Others regions
- Brittany: 53 % samples are resistant, 61 % fields
- Alsace: 33 % samples are resistant, 33 % fields
- Aquataine: 50 % samples are resistant, 93 % fields

The metalaxyl resistance seems to increase particularly on dumps in North of France.

Conclusion: the population is changing. What are the consequences on the epidemy?

Effect of aggressiveness level of *Phytophthora infestans* on over-winter survival of tubers

Roselyne Corbiere, Josselin Montarry & Didier Andrivon

INRA, UMR 1099 BiO3P, INRA/ AgroCampus Rennes, BP 35327, F 35653 LeRheu Cedex, France,
Roselyne.Corbiere@rennes.inra.fr, Didier.Andrivon@rennes.inra.fr

Abstract

The aim of this study was to understand selection pressure on *Phytophthora infestans* populations, during winter, the inter-epidemic phase, and to address the question of a trade-off between aggressiveness during the epidemic phase and survival capacity during the winter season in *P. infestans*.

In France, *P. infestans*, the causal agent of potato late blight, behaves as an obligate biotroph. French populations are essentially thought to survive as mycelium in tubers remaining either in the soil or in refuse piles near potato fields. Its inability to survive in the absence of living plant tissue raises the question of possible negative selection against the most aggressive isolates during winter. Indeed, the most aggressive isolates are not necessarily the fittest isolates over the whole season or over several seasons: while such isolates were favored during the epidemic season, they might exhaust their nutrient base (infected tubers) too fast to successfully bridge seasons. Intermediate or weakly aggressive isolates would then tend to best survive, in contrast to highly aggressive isolates, which would probably kill tubers before they sprout.

To investigate this hypothesis, we inoculated tubers with isolates of different aggressiveness levels (low, medium, high), leaving them in piles (outdoors) at three different sites during the winter, and scored the proportion of living tubers in the following spring.

Our data indicated that over-winter survival of potato tubers was not related to the aggressiveness level of the isolates and thus did not lead to negative selection of the most aggressive isolates. A strong site effect was observed, but the absence of interaction between piles (i.e. aggressiveness levels) and sites indicated that the lack of trade-off was true for all three winter French conditions.

These results suggest that the most aggressive isolates are not eliminated faster than less aggressive ones during over-winter survival in tubers. In absence of a trade-off between aggressiveness and over-winter survival, the selection process may occur at another stage of the life cycle.

Reference

Montarry, J., Corbière, R. & Andrivon, D. 2007. Is there a trade-off between aggressiveness and over-winter survival in *Phytophthora infestans*? *Functional Ecology*, published article online: 10-Apr-2007; doi: 10.1111/j.1365-2435.2007.01252.x.

Index words: potato late blight, fitness, trade-off, plant-pathogen co-evolution, pathogenicity

NorPhyt – Studies on the Nordic Blight population

Asko Hannukkala[1)], Ari Lehtinen[1)], Björn Andersson[2)], Arne Hermansen[3)], Vinh H. Le[3)], Ragnhild Nærstad[3)], May B. Brurberg[3)], Bent J. Nielsen[4)], Jens G. Hansen[5)] & Jonathan Yuen[2)]

[1)]MTT Agrifood Research Finland, Plant Production Research, FI-31600 Jokioinen, Finland, asko.hannukkala@mtt.fi
[2)]Swedish University of Agricultural Sciences, Dept of Forest Mycology and Pathology, PO Box 7026, S-750 07 Uppsala, Sweden
[3)]Bioforsk- Norwegian Institute for Agricultural and Environmental Research, Høgskoleveien 7, 1432, Norway
[4)]University of Aarhus, Institute of integrated Pest Management, Research Centre Flakkebjerg, Forsoegsvej 1, DK-4200 Slagelse, Denmark
[5)]University of Aarhus, Institute of Agroecology, Research Centre Foulum, P.O.Box 50, 8830 Tjele, Denmark

Abstract

A total of 743 single-lesion isolates of *Phytophthora infestans* were collected in summer 2003 from Denmark, Finland, Norway and Sweden. Most of the isolates were tested for mating type, and subsets were tested for sensitivity to fungicides and virulence. The genetic variation was examined from 200 isolates by SSR microsatellites. Aggressiveness properties, infection efficacy, latency period, lesion growth and spore production was studied from 25 isolates from each four Nordic country.

Approximately 60 percent of the isolates were A1 mating type in each country. Both mating types were present in 40 % of the fields where more than one isolate was tested indicating strong potential for sexual reproduction. The proportion of metalaxyl resistant isolates dropped to under 15 % from the 60 % observed in the early 1990s in Norway and Finland. A possible reason for the reduction is lowered selection pressure due to decreased use of metalaxyl. Propamocarb-HCl sensitivity remained unchanged in the Nordic countries when compared to the situation in 1997–2000 in Finland. Four isolates collected from Finland and Sweden were able to sporulate in the presence of this fungicide at a concentration of 1000 mg L-1.

In Norway and Finland the frequencies of virulence factors and pathotypes remained nearly unchanged since the 1990s, but the mean number of virulence factors per isolate increased from 5.6 to 6.3. In Denmark and Sweden virulence factors 2 and especially 6 were more common than in Norway and Finland. In addition, in the Swedish population the frequencies of pathotypes were quite even while in other countries pathotype 1.3.4.7.10.11 was clearly the most prevalent one.

Genetic variation in the Nordic blight population as indicated by 9 SSR markers was considerable. 192 isolates out of 200 gave results for seven or more markers. 181 different genotypes were found. Two genotypes occurred twice, two genotypes occurred three times and one genotype was present in six isolates. The differences in aggressiveness between four countries were generally small or inconsistent between the two test cultivars Bintje and Matilda. On the contrary the variation within the countries was substantial. An estimated mean length of latent period varied between 80 and 140-180 hours, sporulation capacity between 0 and 400-1300 sporangia mm^{-2} and lesion growth rate nearly zero to 5-8 mm day^{-1}. The frequency of infectious sporangia remained below 1 % in all labs except in Norway preventing making a clear conclusion. High variation in results between the test laboratories emphasizes the need of caution when comparing results obtained by different research groups.

Index words: Fungicide resistance, Phytophthora infestans, mating type, virulence, pathotype, oospore, genetic diversity, aggressiveness

Mildi-LIS®, an online decision support system for treatment against potato late blight

Denis Gaucher

Station expérimentale ARVALIS-Institut du vegetal, F-91720 Boigneville, France, d.gaucher@arvalisinstitutduvegetal.fr

Abstract

Introduction

Mildi-LIS® is an online decision support system that allows a reduction of the number of treatments against late blight potato. It is based on the epidemiological model Premil from ARVALIS – Institut du végétal researches. The institute works since 1998 to adapt the Ullrich Schrödter model to french climatic conditions. Premil is validated since 2002. In the years 2002 and 2003, Arvalis sold a PC-version but the potato growers asked Arvalis to develop an internet version. An online system is better to exchange data between technicians and growers.

Description of the D.S.S.

Mildi-LIS® is based on hourly data of temperature, relative humidity and rainfall recorded by a weather station located near to the followed plot. The specific characteristics of the field are taken into account (previous treatments, variety, emergence date…) by the online D.S.S. It is the ideal tool for the pooling of a weather station which can be used for several close plots, in particular, for groups of growers. In fact, there is a specific functionality for groups: the weather data is managed and put online by the technician who can follow up the plots of each grower very simply. Moreover, for a better reactivity, the user of the D.S.S. can be alerted by a SMS on his mobile phone in case of risk in one of the followed plots. Thus, he can quickly react to protect his fields. In addition, the different potato varieties are classified according to their sensibility to late blight. A farmer, using Mildi-LIS® can then benefit from the resistance characteristics of his potato variety. The use of weather forecasts can help them to anticipate a risk period and to protect their fields against potato late blight. We put online late blight risk forecasts based on weather forecasts from MétéoFrance. Mildi-LIS®'s aim is to reduce the number of fungicide applications without risk of potatoes infection by the fungus. The use of Mildi-LIS® fully fits with the proceeding of integrated agriculture and enables environment protection. Moreover, it allows growers to make huge financial saving. The setting on line of the decision support system Mildi-LIS® facilitates exchanges of information between growers.

Results and perspectives

The users of Mildi-LIS® saved up to 4.5 treatments for starch potatoes production in 2004 compared to a weekly treatment. The number of saved treatments is less important, with regard to ware potatoes production in the same area, because the culture cycle is shorter and, furthermore, irrigation is more widespread on this kind of production (average of 3 treatments saved). The number of saved treatments could have been more important if the diagnoses of the decision support system had been scrupulously followed. Since 2005, about 500 french potato growers have used Mildi-LIS® every year. For next year, a new french DSS will be proposed. It will be create by ARVALIS and the Ministry of Agriculture (SRPV) with the objective to increase the satisfaction of the users of the two precedent systems (Mildi-LIS and MILPV).

Index word: potato, late blight, DSS, epidemiological model

Decision criteria introduced in The French DSS to control late blight

Serge Duvauchelle & Ludovic Dubois

Plant Protection Service BP 47 – 62750 Loos-en-Gohelle, France, serge.duvauchelle@agriculture.gouv.fr

Abstract

The two main targets of a DSS for the Plant Protection Service are:
- To satisfy the grower
  to give the best and more precise advice to control late blight
- To answer at the missions of the Service:
  to know the evolution of the pathogens in the fields and around
  to inform the growers on the evolutions of the rules

I – Give the more precise advice at the best moment

The first think is to determine the risk of the disease:
At the moment two models Guntz-Divoux and Milsol are running and use the data of a network of meteorological stations which are checked every day by phone. If the models are very useful the scouting in field is indispensable. When the risk is known and forecasted, it is necessary to know the susceptibility of the potato cultivar to advise a spray or not.

The grower want to have information to choose the fungicide.
Three criteria are retained: the pressure of the disease and the symptoms in the area, the stage of the crop, the practices of the grower.
There is a big interest:
The grower has to observe his fields and all around, he has to take an account the risk and indicate his practices.
It is necessary to notice that some regulation information are given (example: maximum of number of sprays for the fungicide).

The date of treatment, how to give the information?
The criteria are the epidemiologic risk and the state of the crop: protected or not and the previous indications.
There are two methods:
- Advice at the moment (SMS), the grower has to by ready.
- Advice in advance (one the three next days), so it is necessary to introduce the weather forecast (for the three next days) every day.

II – The missions of the plant protection service

All the information of the stage of the crops, the late blight, some information of other enemies indicated by the grower are collected by the Plant Protection Service.
There is a big question about the collect of the data:
The grower agrees to give the information on the disease but he is careful to give his practices, these one have to be confidential.
In other hand he want to introduce automatically these information in others proceedings of traçability.

We build a new tool with the "Arvalis Insitut du Vegetal" to reach these targets with the will to have permanent exchanges with the growers.

Problems caused by early blight at potato crops

Józefa Kapsa & Jerzy Osowski

Plant Breeding and Acclimatization Institute Padzików, Department of Potato Protection and Seed Science at Bonin, 76-009 Bonin 3, Poland, jkapsa@wp.pl, j.osowski@wp.pl

Abstract

Early blight, economically damaging foliar disease of potato, is caused by two species of A*lternaria* genus: *A. alternata* (Fries.) Keissler and *A. solani* Sorauer.The disease occurs commonly worldwide on potato crops, particularly in regions with alternating periods of dry weather and high humidity, which favour spore formation and disease development. Harmfulness of early blight is estimated differently in various regions of the world. According to Reinoch (1974), the disease reduces yields up to 25%, locally 60%. According to Johnson et al. 1986, Fry 1994, maximum documented yield reductions are usually 20-30%. In Polish climatic conditions high regional losses caused by early blight were recorded, however, most were related to cultivars with recognized susceptibility to this disease or weakened by infection of viruses. In the recent years tuber losses in Poland balanced from 6 to 45% (Kapsa & Osowski 2004).

In the years 1998-2006, in cooperation with the Plant Health and Seed Inspection Service an evaluation of early blight occurrence on potato crops was carried out throughout Poland. Observations revealed that the disease occurrence on potato crop is common in most production areas, average at 86% of observed crops. Early blight occurs usually at the end of May or the beginning of June, earlier than late blight which is observed mainly in June.

In Polish climatic conditions our recommendations regarding the first chemical treatment for protection of susceptible cultivars indicate that, the appearance of the first disease symptoms on potato leaves, is the optimum time for initiating applications of fungicides. In some countries potato crops are regularly irrigated (USA and the Netherlands) and then the early blight occurs at the end of growing season on aging plants. The recommendations for potato protection against the early blight, aiming at tuber protection from pathogen infection, refer to the end of the season as the best time for fungicide application (Fry 1994).

References:

Fry, W.E. 1994. Role of early and late blight suppression in potato pest management. In: Advances in Potato Pest Biology and Management. Zehnder, G.W., Powelson, M.L., Jansson, R.K. & Raman, K.V. (eds.). The American Phytopathology Society, St.Paul, Minnesota, USA: 166-177.

Johnson, K.B., Radcliffe, E.B. & Teng, P. 1986. Effects of interacting populations of *Alternaria solani, Verticillium dahliae* and potato leaf hopper (*Empascafabae)* on potato yield. Phytopathology 76: 1046-1052.

Kapsa, J. & Osowski, J. 2004. Occurrence of early blight (*Alternaria* ssp.) at potato crops and results of its chemical control in Polish experiences. Special Report no.10 (2004) Proc.8th Workshop of an European network for development of an integrated control strategy of potato late blight. Jersey, England-France, 31st March-4th April 2004. Westerdijk, C.E. & Schepers, H.T.A.M. (eds.) Applied Plant Research Wageningen: 101-107.

Reinoch M. 1974. Alternariozy ziemniaka. [Potato early blight]. Z Prac Inst.Ziemn. 1974, 1/2, 19-28.

Index words: potato, fungal disease, early blight

Rhizoctonia solani soil infestation in Sweden

Ulla Bång

Swedish University of Agricultural Sciences, Box 4097, SE 904 03 Umeå, Sweden, Ulla.Bang@njv.slu.se

Abstract

Attack of potatoes by *Rhizoctonia solani* has been a serious problem in Sweden for a long time. Earlier work with this disease in the country was focussed on chemical and alternative treatments of seed tubers. The aim of the work presented here is to investigate the occurrence of soil infestation and incidence of various anastomosis groups under various crop rotations and soil types in various regions of Sweden. The study started in 2003 and is still ongoing. It is financially supported by the Swedish Farmers Association for Agricultural Research, SLF.

With the help of local advisers, soil samples are collected from fields with a history of *R. solani* attacks. Samples are taken from three spots of 25 m^2 in each field and the positions of the spots are registered on maps or by GPS, thus making repeated sampling from the same spot possible. The rotations, soil type, pH etc. is well documented for each field. The soil infestation has so far been analysed by means of minitubers as a catch crop. After thorough mixing of the soil it has been distributed in pots wherein the tubers have been planted. After around two months in the dark at +10°C and watered as needed, the occurrence of stem canker and sometimes black scurf on the seed tuber has been registered. The cause of injury has been validated by observations under magnification where the mycelium of *R. solani* is visible and by putting small pieces of canker tissue on artificial media.

R. solani infestation has been found in Swedish soils at levels high enough to cause damage on potato plants grown under conditions extremely favourable for attack of the pathogen. The pathogen was detected most frequently in soil samples collected from fields where potatoes were grown the previous year. The proportion of positive samples progressively declined with increasing numbers of years without potatoes. No evident pattern regarding influence of specific crops in the rotations on the decline of infestation has been found. However, in the northern part of the country, there were very few positive samples compared with the southern part at a similar time span to potato crops. Possible reasons for this will be discussed.

In 2006, a collaboration with SCRI in Scotland (Alison Lees) has started aiming at comparing three different methods for detection of *R. solani* soil infestation: minitubers or Quinoa seeds as catch crops, where the DNA from the latter will be analysed at SCRI, or direct analysis of DNA from soil (quantitative PCR at SCRI). Another goal, achieved simultaneously, is to confirm the occurrence of *R. solani* AG-3 in Sweden. It is also of interest to investigate the prevalence of other anastomosis groups. This will be done when easily handled methods are available.

Index words: Rhizoctonia solani, potato, soil infestation, Sweden

Disease cycle of seed-borne *Rhizoctonia*-disease

Paavo Ahvenniemi, Mari Lehtonen, Paula Wilson & Jari Valkonen

University of Helsinki, Faculty of Agriculture and Forestry, Department of Applied Biology, Latokartanonkaari 7, 00014 University of Helsinki

Abstract

Studies on etiology and control of the stem canker and black scurf diseases caused by *Rhizoctonia solani* in Finland have been carried out at University of Helsinki, Department of Applied Biology, since 2003. One of the studies repeated during three growing seasons was carried out to provide a detailed characterization of the disease cycle. Because the diseases caused by *R. solani* can be soil- and seed-borne, the experiments were placed in an *R. solani* – free field and established using seed tubers infested with black scurf, so to be able to focus on the seed-borne infection. Only the young below-ground parts of the potato plants were detectably infected. Four phases could be distinguished during the disease cycle, all of which were characterized by different phenotypic features and consequences on yield. The first phase included infection of the tips of sprouts prior to emergence. It resulted in delayed emergence, fewer stems and retarded development of canopy, and reduced yield and starch content in tubers. The second phase included infection of stolon tips 2-3 weeks after emergence of plants. During this phase the stems were no more damaged. Infection and death of stolon tips resulted in shorter stolons than observed in uninfected plants. Consequently, infected plants had a tight tuber nest in which tubers were misshaped, furrowed and highly variable in size. The third phase of the disease progression, 3 to 4 weeks after emergence, resulted in damage to the youngest tubers. They suffered from scabby, often sunken surface areas and holes, which were usually situated at the sprout-end of the tuber. In some varieties, cracking of tubers was also observed. The fourth and last phase was defined by the development of sclerotia (black scurf) on tubers. This phase was initiated by the time of maturation in all below-ground parts of the potato plant. It was triggered also by chemical haulm killing at ca. 2 weeks after the treatment. Between the aforementioned, active phases of disease progression, *R. solani* seemed to be inactive, residing as a tight, brown mycelium on stem bases, stolons and roots. The mycelium also formed typical fruiting bodies under moist conditions. These studies were carried out with financial support from the private sector, advisory organisations, Ministry of Agriculture and Forestry and University of Helsinki.

Index words: potato, Rhizoctonia solani, black scurf, stem canker

Strains and distribution of *Potato mop-top virus* in Finland and other countries of the Baltic Sea region

Satu Latvala-Kilby[1)], Johanna M. Aura[2)], Neda Pupola[3)], Asko Hannukkala[1)] & Jari P.T. Valkonen[2)]

[1)]MTT Agrifood Research Finland, Plant Production Research, FI-31600 Jokioinen, Finland
[2)]Department of Applied Biology, PO Box 27, FI-00014 University of Helsinki, Finland, jari.valkonen@helsinki.fi
[3)]State Plant Protection Service, National Phytosanitary Laboratory, Lielvārdes ielā 36/38, Riga, LV–1006 Latvia

Abstract

The spraing symptoms caused by *Potato mop-top virus* (PMTV, genus *Pomovirus*) in potato tubers are an important quality problem in potato production in the Nordic countries. PMTV is very difficult to control because the virus remains infective in the resting spores of its vector, *Spongospora subterranea* (the powdery scab pathogen), in soil for many years and because PMTV-resistant cultivars are not available. Further problems are caused by the year-to-year variability in the portion of infected tubers which develop symptoms, and the similar symptoms caused by the nematode-transmitted *Tobacco rattle virus*. Hence, detection of PMTV in tubers cannot be based on observation of symptoms only. Since 2005, a coordinated action by the ten Baltic Sea region countries has aimed to determine the current geographic distribution of PMTV, improve diagnostic tools for detection of PMTV, and build up the necessary knowledge base for enhanced control of PMTV and the spraing disease. Because little was known about the genetic variability of PMTV in Finland, other Nordic countries and the few additional countries where PMTV occurs, sequences of PMTV isolates were characterized from 18 spraing-affected tubers grown in the field in Finland and from five symptomless tubers produced in a greenhouse in Latvia. The sequences were compared to ten PMTV isolates of which sequences were available from databases. The variability of the coat protein (CP) gene (98-100 %) and the readthrough (RT) region (97-100 %) in RNA2 was low. In contrast, the 8K gene located at the 3'-proximal part of RNA3 was highly variable, followed by a 3'-untranslated region (3'UTR) that was virtually identical in all isolates compared. Identity of the deduced 8K amino acid sequences was 88-100 % and sequence comparisons indicated existence of two readily distinguishable genetic strains. These results provided the first sequence information on PMTV isolates in Finland and Latvia, and the first report of occurrence of PMTV in Latvia, and the existence of two genetic strains of PMTV. Similar studies on the local PMTV isolates are on-going in Sweden and Norway. The data will be utilized in development of diagnostic tools, resistance breeding, and studies on interactions of PMTV with potato plants and the vector.

Index words: Potato mop-top virus, PMTV, potato, virology, disease control, Baltic Sea region

PCR - detection of *Synchytrium endobioticum* (Schilb.) Perc.

Frank Niepold

Federal Biological Research Centre for Agriculture and Forestry (BBA), Institute for Plant Protection in Field Crops and Grassland, 38104 Braunschweig, Messeweg 11-12, Germany

Abstract

The ITS-DNA region of *Synchytrium endobioticum* (Schilb.) Perc, the causal agent of potato wart disease, was used to generate specific primers for a PCR. DNA was extracted from wart galls of all *S. endobioticum* pathotypes (1, 2, 6, 18) currently occurring and used for official testing purposes in Germany. Using the universal ITS primer # 4 and the *S. endobioticum* specific primer Kbr1, a PCR fragment of 525 bp was obtained from all four fungal pathotypes. DNA for PCR based diagnosis of the fungus could be extracted easily from summer sori, however, we did not succeed to extract amplifiable DNA from resting sori found in contaminated soils. To circumvent this problem, zoospores emerging from resting sori were used for DNA extraction and indirect detection. PCR was also useful to discriminate between of weakly resistant and moderately susceptible response of potato varieties in addition to the routine visual inspection, since only alive summer sori of the weakly susceptible reacting potato varieties released quantities of zoospores sufficient to be detected. No PCR signal was obtained from weakly resistant or resistant potato varieties, since no zoospores were released from the dead sori, due to the resistance response of the potato.

Environment-friendly agent [SG101] for the Control of Common Scab on Potato

Leah Tsror (Lahkim)[1)], Marina Hazanovsky[1)], M. Lavee[2)], Nimrod Ben-Yehuda[2)] & Uri Zig[3)]

[1)]Agricultural Research Organization, Dep. of Plant Pathology, Gilat Research Center, M.P. Negev, 85280 Israel, tsror@volcani.agri.gov.il
[2)]Pimi-Marion Holdings Ltd., P.O.B 117, Hutzot Alonim 30049 Israel
[3)]Mao'n Enterprises Ltd., Israel

Abstract

Common scab on potato, caused by *Streptomyces* spp., can result in severe damage to potatoes. The increased prevalence of this disease in Israel, especially in Ma'on region (South-West Israel), is attributable to several factors, among which are: susceptible crops such as peanuts and radish being grown in short rotations, soils that are conducive to the disease, and the absence of effective eradication methods. Contaminated potato seed tubers are the major means of spreading the pathogen. Seed borne inoculum arrives through certified seed lots imported from Northern-Europe for the spring. In average 26% of the seed lots were contaminated with intermediate and high levels of common scab between 2004 and 2007.However, so far any of the tested seed treatments was efficient in reducing the disease incidence or severity. The primary inoculum source of *Sreptomyces* is seed tubers. Once the pathogen is introduced and established into the soil, it survives for a long time, and only a radical soil fumigation (such as formaldehyde) can reduce the pathogen levels.

The objective of the present study was to evaluate SG101, a stabilized formulation of hydrogen peroxide agent (3.5-7% H_2O_2) as a seed treatment for controlling common scab on potatoes.

Seed tubers (cv. Desiree) highly contaminated with common scab were treated with SG101 or Bactoril (Quat Ammonium) by a low volume spray, and mancozeb by dusting. Two experiments arranged in a randomized complete block design, with four replications were planted in two sites (Gilat -loess soil and Halutza - sandy soil). In Gilat, the incidence of progeny tubers with russet scab was significantly reduced in both SG101 and mancozeb treatments. In Halutza, the incidence of russet and common scab were significantly lowerin SG101, compared with the control and Bactoril. mancozeb treatment.The findings in this study indicate the high potential of using SG101 as a seed treatment for controlling scab in the short-term (in the harvested progeny). Furthermore, because of this SG101 efficiency, an advantage for the long-term is being achieved, by preventing the spread of the pathogen and infestation of soils. Additional studies on the potential use of SG101 as a furrow treatment and its effect on other seed-borne pathogens are being currently conducted.

Index words: Streptomyces, common scab, seed treatment

Preliminary characterization of the etiologic agent causing zebra chip symptoms in potato

Solke H. De Boer[1)], Gary Secor[2)], X. Li[1)], J. Gourley[1)], P. Ross[1)] & Viviana Rivera[2)]

[1)]Canadian Food Inspection Agency, Charlottetown Laboratory, Charlottetown, PE, Canada C1E 1Z5, deboers@inspection.gc.ca
[2)]North Dakota State University, Department of Plant Pathology, Fargo, ND, USA 58105, gary.secor@ndsu.edu

Abstract

A new disease of potato characterized by severe internal necrosis of tuber tissue was first observed in Mexico in 1994 and since 2000 has been observed in Guatemala, and several potato growing areas in the southern United States. Affected tubers are unmarketable because of severe discoloration throughout the tuber flesh, and when processed into chips (crisps) display bands of darkened tissue from which arose the common designation of 'zebra chip' for this condition. In affected geographic regions, zebra chip has become a leading cause for rejection of potatoes for consumption and processing. Whether or not the appearance of this disease and its northward spread is related to changes in weather patterns associated with global warming is uncertain, but its appearance and spread is of increasing concern to the potato industry.

Zebra chip-infected tubers often fail to sprout or when they do, produce hair sprouts and weak plants. Current season infection with zebra chip is associated with foliar symptoms that resemble those typically caused by phytoplasma. Despite the similarity of zebra chip-associated symptoms to phytoplasmal diseases, phytoplasma cannot be consistently detected in infected plants by the polymerase chain reaction (PCR) using standard procedures. Only the potato psyllid, *Bactericerca cockerelli*, has been consistently associated with disease incidence and spread. Psyllid salivary toxins, however, are not implicated in the disease etiology as the disease has been successfully graft transmitted in greenhouse trials.

Transmission electron microscopy studies revealed the presence of bacteria-like organisms (BLOs) in the vascular tissue of infected plant parts that in appearance are similar to phloem-restricted BLOs associated with the 'basses richesses' syndrome of sugar beets. To amplify purported BLO DNA, DNA template extracted from zebra chip-infected potato tubers was amplified with primers initially used to investigate phloem cucurbit yellow vine disease and marginal chlorosis of strawberry. While the primers that amplified DNA from strawberry BLO (subsequently identified as *Ca*. Phlomobacter fragariae) did not amplify specific DNA fragments, the primers that amplified DNA from the cucurbit BLO (subsequently identified as an atypical strain of *Serratia marcescens*) specifically amplified a 690 bp product from zebra chip-infected tuber tissue extracts. This fragment was cloned, sequenced, and blasted against the Genbank database. Identical sequences were not identified but the amplicon had a similarity of >97% to various enteric bacteria originating from diverse environmental plant and insect sources. Currently a genetic library of eubacterial *rrn* operons amplified with universal *rrn* primers from zebra chip-infected tubers is being constructed to evaluate the entire endophytic prokaryote community associated with the disease. Attempts to isolate zebra chip-associated bacteria on media designed for fastidious microorganisms are also ongoing.

Index words: zebra chip, phytoplasma, bacteria-like organism, phloem-limited bacteria

Seed Potato Certification in Finland

Hanna Kortemaa

Finnish Food Safety Authority Evira, Unit of Seed Testing and Organic Production Control, P.O.Box 111, FI-32201 Loimaa, Finland, hanna.kortemaa@evira.fi

Abstract

Finnish Food Safety Authority Evira, Unit of Seed Testing and Organic Production Control is responsible of the seed potato inspection and testing in Finland. The seed potato production area was 1290 hectares year 2006. The seed potato production is concentrated in the Nothern parts of Finland where the High Grade Region (Tyrnävä and Liminka in the Oulu region) for the production of seed potato is located.

Four generations of prebasic seed (class SS, S, SEE and SE), three generations of basic seed (class EC1, EC2 and EC3) and one generation of certified seed (class A or B) are produced in Finland.

The seed potato inspection schema of Finland includes several steps: the field inspection, the laboratory tests of potato cyst nematodes, bacterial ring rot, brown rot and potato virus and finally the visual tuber inspection. The field inspection, sampling and visual tuber inspection are done by the authorized inspectors. For prebasic and basic seed the inspectors make two official field inspections. For certified seed only one field inspection is needed. Official requirements are set for varietal purity, rogues, potato virus, black leg (*Erwinia* spp.*)* and *Rhizoctonia*. During the field inspection the background information as previous crop is checked. The soil sample for testing potato cyst nematodes is taken per each hectare. The potato cyst nematodes (*Globodera* sp.) are quarantine organisms and the seed potato production is not possible on the field infected by the nematodes.

In the autumn the tubers for winter tests in the laboratory are sampled. For bacterial ring rot a sample is 200 tubers/ha and for virus tests 200 tubers/field. Brown rot is tested as a survey of seed potato production. The testing method for bacterial ring rot (*Clavibacter michiganensis* ssp. *sepedonicus*) and brown rot (*Ralstonia solanacearum*) is the immunofluorescense (IF) method based on the specific antibodies. These quarantine organisms are not accepted in the seed potato production.

The potato virus Y-, A-, X-, S-, M- and Potato Leaf Roll are tested once during seed potato certification process usually as the prebasic seed. For the other seed classes the potato virus Y and potato virus A are tested. For certified seed potato class A there is a list of varieties which are tested. The seed class B is not routinely tested. The testing method is ELISA-test.

The seed potato companies need certificate labels before sorting and packing potatoes. A visual tuber inspection is done by the local inspectors. A sample of 400 tubers/50 tn is cut by knife and tubers are inspected one by one. There are requirements for soil, dry and wet rot, external blemishes, common scab, black scurf, skin spot and deep-pitted scab. The quarantine organisms or visual symtops of moptop virus or tobacco rattle virus are not accepted. If all steps of inspection and testing are according to legislation, the seed potato lot is officially certified and can be marketed as seed potato to the farmers.

Index words: seed potato, seed certification, inspection.

Why is *Erwinia chrysanthemi* (*Dickeya* sp.) taking over? – The ecology of a blackleg pathogen

Jan van der Wolf[1)], Arjen Speksnijder[1)], Henk Velvis[1)], Jan van de Haar[2)] & Joop van Doorn[3)]

[1)]Plant Research International, P.O. Box 16, 6700 AA Wageningen, Jan.vanderWolf@wur.nl
[2)]HZPC Research, P.O. Box 2, 9123 ZR, Metslawier, Henk.Velvis@HZPC.nl
[3)]Applied Plant Resaeaarch, P. O. Box 85, 2160 AB Lisse, Joop.vanDoorn@wur.nl

Abstract

Erwinia chrysanthemi (Ech) is causing large problems in potato production and is responsible for increasing incidence of blackleg in Europe. In 2005, when the temperature was high during the growing season, Ech was responsible for 50-100% of blackleg cases in France and The Netherlands. Also in 2006, the relative incidence of potato diseases caused by Ech was high. In this paper some ecological aspects of Ech are discussed which may explain the increasing significance of this pathogen.

Ech has been renamed recently and various strains are now distributed among six different *Dickeya* species. In potato, different *Dickeya* species have been found in Europe, viz. *D. dianthicola*, *D. dadantii* and *D. zeae*. Furthermore, *Dickeya* strains have been found in potatoes grown in Israel, which could not be classified in any of the six new species. *D. dianthicola (Dcd)* causes blackleg in temperate zones, whereas the other species are associated with potato diseases in warm climates. We have indications that due to increasing temperatures, the 'warm climate *Dickeya* species" are taking over *Dcd*. Possibly these species are more virulent, which may explain the increasing dominance of *Dickeya* spp. in current blackleg epidemics.

Dickeya sp. seem to act like biotrophic organisms, which need the host for long-term survival. *Dcd* survived poorly free in soil. Different strains were found to survive for one week but not three weeks after being inoculated into different soil types (sand, clay and peat) kept at different temperatures and humidities. In contrast *Pectobacterium atrosepticum (Pca)* and *Pectobacterium carotovorum* subsp. *carotovororum* survived for three months. Also survival was poor on various material surfaces (rubber, iron, aluminium, PVC, wood, concrete); *Dickeya* populations survived only three days on such surfaces and two weeks in the presence of plant extracts. However, *Dcd* has been frequently found in surface water, suggesting that it can persist for long periods in water. *Dcd* is able to cause disease symptoms even when present in seed at low densities. In field experiments with vacuum-inoculated tubers a level of 40 cells per gram of potato peel was sufficient to end up with 30 and 15% diseased plants in 2005 and 2006, respectively. Such low levels of infection easily remain unnoticed during seed testing, even if sensitive detection methods are used.

As for *Pca*, spread of contamination within and between seed stocks often occurs during harvesting and grading. In an experimental field, contamination with *Dcd* was spread by mechanical harvesting up to a distance of 80 m behind a zone with rotten tubers, with an average of 12 meter. Hand-harvested tubers from a disease-free crop remained clean.

Spread within a crop may also occur during crop production if *Dickeya* spp. are disseminated via free water in soil from rotten tubers to tubers of adjacent plants. We showed that plants adjacent to blackleg diseased plants both within a row and between rows became contaminated after heavy irrigation.

Index words: Dickeya, Erwinia, ecology, survival, dissemination

Erwinia chrysanthemi in Israel - epidemiology and monitoring in seed tubers

Leah Tsror (Lahkim)[1)], Orly Erlich[1)], S. Lebiush[1)], Uri Zig[2)] & Jan J. van de Haar[3)]

[1)]Agricultural Research Organization, Dep. of Plant Pathology, Gilat Research Center, MP Negev, 85280, Israel, tsror@volcani.agri.gov.il
[2)]Mao'n Enterprises Ltd., Israel
[3)]HZPC Research BV, NL-9123 ZR Metslawier, The Netherlands

Abstract

In recent years, *Erwinia chrysanthemi* (Ech) on potato in Israel, in plants grown from imported Dutch seed tubers has been occurring more frequently causing economic damage. Disease symptoms first appear as wilt of the top leaves, which then spreads to the lower ones, followed by desiccation. Discoloration of the vascular system in the stem base is usually observed, followed by external darkening. In severe infections, the stem, and even the whole plant can dry out. Symptoms are usually associated with soft rot of the mother tuber, and sometimes (depending on level of infection) of the daughter tubers as well.

The objectives of the present study were: a) to assess the impact of Ech-infected seed tubers imported from The Netherlands on disease expression in Israel, b) to develop a protocol for the detection of latent Ech infection in seed tubers.

In spring 2004, disease was observed in several plots on imported cvs. Desirée and Mondial. In 2005, disease incidence on various imported cultivars ranged from 5 to 30% (8.2% on average) on more than 200 ha. In the autumn crop where domestic tubers harvested from an infested field were used disease incidence was 10-15%. In 2006, the disease was observed on more than 260 ha in various cultivars with disease incidence ranging from 2 to 30% (10% on average). Seed tubers sampled from commercial lots imported from Holland were tested for latent Ech infection, based on bio-PCR or enrichment ELISA. Out of 36 tested lots 24 were Ech-positive. Disease levels recorded in the fields in these lots ranged from 3% to 35% (10% on average), with only one exceptional case, where a low incidence of diseased plants was observed in a field originated from a Ech-negative seed lot.

A protocol for detection of Ech in seed tubers was developed. A sample comprised of 200 tubers per 25 tons per lot divide into four or 10 replicates (50/20 tubers each), surface-sterilize with 0.5% NaOCl for 1 min, and the stolon end of each tuber was cut and placed in enrichment medium. After incubation of 48h, 0.2-ml aliquot was used for ELISA analysis or DNA extracted from the supernatant was used for PCR analysis. Our findings so far demonstrated the higher sensitivity of the bio PCR in comparison with the ELISA.

This protocol is being tested also in spring 2007 with a large number of seed lots. Samples from these lots were planted in the field and Ech incidence is being recorded. Correlations between latent infections in the seed tubers and disease expression will be further studied, in order to evaluate the accuracy of the suggested protocol, and/or to improve it.

Index words: Erwinia chrysanthemi, latent infection teting, bio PCR, enrichment ELISA

Characterisation of *Dickeya* (*Erwinia chrysanthemi*) strains causing potato blackleg and soft rot in Finland

Jaana Laurila[1)], Ari Lehtinen[1)], Virpi Ahola[2)], Miia Pasanen[3)], Asko Hannukkala[1)] & Minna Pirhonen[3)]

[1)]Agrifood Research Finland, Plant Production Research, Plant Protection, FI-31600 Jokioinen, Finland, asko.hannukkala@mtt.fi
[2)]Agrifood Research Finland, Biotechnology and Food Research, FI-31600 Jokioinen, Finland
[3)]University of Helsinki, Department of Applied Biology, P.O. 27, FI-00014 Helsinki, Finland, minna.pirhonen@helsinki.fi

Abstract

Contamination of seed tubers with soft rotting enterobacteria is a problem in seed potato production. These bacteria cause blackleg (rotting of potato stems in the field) and soft rot of tubers during storage. In the temperate climate blackleg is caused mainly by *Pectobacterium atrosepticum*, while *P. carotovorum* mostly causes rotting of potato tubers. Pathogens in the genus *Dickeya* (former *E. chrysanthemi*) were earlier thought to cause both kinds of symptoms in warm and tropical climate, but during the last years they have been reported to spread fast in the Central Europe.

To characterise the Finnish soft rot pathogens, bacteria were isolated from diseased potato stems and tuber samples and from river water samples collected from southern and western Finland. The isolated bacteria were verified as *Pectobacterium* or *Dickeya* by PCR–tests and analysis of 16S–23S rDNA intergenic sequences. All the strains isolated from river samples and 24% of the strains from stems showing blackleg symptoms were identified as *Dickeya*, whereas only few *Dickeya* strains were isolated from diseased tubers. Phylogenetic trees based on the 16S and 16S–23S intergenic sequences showed that three different *Dickeya* groups were present in rivers water, and two of the groups were isolated also from potato samples. One of these groups present in potato and water samples was similar to *D. diantihicola*, a quarantine pathogen in greenhouse-cultivated ornamentals, but the other groups did not resemble the previously characterised *Dickeya* species. Field assays suggested that *D. dianthicola* strains caused symptoms in the majority of the plants and reduced the yield up to 50%.

Our results suggest that *Dickeya* has spread to northern Europe and is more variable than previously anticipated. The results also suggest that some of the highly virulent *Dickeya* species/strains may be present in rivers and there is a risk that they will spread into potato stocks if contaminated river water is used for irrigation of seed potato fields.

Susceptibility of potato cultivars to soft rot caused by *Pectobacterium chrysanthemi*

Renata Lebecka[1)], Krystyna Michalak[1)] & Boris Gurevich[2)]

[1)]Plant Breeding and Acclimatization Institute, Młochów Center, Platanowa 19, 05-831-Młochów, Poland, R.Lebecka@ihar.edu.pl
[2)]Russian Institute of Phytopathology (VNIIF), Moscow region, Odintsovo district, Bolshiye Vyazemy, 143050, Russia

Abstract

Pectobacterium chrysanthemi Ech (Burkholder *et al*. 1953) Brenner *et al*. 1973, Hauben *et al*. 1998, is the causal agent of two diseases of potato: blackleg and soft rot (1). Tuber rot of potato induced by Ech is a threat to potato cultivation in the tropics (2), but it is also found in the cooler climates (3). The diploid interspecific hybrid of *Solanum* spp., DG 88-9, and 72 potato cultivars registered in Poland were evaluated for their susceptibility to Ech strain SCRI 4063 at two different temperatures, 30°C and 20°C. After incubation the width of decayed tissue was measured (in mm) in the widest part of vertically sliced tubers. All tubers of cultivars and the diploid clone were infected at a temperature 30°C, but not all were infected at a temperature 20°C. There were significant differences among cultivars in susceptibility to Ech. The statistical analysis of data (the width of decayed tissue at 30°C) obtained from 72 cultivars and one diploid clone has defined four groups (mean ± 95 % a confidential interval): I - 8 cultivars and the diploid clone poorly susceptible (9.0 ± 2.1), II - 17 cultivars moderately susceptible (13.2 ± 2.3), III - 36 cultivars susceptible (16.9 ± 2.1), IV - 11 cultivars strongly susceptible (19,9 ± 2,0). The cultivars, which were most susceptible at temperature 30°C, were more susceptible at temperature 20°C. The mean diameter of decayed tissue was 15.9 mm, with a range for individual cultivar from 7.7 mm to 22.0 mm. The diploid clone DG 88-9, used as resistant standard to tuber soft rot, showed the least infection with the mean value 7.2 mm. Tubers of 48 cultivars and the clone DG 88-9 did not show any symptoms of infection with Ech at a temperature 20°C. Tubers of 24 cultivars showed partial rotting, since symptoms of infection were observed for three to 10 inoculation sites out of 20 for each cultivar. It was observed that among 9 less infected cultivars at a temperature 30°C there was only one cultivar with symptoms of infection at a temperature 20°C. On the contrary, in the group of 11 cultivars highly infected cultivars at a temperature 30°C, 7 showed symptoms of infection at a temperature 20°C. The expression of potato resistance to bacteria Ech differs depending on the temperature. Temperature influences the bacterial growth rate as well as the wound-induced suberization and periderm formation in potato tubers. The wound healing occurs most rapidly at 25°C, and is delayed at 10 or 15°C, while a temperature of 35°C prevents the periderm formation and retards suberization (4). Our observations are in agreement with the statement of Perombelon et al. (5) that Ech could be a threat to potato in warmer countries but also in Central Europe due to warming climate.

1. Perombelon, M.C.M. 2002. Potato diseases caused by soft rot erwinias: an overview of pathogenesis. Plant Pathol. 51: 1-12.
2. Perombelon, M.C.M. & Kelman, A. 1980. Ecology of the soft rot erwinias. Annual Review of Phytopathology 18: 361-387.
3. Janse, J.D. & Ruissen, M.A. 1988. Characterization and classification of *Erwinia chrysanthemi* strains from several hosts in the Netherlands. Phytopathology 78: 800-808.
4. Thomas, P. 1982. Wound-induced suberization and periderm development in potato tubers as affected by temperature and gamma irradiation. Potato Res. 25: 155-164
5. Perombelon, M.C.M., Lumb, V.M., Zutra, D. 1987. Pathogenicity of soft rot erwinias to potato plants in Scotland and Israel. J. Appl. Bacteriol. 63: 73-84

Index words: Pectobacterium chrysanthemi, potato, susceptibility, temperature

Confirmation of bacterial ring rot detection using real-time PCR with an internal reaction control

D. Smith, Solke H. De Boer & J. Gourley

Canadian Food Inspection Agency, Charlottetown Laboratory, Charlottetown, PE, Canada, C1A 5T1,
deboers@inspection.gc.ca

Abstract

The ring rot disease of potato, caused by the Gram-positive bacterium, *Clavibacter michiganensis* subsp. *sepedonicus* (Cms), is under good regulatory control in Canada. With a zero tolerance for the disease in seed potato production, and a certification requirement for annual laboratory indexing of selected seed lots for the possible presence of asymptomatic latent infections, occurrences of bacterial ring rot are infrequent and limited in scope. The laboratory indexing requirement is considered to be a particularly important component of the seed certification program for ring rot control, because the disease, when first present, is, under Canadian production conditions, often not detected by field inspection of growing crops or by bin inspection of harvested tubers, and will be of increasing importance should changing climatic conditions impact negatively on symptom expression.

In Canada, the primary test for laboratory indexing is the enzyme-linked immunosorbent assay (ELISA) with a monoclonal antibody targeting the Cms extracellular polysaccharide, followed by a somatic antigen-directed monoclonal antibody-based immunofluorescence (IMF) confirmatory test for ELISA positive samples. A real-time (kinetic) PCR test (kPCR) using TaqMan chemistry, adapted from a published method and supplemented with an internal reaction control (RC) was implemented to evaluate the efficiency of the serological methods.

The RC was constructed from a corn invertase gene fragment flanked by sequences complementary to the Cms primers, and was designed to generate an amplicon that differed from the Cms-specific amplicon but by its amplification would confirm the absence of PCR inhibitory substances in template DNA. The RC construct was cloned into plasmid vector pCRII-TOPO (to create plasmid, pCmsC4) and propagated in *Escherichia coli* strain DHα-T1. The RC amplicon did not hybridize to the Cms-specific TaqMan probe, but could be detected in kPCR runs with the inclusion of SYBR Green in the reaction mix. The Cms-specific and the RC amplicons were readily distinguished by their respective post-amplification melting temperatures in the presence of SYBR Green. The addition of 100 copies of pCmsC4 to the reaction mix did not adversely affect sensitivity of Cms detection by kPCR.

The presence of Cms in all ELISA/IMF-positive samples was confirmed by kPCR. However, in a 320-sample data set, 50% of ELISA-positive samples with cell counts below the IMF threshold were positive by kPCR, verifying the applicability of kPCR as a valuable additional confirmatory test. In the same data set, 16% of samples that had both ELISA and IMF readings below the positive thresholds were positive by kPCR. While it was difficult to discount entirely the possibility of false positive kPCR tests resulting from cross-contamination during collection and processing of samples or PCR setup, the data confirms the greater sensitivity of kPCR for detecting asymptomatic (latent) infections of bacterial ring rot.

Index words: ring rot, indexing, detection, kPCR, ELISA, immunofluorescence

Why have *Colletotrichum* and *Helminthosporium* become such a problem for fresh and ware potato quality - pathogen change or climate change

Leah Tsror (Lahkim)[1)], B.H. Ben-Daniel[1)], Orly Erlich[1)], Marina Hazanovsky[1)], S. Lebiush[1)], Menashe Aharon[1)] & Uri Zig[2)]

[1)]Agricultural Research Organization, Dep. of Plant Pathology, Gilat Research Center, MP Negev, 85280, Israel, tsror@volcani.agri.gov.il
[2)]Mao'n Enterprises Ltd., Israel

Abstract

Both black dot and silver scurf caused by *Colletotrichum coccodes* and *Helminthosporium solani*, respectively, cause blemishes on the potato periderm. These diseases often occur together and frequently confused, cause reductions in fresh and ware potato production potential and damage value of seed potatoes.

These diseases are largely distributed in all potato growing regions of the world, but black dot is most important in areas with dry and hot conditions, such as the Mediterranean regions, western USA, South Africa and southern Australia, although it is also well established in more temperate areas, such as UK, France, the Netherlands and Germany.

Both diseases became a major problem in potato production over the past decade due to an increased demand for washed potatoes with a high-quality appearance.

C. coccodes appears as a highly diverse species morphologically, physiologically and genetically; the existence of vegetative compatibility groups might explain this diversity, despite the fact that no sexual stage is known for the pathogen. *C. coccodes* is also diverse from a pathological point of view: it infects a range of plant species within and outside the Solanaceae, and shows some specific interactions with individual potato cultivars. In contrast, with *H. solani* there are no alternative hosts except to tuber-bearing *Solanum* species.

Changes in cropping systems and in consumer dictate a reassessment of the economic importance of the skin blemish diseases, that severely affects the economic value of fresh market and seed potato production in regions of the world where external appearance is an essential driver of market access. An integrated disease management approach that includes cultural, biological and chemical control methods, in the field and in storage, is necessary for long-term control of skin blemish diseases. The fungicide TBZ was used for silver scurf control until the 1980's, but due to high frequency of resistance imazalil has become the main fungicide used on seed tubers in Europe. However, *C. coccodes* is not sufficiently controlled by imazalil, suggesting another reason why black dot became a major pathogen on potato. Additional fungicides e.g. prochloraz, fludioxonil and azoxystrobin that control both pathogens are being introduced, however resistance to fludioxonil in *H. solani* was recently reported.

Adequate control of the skin blemish diseases with very low tolerance for market access is highly problematic, and will require integrated strategies combining all currently available control methods.

Index words: Colletotrichum coccodes, Helminthosporium solani, black dot, silver scurf seed tuber treatment

Diagnostic assays: quantitative tools for investigating the epidemiology of skin blemish and storage rot diseases and making disease risk assessments

Alison K. Lees[1)], Jennie L. Brierley[1)], Jeff C. Peters[2)], P. Gladders[3)], Nick Bradshaw[4)], Alex J. Hilton[5)] & Stuart J. Wale[5)]

[1)]SCRI, Invergowrie, Dundee, DD2 5DA, UK, alees@scri.ac.uk
[2)]British Potato Council, Sutton Bridge Experimental Unit, Sutton Bridge, Spalding, Lincs. PE12 9YD, UK
[3)]ADAS Boxworth, Boxworth, Cambridge, CB3 8NN
[4)]ADAS Consulting Ltd, Henstaff Court Business Centre, Groesfaen, Cardiff, CF72 8NG, UK
[5)]SAC, Craibstone Estate, Bucksburn, Aberdeen, AB21 9YA, UK

Abstract

The requirement of the potato industry for high quality healthy tubers is well established and blemish diseases are therefore of particular concern.

In recent years, quantitative molecular diagnostic assays based on real-time PCR have been developed for many pests and pathogens of potato. These diagnostic assays are now being used as tools to study outstanding questions in the epidemiology of potato diseases including blemish diseases such as black dot, powdery scab and black scurf and storage rots caused by Fusarium spp. Examples of various investigations designed to examine the relative contribution of seed- and soil-borne inoculum in causing disease on progeny tubers and the effect of environmental factors on the incidence and severity of disease are described.

To enable real-time PCR diagnostic assays to be used not only for research purposes, but also more directly in the management of potato diseases, diagnostic results must be associated with factors affecting the risk of disease. Therefore, a comprehensive system of soil and seed tuber sampling, testing and disease monitoring has been initiated in a project funded by the British Potato Council to validate these assays and enable results to be translated into disease risk. Some of the techniques employed in this validation, and results of experiments focusing on black dot (*Colletotrichum coccodes*), are presented. The refinement of a direct soil DNA extraction method and the detection and quantification of target DNA in both seed and progeny tubers are described.

Consideration is given to the development of appropriate diagnostic assays, their use in conjunction with relevant and robust sampling techniques and a direct soil DNA extraction method, and the interpretation of results to inform disease risk assessment and control strategies through collaboration with the potato industry.

Index words: Real-time PCR, epidemiology, risk assessment, black dot, powdery scab, dry rot

Control of black dot: Integrating agronomy and storage

Jeff C. Peters[1)], Alex J. Hilton[2)], Alison K. Lees[3)], Jennie L. Brierley[3)], P. Gladders[4)], Nick Bradshaw[5)] & Stuart J. Wale[2)]

[1)]British Potato Council, Sutton Bridge Experimental Unit, Sutton Bridge, Spalding, Lincs. PE12 9YD, UK, jpeters@potato.org.uk
[2)]Scottish Agricultural College, Craibstone Estate, Bucksburn, Aberdeen, AB21 9YA, UK
[3)]Scottish Crop Research Institute, Invergowrie, Dundee, DD2 5DA, UK
[4)]ADAS Boxworth, Boxworth, Cambridge, CB3 8NN, UK
[5)]ADAS Consulting Ltd, Henstaff Court Business Centre, Groesfaen, Cardiff, CF72 8NG, UK

Abstract

The trend towards washed and packed potatoes for the fresh market has led to an increase in demand for tubers with a good visual appearance. As a consequence of this, blemish diseases, and black dot in particular, are increasingly becoming concerns for the industry (Lees & Hilton, 2003). In GB alone, it is estimated that the blemish diseases, silver scurf and black dot, reduce the value of the total annual crop by around €4.5m. Black dot, caused by the fungus *Colletotrichum coccodes* has become particularly important because the pathogen is widespread in GB soils and there are limited control options.

Field and storage experiments were set up to investigate the interaction between soil inoculum levels for *C. coccodes* (between 40 and 500 pg DNA/g soil), crop duration and storage regime on black dot development throughout storage. There was an interaction between soil inoculum level and crop duration (measured as days from 50% emergence to harvest) on black dot tuber severity at harvest. Black dot severity increased with lengthening crop duration, and the severity increased more rapidly at higher soil inoculum (P=0.005).

Disease progress curves for black dot were used to determine the influence of storage treatments and crop duration on disease development in crops grown in field plots with a high level of inoculum. Post-harvest black dot was shown to be higher on tubers subjected to an extended-cure treatment than those which had minimal-curing in a maincrop variety that had been grown for more than 130 days from 50% emergence to harvest (P=0.024).

The integration of the results from the field and storage components of this three year trial into practical recommendations for the control of black dot will be discussed.

Acknowledgements

The British Potato Council and the Scottish Executive Environment and Rural Affairs Department are gratefully acknowledged for funding this work.

Reference

Lees, A.K. & Hilton, A.J. (2003). Black dot (*Colletotrichum coccodes*): an increasingly important disease of potato. *Plant Pathology* 52: 3-12.

Index words: Colletotrichum coccodes, black dot, PCR, Storage

Posters

Overview of research conducted in France on three important potato blemish diseases (common scab, black scurf and powdery scab)

Karima Bouchek-Mechiche[1),2)], C. Campion[3),4)], Catherine Chatot[3)], C. Pasco[1)], Yves Le Hingrat[5)], Françoise Montfort[1)] & Didier Andrivon[1)]

[1)]INRA, UMR BiO3P, Domaine de la Motte, 35653 Le Rheu, France
[2)]GNIS, 44 rue du Louvre, 75001 Paris, France
[3)]Germicopa R&D Station, Kerguivarch, 29520 Chateauneuf du Faou, France
[4)]UMR Pathologie Végétale INRA-INH-Université, Université d'Angers, U.F.R. Sciences, 2 Bd Lavoisier, 49045 Angers Cedex 01, France
[5)]FNPPPT, Station Bretagne-Plants, Roudouhir, 29460 Hanvec, France

Abstract

In France, several research programs on major blemish diseases are mainly conducted at INRA with the financial support of professional organisations. The general objectives of these programs are 1) to understand the aetiology and epidemiology of the diseases, 2) to develop appropriate detection tools, and 3) to design sustainable strategies for disease control. This paper will focus on the work carried out during the past few years on common and netted scabs due to *Streptomyces spp*., black scurf due to *Rhizoctonia solani* and powdery scab due to *Spongospora subterranea*.

Aetiology and detection

Large species diversity exists within common scab pathogens (*S. scabiei*, *S. europaeiscabiei*, *S. stelliscabiei*, etc…), but almost all of these species have identical pathological features. Netted scab pathogens seem to be less diverse, and primarily include *S. reticuliscabiei* which is genomically close to *S. turgidiscabies* producing common scab. Some isolates of *S. europaeiscabiei* which are able to produce either common or netted scab complicate the issue of aetiology of potato scabs and support a model of horizontal transfer of pathogenicity determinants among *Streptomyces*. The improved knowledge of the aetiology of these diseases allowed us to design appropriate identification and detection tools.

For *Rhizoctonia solani*, a characterisation study based on ITS sequences, morphology and anastomosis groups of 241 isolates collected from potato plants grown in different areas in France showed that 94 % of the isolates were AG3, 4% AG2-1 and 2% AG5. Most AG3 and AG2-1 isolates were obtained from sclerotia, whereas all AG5, some AG3 and some AG2-1 were recovered from superficial tuber alterations. However, the pathogen could not be re-isolated from symptomatic plants harvested from soil infested with AG5 or AG2-1 isolates, and some symptoms like restricted surface haloes with desquamations (symptoms from which isolates of AG5 were isolated) were not expressed under experimental conditions. To determine unambiguously whether *R. solani* is the causal agent of the atypical superficial alterations or whether these symptoms are due to other causes, such as netted scab or physiological reactions, a study on a large set of potato tuber samples showing several atypical alterations and originating from different French regions and from different countries in the world is under investigation at INRA Dijon France.

We developed and assessed reliable and sensitive methods of detection and quantification of *Spongospora subterranea* on tubers and in the soil. These are useful for epidemiological studies. For the seed certification procedure, where the inspection is visual, it is sometimes difficult to discriminate scab symptoms due to some *Streptomyces* strains from those due to powdery scab. To avoid the risk of misidentification, we demonstrated the value of the quick tuber test "Elisa AgriStrip" (developed by U. Merz and Bioreba) by comparing the results of this method with those of sensitive conventional tools (PCR, Taq Man PCR, Elisa) on several samples including those with doubtful symptoms.

Epidemiology

Epidemiological studies on *Streptomyces* showed clearly that common and netted scab differ in ecological requirements (behaviour to potato cultivars, host plants, soil temperatures, and soil humidity). These epidemiological data underline the importance of adapting cultural methods to the pathogenicity groups present in the soil.

We showed that sclerotia of *Rhizoctonia solani* AG3 were formed on tubers grown in soil artificially infested, without differences in susceptibility among the tested cultivars. Sclerotia were not formed on tubers grown in soil infested with AG5 or AG2-1. The proportion of tubers with lesions and deformations was higher in soil infested with AG2-1. All varieties tested under controlled and field conditions were susceptible to the pathogen but at different degrees. Preliminary results on pathogen transmission confirmed that seed can also be a source of progeny tuber contamination and induce yield losses from 9 to 20% according to the cultivars (F. Trehorel, unpublished data).

Epidemiological studies on *Spongospora subterranea* focused on assessing the relationship between symptom severity on tubers and potential soil contamination and on cultivar resistance. Data obtained on tubers of several cultivars with different disease severity indicate that infected seed is a source for soil contamination. The behavior of 10 reference cultivars with different powdery scab susceptibility was assessed during 3 consecutive years in field screening trials. This study is the part of the European powdery scab resistance ring trials project which will provide useful information on the genotype x environment relationship.

Perspectives on control strategies

Management of soilborne diseases, which are persistent and recurrent problems in potato production, requires the integration of several control measures during the crop succession. Our current research focuses on management of the inter-crop period to reduce soilborne pathogens *Streptomyces* spp. and *R. solani* in cultural rotation (wheat/potato). The efficacy of inter-crop plants and wheat straw management is assessed for the reducing inoculum survival under field and green house conditions.

Acknowledgements

This work was funded by **GNIS** (Groupement National Interprofessionnel des Semences et Plants), **CNIPT** (Comité National Interprofessionnel de la Pomme de Terre) and **Germicopa** SA.

Index word: common scab, netted scab, black scurf, powdery scab, aetiology, detection, epidemiology

The influence of competition, aggressiveness and host resistance on selection of *Phytophthora infestans* populations in the US and Northern Ireland

Gillian K. Young[1) 2)], Louise R. Cooke[1)], William W. Kirk[2)] & Pavani Tumbalam[2)]

[1)]Queen's University of Belfast, Applied Plant Science Department, Newforge Lane, Belfast, BT9 5PX, UK
[2)]Plant Pathology Department, Michigan State University, East Lansing, Michigan, US

Abstract

The majority of commercially available potato cultivars are highly susceptible to foliar late blight caused by the oomycete *Phytophthora infestans*. Although new resistant cultivars with good agronomic characteristics are now becoming commercially available, the impact of cultivar on selection in the surrounding late blight population is poorly understood. In 2003, 2004 and 2005 field trials were planted in Michigan and N. Ireland using cultivars with differing ratings for field resistance to foliar late blight. Epidemics were established using multiple local genotypes of *P. infestans*, through the use of inoculated spreader rows of a susceptible cultivar which surrounded test plots. Once plots had reached approximately 1% infection, lesions were collected and isolated for characterisation and genotypic assignment. There was a significant effect of cultivar on the distribution of genotypes within the N. Ireland field trials. All genotypes infected the most susceptible cultivar but extreme genotypic selection was observed within the other more resistant cultivars. This trend was not observed in the US field trials where one genotype (US-8) dominated infection of all cultivars. The US-8 was significantly more aggressive than other US genotypes in detached leaflet aggressiveness tests. In contrast, there was little correlation observed between competitive fitness in the field and aggressiveness on detached leaflets in the N. Ireland study.

The question of metalaxyl resistance on late blight causing pathogen *Phytophthora infestans* in Estonia

Eve Runno-Paurson & Mati Koppel

Jõgeva Plant Breeding Institute, Aamisepa 1, 48309 Jõgeva alevik, Estonia, Eve.Runno@jpbi.ee

Abstract

Metalaxyl containing fungicides are commonly used by Estonian potato growers because of their efficiency in control of potato late blight. Metalaxyl-resistant isolates have become an important part of Estonian population of *Phytophtora infestans*. The aim of current study was to measure the frequency of metalaxyl resistance among Estonian population of *Phytophtora infestans* and to test efficacy of metalaxyl based fungicides in control of potato late blight. 138 isolates of *Phytophtora infestans* were collected from conventional, experimental and small scale growers fields in different parts of Estonia in 2003-2005 and assessed for resistance to metalaxyl. Metalaxyl resistant, intermediate and sensitive isolates were recorded at frequency of 37.1, 45.4 and 15.1%, respectively. Statistically significant differences ($P<0.001$) between locations, potato growing field types and years in the frequency of resistance to metalaxyl were observed. The proportion of metalaxyl-resistant isolates from different locations ranged from 0 to 67%. Metalaxyl resistant isolates were predominant (66.7%) on conventional potato fields in 2004 and 2005 where metalaxyl consisting fungicide had been applied. In 2004 none metalaxyl-resistant strains were detected among isolates collected from the field (Naha) where metalaxyl containing fungicide was not used. As might be expected, insensitivity was more often found at conventional fields, where metalaxyl was commonly applied, than small scale growers fields where fungicides were rarely used. The increase of frequency of metalaxyl-resistant isolates has been detected in period from 2003 to 2005. Even the proportion of metalaxyl-resistant isolates fluctuates from year to year there are strong evidences that quantity of metalaxyl-resistant isolates has been increased compared with previous results (Runno, et al. 2005). Reason for such increase could be the more consistent use of metalaxyl containing fungicides.

Metalaxyl showed lowered efficacy only in conditions of extreme late blight pressure in 2004. Therefore metalaxyl could be effectively used for control of potato late blight in maximum of two times during the growing period.

As long as metalaxyl is used according to the recommendations in Estonia it is unlikely that metalaxyl-resistant isolates will completely displace sensitive isolates. Several reports suggest that resistance is unstable in the population and is selected anew each year, increasing steadily during the season and declining over winter (Gisi & Cohen 1996).

Trials of late blight control with metalaxyl containing fungicide Ridomil Gold MZ 68 WG were performed in the same period. Metalaxyl containing fungicide was applied 2 times in all three years. The foliage of untreated plots was completely destroyed for the end of the growing season in all trial years. Metalaxyl provided high protection in 2003 and 2005, but showed lowered efficacy only in conditions of extreme late blight pressure in 2004 when the foliage was infected during the period when metalaxyl was used. The trial result show that in spite of occurrence of resistant strains the use of metalaxyl consisted fungicides is still effective. Therefore metalaxyl could be used effectively for control of potato late blight in maximum of two times in beginning of the fungicide treatments. By following the application rules for metalaxyl fungicides it is possible to restrict the development of metalaxyl-resistant strains and thus avoid the reduction of efficacy of the fungicide.

Acknowledgements

The study was supported by the Estonian Science Foundation grants No 4734 and 6098.

References

Gisi, U. & Cohen, Y., 1996. Resistance to phenylamide fungicides: a case study with *Phytophthora infestans* involving mating type and race structure. Annual Review of Phytopathology 34, 549-72.

Runno, E. & Koppel, M. 2005. *Phytophthora infestans* Eesti isolaatide metalaksüülitundlikkus ja paarumistüübid. Agronoomia 2005. Teadustööde kogumik 220:168-170.

Late blight control by using a decision support system in organic potato cultivation

Lars-W. Bangemann[1)], M. Benker[2)], B. Kleinhenz[3)], Michael Zellner[2)] & Gerhard Bartels[1)]

[1)]Federal Biological Research Centre for Agriculture and Forestry, Braunschweig, Germany, l.bangemann@bba.de
[2)]Bavarian State Research Centre for Agriculture, Freising, Germany
[3)]ZEPP (Central Institution for Decision Support Systems in Crop Protection), Bad Kreuznach, Germany

Abstract

Introduction
The late blight disease (*Phytophthora infestans*) is still regarded as an important yield-limiting factor in the organic potato- production. Therefore the use of copper forms a crucial basis of the yield and quality- assurance. However, the copper enchrichment – problems in the soil and their subsequently negative effects on non-target organisms appear to be on reason that a reduction of the copper-use is inevitable. For this reason, different strategies are developed for controlling the secondary-attack in the framework of the research project ÖKO-SIMPHYT. This project aims to achieve a sufficient control of the disease with less copper as possible. In the following, the results of the periods (2005 and 2006) out of a three year project are presented.

Methods
Different copper-preparations and copper concentrations were tested in field trials carried out in Northern Germany at three locations. Furthermore the spray intervals and doses of copperproducts were adjusted variably to the infection pressure and compared with conventional weekly applications. Current data of the infection pressure and application recommendations were provided by the forecasting model ÖKO-SIMPHYT, which is specially developed for organic potato cultivation.

In addition to the field trials the rain-stability of the copper-preparations was tested during winter periods. Products with different copper concentrations were tested in greenhouse experiments for their rain fastness. Precipitation was simulated by precipitation intensities. The effected loss was then evaluated using artificial inoculation with *P. infestans* in climate chambers.

Tab. 1: Copper-products and doses used in the field trials

Product:	Doses (g Cu/ha):	Spray interval:
Cuprozin fl. (460,6 g Cu-hydroxid/l)	150, 250, 375, 500, 625, 750	Due to infection pressure, weekly
Funguran (756 g Cu-oxychlorid/kg)	150, 250, 500, 750	Due to infection pressure, weekly
SPU 2690 (200g Cu-hydroxid/l)	150, 250, 450, 500	Due to infection pressure, weekly
SPU 01010 (63g Nano-Cu/l)	150	Due to infection pressure, weekly
Cuprozin fl. + Nu-Film P (additive)	500 + 0,3 l/ha	weekly, 14 days

Results and discussion

In the two years 2005 and 2006, due to the dry climate a relatively low infection pressure of *P. infestans* took place in the field trials. Caused by a drought period in June and July, the first symptoms of late blight emerged only at the end of July or at the beginning of August. Under this environmental circumstances it turned out, that a sufficient control of late blight was possible with a reduced copper dose up to 250 g Cu/ha per application. However, the dose of 150 g Cu/hectare per application did not achieve any sufficient control effect on late blight. In contrast to the conventional applications the total amount of copper could be reduced up to 46% and at least one application could be left out by applying the decision support system, while no efficiency loss was observed.

Despite the provable effect of the copper treatment on late blight symptoms on the leaves, there were no significant influences on the tuber yield. This is mainly due to the late appearance of the disease during the vegetation period, because by then yield formation was already completed. Therefore, the aspect of yield formation and first appearance of late blight will be investigated more deeply during this project.

In the greenhouse tests copper- hydroxid showed higher rain strength in comparison to copper- oxychlorid when rain precipitations of 25 mm were applied.

Furthermore it turned out that precipitations of more than 30 mm could lower the degree of effectiveness of a copper application by up to 25%.

This effect proved to be more distinctive, the lower the amount of copper per application was set. These results are consulted to improve the recommendations of the spray intervals in the ÖKOSIMPHYT prognosis system.

Conclusions

The first two years of the project ”ÖKOSIMPHYT” pointed out that this forecast system was a suitable tool to reduce the total amount of copper in organic potato cultivation in Northern Germany. Adjustments of the application strategy in regards to the infection pressure led to a more effective and target oriented application of copper.

It could be pointed out that under low infection conditions a control of the late blight is already possible with an on-wall set of 250 g of Cu/hectare per application.

Nevertheless whether the application strategies can prove their usefulness also in years with a high attack pressure of *P.infestans* must be checked further.

We would like to thank the BMELV und the BLE for supporting this project in the Framework of the ”Bundesprogram für Ökologischen Landbau”.

The effect of copper seed treatment on potato late blight

Marianne Benker & Michael Zellner

Bavarian State Research Center for Agriculture, Institute for Plant Protection, Lange Point 10, D-85354 Freising, Germany.

Abstract

Introduction

Primary stem infections resulting from *Phytophthora infestans* infected potato tubers are an increasing problem in potato production. In the project ÖKO-SIMPHYT primary stem infections should be reduced by seed treatment with copper fungicides in order to postpone the beginning of the blight epidemic as well as the start of spraying. In the field trials in 2005 and 2006 a copper seed treatment reduced primary stem infection of potato plants and furthermore it decreased infection of daughter tubers with *Phytophthora infestans*.

Materials und Methods

To ensure the appearance of primary stem infections, artificially infected tubers (Varieties Agria and Quarta inoculated with zoospores) were planted in field trials. Subsequently seed tubers were treated with different application methods and copper fungicides. After emergence visible primary stem infections were measured weekly and confirmed by PCR detection. Finally the daughter tubers were analysed for tuber blight by PCR.

Results

Latent infected seed tuber are becoming increasingly important in potato production, because many seed tuber lots are containing latent infected tubers. In 2007 different seed lots (from conventional and organic potato production) were examined by PCR (Tab. 1). The infection incidence ranged from 0 % - 37.2 %, whereas only one lot showed absence of tuber infection.

Tab. 1: Numbers of infected tubers in different seed lots (Storage 2007).

Samples	Number of tubers	Visible symptoms	Positive PCR-results	Total infected tubers
1	94	0/94	35/94	37.2%
2	95	1/95	1/94	2.1%
3	94	0/94	6/94	6.4%
4	94	0/94	0/94	0.0%
5	95	1/95	0/94	1.1%
6	95	0/94	10/94	10.6%

Tuber infection with *Phytophthora infestans* significant decreased emergence depending on severity of tuber infection (Tab. 2+ 3).

Tab. 2: Emergence of latent infected tubers depending on infection severity in field trials (Site Puch 2003, variety Agria).

Inoculated with	Ermergence
50 zoospores	77.5%
500 zoospores	12.5%
1000 zoospores	2.5%

Tab. 3: Emergence of latent infected tubers in field trials (average of 6 trials per year [=2 sites: Puch + Straßmoos, 3 planting times]).

Year	Variety	Inoculated with	Ermergence
2004	Agria	50 zoospores	97.0%
2005	Agria	50 zoospores	80.6%
2006	Agria	50 zoospores	81.5%
		Average	**86.4%**

Year	Variety	Inoculated with	Ermergence
2004	Quarta	200 zoospores	86.8%
2005	Quarta	200 zoospores	53.5%
2006	Quarta	200 zoospores	58.0%
		Average	**66.1%**

A copper seed treatment significant decreased primary stem infections of potato plants (Fig. 1). In 2005 seed treatment resulted in reduced secondary leaf infections. Thus, a delay of the blight epidemic as well as start of spraying were possible. Furthermore a copper seed treatment reduced tuber blight infections of daughter tubers (Fig. 2). The PCR detection applied to daughter tubers showed a decreased latent tuber infection with *Phytophthora infestans*.

Summary

- Infected tubers resulted in decreased emergence depending on infection severity
- Infected seed tubers can cause primary stem infection
- Copper seed treatment decreased primary stem infection significantly
- Copper seed treatment effeced significant reduction of infected daughter tubers

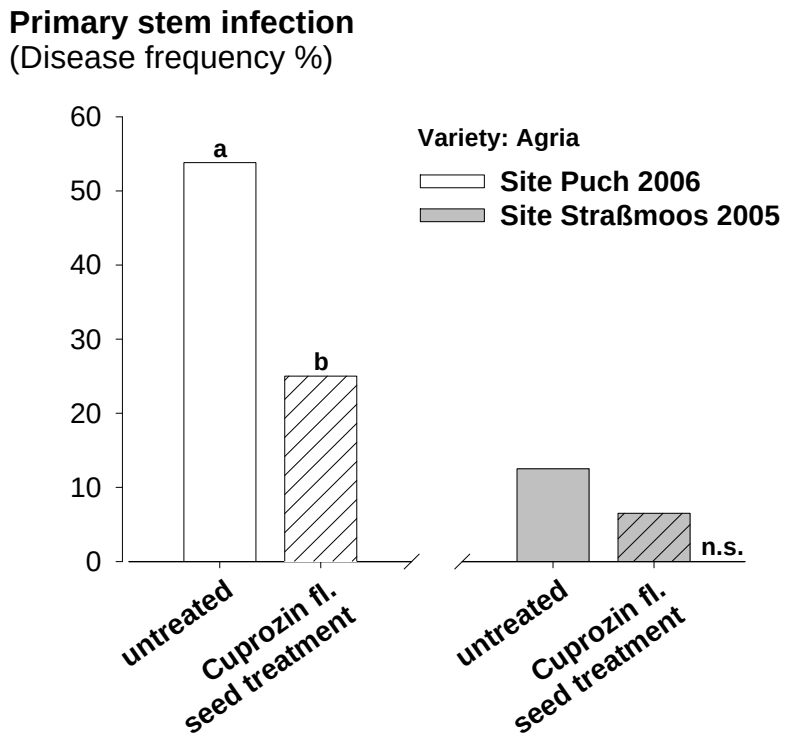

Fig. 1: Effect of copper seed treatment on primary stem infection (48g/t Cu).

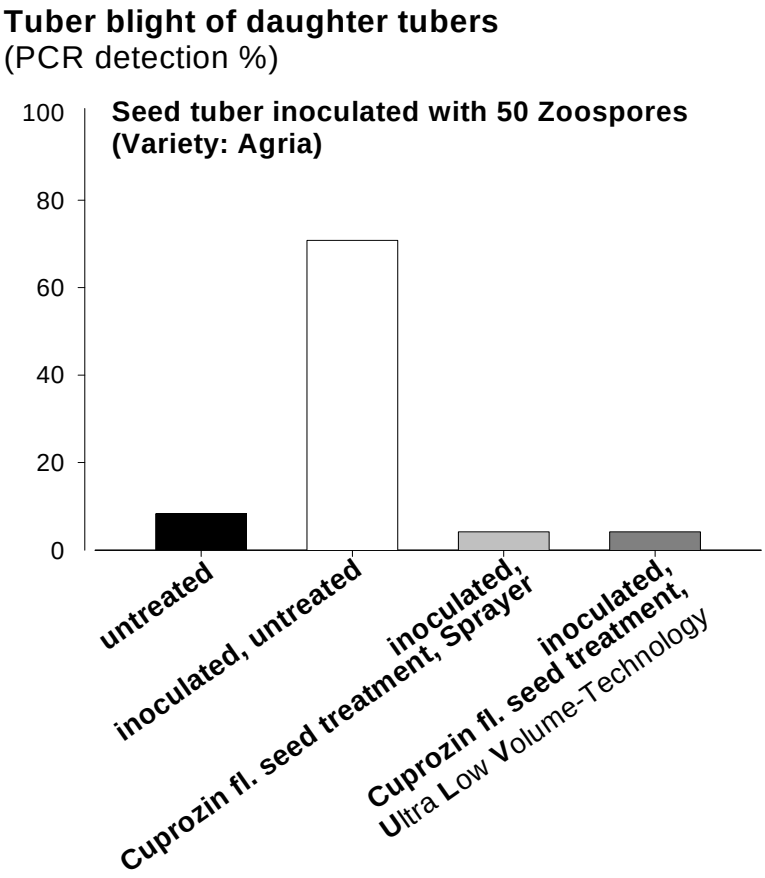

Fig. 2: Effect of copper seed treatment on tuber blight of daughter tubers.

Resistance to silver scurf in wild potato species

Nadezhda M. Zoteyeva

N.I. Vavilov Institute of Plant Industry (VIR), St. Petersburg, Russia

Abstract

Silver scurf caused by *Helminthosporium solani* Dur. et Mont. has been observed in Northwestern Russia from year to year, but from mid of 90th the amount of the affect of this disease on potato increased. To decrease disease development in potato fields the incorporation of resistance into improved cultivars from highly resistant genotypes is a one of the most promising strategies. Wild potato species is a good source of resistance genes to a large amount of diseases. In order to identify potato wild species which are resistant to silver scurf three year observation of tuber had been conducted.

Vegetative seasons with higher temperatures are characterized by more intensive disease development. Disease symptom development on tubers of the same accessions varied in intensity depending on year (LSD = 1,32). During full period of evaluation of large wild potato species (50) and their accession (352) number, the tubers of only individual accessions were symptom free. Such accessions were found within the following species: *S. cardiophyllum* (2 accessions), *S. chancayense* (1 accession), *S. jamesii* (1 accession), *S. pinnatisectum* Dun. (1 accession), *S. stenophyllidium* (1 accession) and *S. tarijense* (1 accession). During three year observation tubers with weak disease symptoms were noted into part of: *S. arnezii*, *S. brachistotrichum*, *S. cardiophyllum*, *S. chacoense*, *S. commersonii*, *S. famatinae*, *S. fendleri*, *S. gibberulosum*, *S. gourlayi*, *S. incamayoense*, *S. jamesii*, *S. leptostigma*, *S. kurtzianum*, *S. maculae*, *S. papita*, *S. pinnatisectum*, *S. piuranum*, *S. polytrichon*, *S. spegazzinii*, *S. stenophyllidium*, *S. stoloniferum*, *S. sucrense*, *S. tarijense*, *S. toralapanum*, *S. venturii* and *S. vernei* accessions. Large shares of the accessions with weak disease development were found within the species: *S. cardiophyllum* (14 of 25 evaluated), *S. famatinae* (3 of 3), *S. jamesii* (11 of 19), *S. megistacrolobum* (4 of 6), *S. spegazzinii* (8 of 29).

The polymorphism for resistance to *Phytophthora infestans* is present in majority of wild potatoes is also their characteristics for resistance to *H. solani*. As highly polymorphic for resistance to silver scurf the following species: *S. chacoense*, *S. fendleri*, *S. hjertingii*, *S. jamesii*, *S. kurtzianum*, *S. pinnatisectum*, *S. polytrichon* and *S. spegazzinii* were identified. The majority of wild potatoes are considered to be polymorphic for resistance to *Phytophthora infestans* (Zoteyeva, 1986, 2006). The accession distribution within the species and within the accessions by resistance levels indicates intra specific and intra population polymorphism for resistance to *H. solani* too.

MTT:n selvityksiä –sarjan kasvintuotanto -teemassa ilmestyneitä julkaisuja

2007

142 New and old pathogens of potato in changing climate. Proceedings of the EAPR Pathology Section seminar, 2.-6th of July 2007, Hattula, Finland. *Hannukkala, A. & Segerstedt, M.* (eds.) 44 s. 2007. Verkkojulkaisu 51 s. Hinta 15 euroa.

139 Sadonkorjuu. Tutkittua puutarhatuotantoa 2003-2005. *Karhu, S.* (toim.) 100 s. 2007. Hinta 25 euroa.

2006

132 Virallisten lajikekokeiden tulokset 1999-2006. *Kangas* ym. 225 s. 2006. Hinta 25 euroa.

125 Peltokasvilajikkeiden viljely- ja käyttöarvon arviointiperusteet 2006. *Kangas A. ym*. 17 s. 2006. (verkkojulkaisu: http://www.mtt.fi/mtts/pdf/mtts125.pdf).

120 Viljalajikkeiden herkkyys tautitartunnoille virallisissa lajikekokeissa 1999-2006. *Kangas,* ym. 34 s. 2006 . Hinta 15 euroa.

122 Siemenperunan High Grade -alueiden tuotannolliset ja ilmastolliset perustiedot. *Takalo, Muilu, Heikkinen, Virtanen, Joki-Tokola ja Sipilä* (toim.)26 s. 2006. Hinta 15 euroa.

123 PerunaRannikko. Perunantuotannon kehittämissuunnitelma – esiselvitys. *Markus, Virtanen, Joki-Tokola, Sipilä* (toim.) 23 s. 2006. Hinta 15 euroa.

117 Turkislanta peltolannoitteena. *Kangas A.* (toim.). 33 s. 2006. (Verkkojulkaisu: http://www.mtt.fi/mtts/pdf/mtts117.pdf).

2005

96 Viljalajikkeiden herkkyys tautitartunnoille virallisissa lajikekokeissa 1998-2005. *Kangas, A*. ym. 33 s. 2005. Hinta 15 euroa.

83 Virallisten lajikekokeiden tulokset. *Kangas, A*. ym. 193 s. 2005. Hinta 25 euroa.

Verkkojulkaisut osoitteessa http://www.mtt.fi/julkaisut/mtts.html

Agrifood Research Working papers 142

142

New and old pathogens of potato in changing climate

MTT