European cooperation in the field of scientific and technical research

# COST 817
# Population studies of airborne pathogens on cereals as a means of improving strategies for disease control
## Annual report 1995

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European Commission

# COST 817
# Population studies of airborne pathogens on cereals as a means of improving strategies for disease control
# Annual report 1995

*Edited by*

Hanne Østergård
Chairperson COST Action 817
and
Jean Pierre Masson
Scientific Secretary COST Agriculture and Biotechnology

**European Commission**

**Directorate-General for Science, Research and Development**
**DG XII-B/1**
**EEA, COST, EUREKA, International Organizations**
**COST Agriculture and Biotechnology**

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# LIST OF CONTENT

# Introduction

# INTRODUCTION

This COST Action 817 is the result of a Danish proposal [COST/202/93]. The Draft Memorandum of Understanding has beeen approved by the Committee of Senior Officials on June 1993 and the Memorandum of Understanding has been signed in Brussels on 16th of December 1993 by 6 countries: Czech Republic, Denmark, Finland, Germany, Hungary and United Kingdom.

The Memorandum of Understanding for COST 817 [COST/213/94, 25-01-1994] has validity from 16-12-93 to 15-12-98.

By the end of 1995, 7 additional countries have signed: France, Italy, Poland, Slovakia, Sweden, Switzerland and The Netherlands and further Institute of Biology, Salaspils, Latvia has been associated. Norway is expected to sign and Dept of Plant Breeding and Biometry, Cornell University, USA, is expected to be associated.

### SUMMARY OF OBJECTIVES

The project aims at improving integrated strategies for use of host resistance genes and fungicides to control pathogens spread by wind throughout Europe and thus support European agriculture in its attempt to produce healthy and high quality cereal crops at a low input and in an environmentally safe way. The emphasis is put on the major pathogens, i.e. the powdery mildews and rusts of barley and wheat.

To achieve these goals, a detailed knowledge of pathogen populations across Europe is required concerning among other things: how the fungal spores are spread; which selection forces influence the pathogen populations; how these selection forces can be changed by better strategies for the use of resistance genes and fungicides; the frequency of mutations and sexual recombination in the pathogen; how these mechanisms influence the appearance of new pathotypes and how molecular markers can be used for improving our understanding of the genetics of host plant resistance and of pathogen virulence, aggressiveness and fugicide sensitivity.

The Action concerns the major cereal pathogens in Europe, powdery mildews and rusts, and has the following objectives:

- to coordinate national surveys on virulence and fungicide resistance as well as analyses of pathogen population data;
- to compare and, where necessary, to standardize methods, e.g. assessment of virulence, aggressiveness, fungicide sensitivity and definition of DNA markers, so that results from different laboratories can be integrated;
- to coordinate definitions and national monitoring of host resistance genes;
- to improve strategies for management of host resistance genes supplemented by fungicides and coordinate national recommendations;
- to establish regular expert meetings and an information system to ensure a rapid and effective exchange of information to scientists, breeders and farmers.

## CURRENT STATUS
## Primo 1996

At the Management Committee meeting in Grignon, March 1995, H. ØSTERGÅRD (DK) was unanimously re-elected as Chairperson and J. BROWN (UK) as Vice-Chairman.

The five Working Groups were continued:

| | |
|---|---|
| Working Group 1 | "Surveys on virulence, aggressiveness and fungicide resistance" (Coordinator: R. Bayles) |
| Working Group 2 | "Variety and species mixtures to control airborne diseases of cereals" (Coordinators: M.S. Wolfe & M.R. Finckh) |
| Working Group 3 | "Cereal rust and mildew genome database" (Coordinator: H. Giese) |
| Working Group 4 | "Nomenclature of powdery mildew resistance and virulence genes" (Coordinator: M. Hovmøller) |
| Working Group 5 | "Epidemiological parameters" (Coordinator: A.J.G. Engels) |

At the MC meeting in Cambridge in December, the WG1-subgroup on fungicide sensitivity was redefined as a new working group, WG6, with F. Felsenstein and B. Nielsen as coordinators.

In summary, we have obtained the following results during the second year of the Action:

- made preparations for merging European survey data for barley powdery mildew, wheat yellow rust and wheat and barley leaf rust (WG1).
- made preparations for an Internet questionare for research related to variety and species mixtures (WG2).
- set up a database on the Internet consisting of molecular markers and virulence genes of the barley powdery mildew fungus. This database is connected to GRAINGENES, a database on cereal genomes. Further, information on resistance genes have been put into the latter database. Without success tried to get a Study Contract for paying the computer work (WG3, WG4).
- held a very successful workshop on epidemiological parameters in October 1995 in Roskilde, Denmark with 40 participants. Summary of sessions are in press in Cereal Rusts and Mildews Bulletin (WG5).
- started preparations for including another mainly airborn cereal disease induced by *Septoria tritici* into WG 1 and WG5 based on an letter of interest from several researchers in that area.
- made 6 exchanges (Short Term Scientific Missions) involving 8 countries.
- made a leaflet describing our activities.
- participated in the COST Interaction Conference in Basel with a poster presented by H. Østergård.

## MANAGEMENT

By the end of 1995, 13 countries have signed the MoU: Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Poland, Slovakia, Sweden, Switzerland, The Netherlands and United Kingdom. Further Institute of Biology, Salaspils, Latvia has been associated, Norway is expected to sign and Dept of Plant Breeding and Biometry, Cornell University, USA, is expected to be associated.

Working group meetings (WG) and management committee meetings (MC) took place in 1995 according to the table below.

| | MC | WG1 | WG2 | WG3 | WG4 | WG5 | Others |
|---|---|---|---|---|---|---|---|
| Risø, DK<br>February | | | | x | | | |
| Grignon, F<br>March | x | x | | | | | |
| Hannover, D<br>March | | | x | | | | |
| Weihenstephan, NL<br>April | | yellow<br>rust <6 | | | | | |
| Risø, DK<br>October | | fungi-<br>cides | | x | | x | workshop:<br>epidemiology |
| Cambridge, UK<br>December | x | x | | | x | | |

**PLANS for future meetings**

| | MC | WG1 | WG2 | WG3 | (WG4) | WG5 | WG6 | Others |
|---|---|---|---|---|---|---|---|---|
| Radzikov/Bakov, PL<br>June 96 | | | x | | | | | |
| Weihenstephan, D<br>summer | | | | | | | <6 | |
| Wageningen, NL<br>September 96 | x | x | | | | x | | workshop:<br>general rusts and mil-<br>dews |
| autumn 96 | | | | <6 | | | | |
| spring 97 | x | | | | | | | workshop:<br>e.g. partial resistance |

# COST Action 817 - Participating Institutes Primo 1996

| Address of institute | Phone<br>Fax | Name of scientist (E-mail)<br>* : Member of Management Committee<br>underlined: institute contact person | Research topics - keywords | Working groups |
|---|---|---|---|---|
| **CZECH REPUBLIC** | | | | |
| Agricultural Research Institute<br>P.O. Box 55<br>Havlíkova 2787<br>CZ-767 01 Kromeríz | 42 634426139<br>42 63422725 | *Antonin Dreiseitl<br>Karel Klem | | WG1, WG2, WG3, WG4, WG5, WG6 |
| Laboratory of Disease Resistance Genetics<br>Research Institute of Crop Production<br>Drnovska 507<br>CZ-161 06 Praha-Ruzyne | 42 360851<br>42 2365228 | *Pavel Bartos<br>J. Sebesta<br>Renata Hanusová<br>Lubomir Vechet<br>(Eva Stuchlíková) | Stem rust | WG1 (WG3)<br>WG5<br>(WG1) |
| **DENMARK** | | | | |
| Danish Institute for Plant and Soil Science<br>Dept Plant Pathology and Pest Management<br>Lottenborgvej 2<br>DK-2800 Lyngby | 45 45872510<br>45 45887707 | *Mogens Hovmøller<br>Bent Nielsen<br>Bo Secher<br>Birgitte Boesen | Virulence dynamics (experimental and modeling) host resistance evaluation Mildew fungicide resistance, seed pathology, fungicide efficasy, disease control strategies, decision support systems for disease control, weather-epidemiology relationship, mildew resistance genes, disease assessment | WG1, WG3<br>WG4, WG5, WG6 |
| Risø National Laboratory<br>Dept Environmental Science and Technology<br>P.O. Box 49<br>DK-4000 Roskilde | 45 46774110<br>45 46323383 | *Hanne Østergård (hanne.ostergard@risoe.dk)<br>Michael Lyngkjær<br>Jørgen Helms Jørgensen<br>Henriette Giese | barley powdery mildew, virulence, epidemiology, fitness, models, fungicide sensitivity, molecular markers, resistance (especially Mlo) | WG1, WG2, WG3, WG4, WG5 |
| Danmarks Miljøundersøgelser<br>Vejlesøvej 25<br>8600 Silkeborg | 45 89201400<br>45 89201413 | Christian Damgaard | | WG1, WG5 |
| Institute of Plant Biology<br>The Royal Veterinary and Agricultural University<br>Thorvaldsensvej 40<br>DK-1871 Frederiksberg C | 45 35283316<br>45 35283310 | Lisa Munk | | WG1, WG2, WG5 |
| **FINLAND** | | | | |
| Agricultural Research Centre<br>Department of Plant Protection<br>FIN-31600 Jokioinen | 358 1641881<br>358 164188584 | *Marja Jalli<br>Jorma Kurtto<br>Jonathan Robinson | Resistance breeding of cereals, virulence survey fungicides, resistance breeding of cereals | WG1 |
| **FRANCE** | | | | |
| SRPV<br>Laboratoire de Résistance<br>23 rue de Cusembourg<br>F-45403 Fleury les Auli | 33 33221111 | *Francoise Godet | Fungicide resistance of powdery mildew | WG1, WG6 |

| Address of institute | Phone<br>Fax | Name of scientist (E-mail)<br>* : Member of Management Committee<br>underlined: institute contact person | Research topics - keywords | Working groups |
|---|---|---|---|---|
| **FRANCE** | | | | |
| INRA<br>Laboratoire de pathologie Végétale<br>F-78850 Thiverval-Grignon | 33 130815435<br>33 130815306 | *Claude Pope de Vallavielle<br>Christian Lannou<br>Ivan Sache<br>Vallerie Caffier<br>Henriette Goyeau | Yellow rust and leaf rust of wheat, powdery mildew of barley, varietal mixtures, induced resistance, monocyclic parameters, virulence survey, genetics of resistance, genetics of avirulence, spatio. temporal models, comparative epidemiology | WG1, WG2, WG5 |
| INRA Amélioration des Plantes<br>Domaine de la Motte<br>B.P. 29<br>F-35650 Le Rheu | 33 99285100<br>33 99285120 | F. Dedryver-Pearson | | WG1, WG6 |
| **GERMANY** | | | | |
| Technische Universität München<br>Institute of Agronomy and Plant Protection<br>Weihenstephan<br>D-85350 Freising | 49 8161713562<br>49 8161744511 | *Friedrich G. Felsenstein<br>A Jahoor<br>F. Ernst | Analysis in virulence, fungicide sensitivity, resistance genes, molecular work | WG1, WG3, WG4, WG5 |
| Fed Centre of Breeding Res. on Cultivated Plants<br>Institute of Epidemiology and Resistance<br>Theodor-Roemer-Weg 4<br>D-06449 Aschersleben | 49 34738790<br>or 879122<br>49 34732709 | Ursula Walther<br>Edgar Schliephake | Race survey, leaf rust barley/wheat, leaf rust database | WG1<br>WG3 |
| Biometrie and Population Genetics<br>Ludwigstr. 27<br>D-35390 Giessen | | Jörn Pons | Fungicide sensitivity | WG1, WG5, WG6 |
| Fed. Biol. Res. Centre for Agric. and Forestry<br>Institute for Integrated Plant Production<br>Stahnsdorfer Damm 81<br>D-14532 Kleinmachnow | 49 033203/<br>48324<br>49 033203/<br>48425 | Marga Jahn | Fungicides - flexible, situation-related doses, mildew, winter wheat | WG1, WG5, WG6 |
| Institut für Pflanzenschutz in Ackerbau und Grünland / Außenstelle Kleinmachnow<br>Stahnsdorfer Damm 81<br>D-14532 Kleinmachnow | 49 3320322423<br>49 3320322278 | *K. Flath | | WG1 |
| **HUNGARY** | | | | |
| Hungarian Academy of Sciences<br>Plant Protection Institute<br>P.O. Box 102<br>H-1525 Budapest | 36 11558722<br>36 11563698 | *Klara Manninger | | WG1 |
| Hungarian Academy of Science<br>Agricultural Research Institute<br>P.O. Box 102<br>H-1525 Budapest | 36 22460016 | László Szunics | Wheat powdery mildew and rust | WG1 |

| Address of institute | Phone<br>Fax | Name of scientist (E-mail)<br>* : Member of Management Committee<br>underlined: institute contact person | Research topics - keywords | Working groups |
|---|---|---|---|---|
| **HUNGARY** | | | | |
| Cereal Research Institute<br>Box 391<br>H-6701 Szeged | 36 62435235<br>36 62434163 | *Akos Mesterhazy | | WG1 |
| **ITALY** | | | | |
| Department of Plant Protection<br>Via Arendola 165/A<br>I-70126 Bari | 39 805443049 | *Casulli Fedele | Leaf rust, epidemiology, host resistance | WG1, WG2, WG3, WG4, WG5 |
| Instituto di Produzioni e Preparazioni Alimentari<br>Via Napoli no. 25<br>I-71100 Foggia | 39 881740211 | *Claudio Ciccarone | | |
| **LATVIA** | | | | |
| Plant Genetics Laboratory<br>Inst. Biology<br>3 Miera Str.<br>LV-2169 Salsapils | 371 2945435<br>371 9345412 | *Isaak Rashal<br>Rita Tuezyapina | Barley mildew, genetics, virulence survey | WG1, WG3, WG4, WG5 |
| **THE NETHERLANDS** | | | | |
| DLO - Research Institute for Plant Protection<br>Binnenhaven 12<br>P.O. Box 9060<br>NL-6700 GW Wageningen | 31 317476161<br>31 317410113 | *Cor H. van Silfhout<br>Gert Kema | | WG1 |
| Wageningen Agricultural University<br>Department of Phytopathology<br>P.O. Box 8015<br>NL-6700 EE Wageningen | 31 317483121<br>31 317483412 | *Tonnie J.G. Engels | Fungicide sensitivity | WG1, WG5, WG6 |
| **NORWAY** | | | | |
| Agricultural University of Norway<br>Department of Horticulture and Crop Sciences<br>P.O. Box 5022<br>N-1432 Ås | 47 64947800<br>47 64947802 | *Helge Skinnes (helge.skinnes@ipf.nlh.no) | Resistance breeding of cereals | WG1 |
| **POLAND** | | | | |
| Plant Breeding and Acclimatization Institute<br>(IHAR) - Radzików<br>PL-05-870 Blonie near Warsaw | 48 227254536<br>48 227254714 | *Henryk J. Czembor | Cultivar mixtures, species mixtures | WG1, WG2 |
| Cearal Department of the IHAR<br>PL-30-423 Kraków | 48 12665700 | Anna Strzembica<br>Maria Mazaraki | Powdery mildew of wheat, rusts of wheat and barley, cultivar mixtures | WG1, WG2 |
| Experimental Plant Breeding Station<br>of the IHAR -Baków<br>PL-46-233 Baków near Kluczbork | 48 77148793<br>48 77148795 | *Edward Gacek<br>Jadwiga Nadziak<br>Zdzislaw Bilinski | Powdery mildew of barley, cultivar mixtures, species mixtures | WG1, WG2, WG4, WG5 |

| Address of institute | Phone<br>Fax | Name of scientist (E-mail)<br>* : Member of Management Committee<br>underlined: institute contact person | Research topics - keywords | Working groups |
|---|---|---|---|---|
| SLOVAK REPUBLIC | | | | |
| Research Institute of Plant Production<br>Bratislavská 122<br>CS-921 68 Piestany | 42 83822311<br>42 83826306 | *Jozef Huszár | Powdery mildew and rust of wheat | WG1 |
| Dept Genetics / Faculty of Natural Sciences<br>Mlymska Dolina B-1<br>CS-842 15 Bratislava | 42 7 ...<br>42 7729064 | *Milan Sykora | | WG1 |
| SWEDEN | | | | |
| Swedish University of Agricultural Sciences<br>Department of Plant Protection Sciences<br>Section of mycology and virology<br>Box 44<br>S-230 53 Alnarp | 46 40415000<br>46 40462166 | *Lars Wiik | | WG1, WG2 |
| SWITZERLAND | | | | |
| Cereal Breeding<br>Swiss Federal Research Station for Agronomy<br>Reckenholzstrasse 191<br>CH-8046 Zürich-Reckenholz | 41 13777375<br>41 13777201 | *Michael Winzeler | | WG1, WG2, WG4 |
| Plant Pathology<br>ETH-Zentrum / LFW<br>CH-8092 Zürich | 41 16321111<br>41 12529613 | Martin Wolfe<br>*Eckhart Limpert<br>Maria Finck<br>Jannie Atsema<br>Urs Brändle | | WG1, WG2, WG3, WG4, WG5, WG6 |
| UNITED KINGDOM | | | | |
| National Inst. Agricultural Botany<br>Huntingdon Road<br>Cambridge CB3 0LE<br>United Kingdom | 44 1223276381<br>44 1222277602 | *Rosemary Bayles<br>John Clarkson<br>Sue Slater | Yellow rust, mildew, virulence, fungicide resistance, cultivar evaluation | WG1 |
| Scottish Crop Research Institute<br>Invergowrie<br>Dundee DD2 5DA<br>Scotland<br>United Kingdom | 44 1382562731<br>44 1382562426 | Adrian Newton<br>George Golewnenski | Mixtures epidemiology | WG2, WG5 |
| John Innes Centre<br>Cereals Research Department<br>Norwich NR4 7UH<br>United Kingdom | 44 1603452571<br>44 1603502241 | *James Brown<br>Lesley Boyd<br>Bob O'Hara | Mildew, brown rust, yellow rust, pathogen genetics, host resistance genetics, molecular genetics, fungicide responses | WG1, WG3, WG5 |

| Address of institute | Phone<br>Fax | Name of scientist (E-mail)<br>* : Member of Management Committee<br>underlined: institute contact person | Research topics - keywords | Working groups |
|---|---|---|---|---|
| UNITED KINGDOM | | | | |
| AFRC Inst. Grassland and Environmental Res.<br>Welsh Plant Breeding Station<br>Plas Gogerddan, Aberystwyth<br>Dyfed SY23 3EB<br>United Kingdom | 44 970828255<br>44 970828357 | Brian Clifford | | WG1 |
| Plant Pathology Research Division<br>Department of Agriculture North Ireland<br>Newforge Lane<br>Belfast BT9 5PX<br>United Kingdom | 44 232661166<br>44 232668375 | Peter C. Mercer | | WG1 |
| USA | | | | |
| Department of Plant Breeding and Biometry<br>Cornell University<br>Ithaca, NY 14853<br>USA | 1 6072559951 | David E. Mathews<br>matthews@greengenes.cit.cornell.edu | | WG3 |

# Minutes of Management Committee Meetings

EUROPEAN COMMISSION
DIRECTORATE GENERAL XII
SCIENCE, RESEARCH AND DEVELOPMENT / JOINT RESEARCH CENTRE
Direction B : R&TD : Cooperation with non member countries and international organizations
Unit XII-B-1 : European Economic Area, COST, EUREKA, international organizations

Brussels, 8 May, 1995
JPM/ASP/817/95-MC4

# COST 817

# POPULATION STUDIES OF AIRBORNE PATHOGENS ON CEREALS AS A MEANS OF IMPROVING STRATEGIES FOR DISEASE CONTROL

## MINUTES OF THE FOURTH MANAGEMENT COMMITTEE MEETING HELD IN THIVERVAL-GRIGNON (PARIS), FRANCE (F) ON SATURDAY, 1ST APRIL, 1995

COMMISSION
EUROPEENNE

DIRECTION GENERALE DE LA SCIENCE,
RECHERCHE ET DEVELOPPEMENT

CENTRE COMMUN DE RECHERCHE

DG XII/B/1
Actions RDT : Espace Economique Européen,
COST, EUREKA, Organisations Internationales

# COST 817

# POPULATION STUDIES OF AIRBORNE PATHOGENS ON CEREALS AS A MEANS OF IMPROVING STRATEGIES FOR DISEASE CONTROL

## MANAGEMENT COMMITTEE MEETING

held in Thiverval-Grignon (Paris) / France
on Saturday, 1st April, 1995

## DRAFT AGENDA

1. Approval of the agenda
2. Approval of the minutes of 2nd and 3rd Management Committee Meeting
3. Status of the member countries and institutes
4. Evaluation of the work in Working Groups
5. Status for Study contracts and training course
6. Discussion of representation at the Interaction Conference in Basel in October.
7. Approval of applications for Short Term Scientific Missions
8. Discussion of reimbursement procedure
9. Discussion of budget 1995/1996 and account for 1994
10. Election of the Chairperson and Vice-Chairperson
11. Any other business.
12. Dates and places of the next meetings

H. Ostergard, Chairperson of COST Action 817, opened the meeting and welcomed the participants (see Annex I - List of Participants).

1. Approval of the draft agenda

The draft agenda was approved.

2. Approval of the Minutes of the Second and Third Management Committee Meeting

The minutes of the Second and Third Management Committee Meeting (respectively held in Szeged (H) - 21.09.1994 and in Zürich (CH) - 09.11.1994) were approved.

3. Status of the member countries and institutes

13 countries actively participated to the COST Action 817 : Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Poland, Slovakia, Sweden, Switzerland, The Netherlands and United Kingdom.

As far as non-COST Institutes are concerned, it was decided to focus on the participation of institutions already in connection with scientists involved in COST Action 817 network - Bielorussia, Latvia, Ukraina and Israël.

This point will be discussed at the next Management Committee Meeting foreseen to be held in December 1995.

4. Evaluation of the work in Working Groups

The minutes of Working Group meetings - W.G. 3 on "Cereal rust and mildew genome database" held in Roskilde (DK) (28.02.95-02.03.95) and W.G. 2 on "Variety and species mixtures to control airborne diseases of cereals" held in Hannover (D) (17.03.95) - can be found in Annex II.

4.1. Working Group 1 - Surveys on virulence, aggressiveness and fungicide resistance in Europe (coordinator : F.G. FELSENSTEIN)

The following subjects were presented :

- the questionnaire has been quite successful and a lot of information on teams involved in W.G. 1 is now available.

- the standardization of methods and techniques has improved

- Rosemary Bayles will be coordinator for the next period and will take in charge the organisation of the next Working Group Meeting (Cambridge (UK) - December 1995).

4.2. Working Group 2 - Variety and species mixtures to control airborne diseases of cereals (coordinator : M. WOLFE and M. FINCKH)

A summary of the minutes of the last Working Group Meeting was distributed (Annex IIb).

The next Working Group meeting is foreseen to be held in Poland (near Warsaw) in June 1996.

J. Brown strongly supported the idea of bringing together pratical and theoretical aspects and recommended to facilitate meetings among pathologists and mathematical modelers.

It was suggested to send a questionnaire focused on "Cereal airborne pathogens" to the Management Committee Members (like in WG 1) in order to let them circulate the information in their own country.

4.3. Working Group 3 - Cereal rust and mildew genome database (coordinator : Henriette GIESE)

A subgroup of experts met in Roskilde (DK) at the end of February 1995 (the minutes of this meeting can be found in Annex IIa).

A copy of the "Graingene database" - provided by D. Matthews (Cornell University - USA), will soon be available in Riso.

- This database - mainly concerned with the "Genetic research on cereals" - will be be a model and will help to achieve a database more particularly oriented towards "Cereal rust and mildew genomes".

  It was recommended to strenghten the existing links among the scientists of Working Group 1 and 3.

4.4. Working Group 4 - Nomenclature and distribution of cereal mildew and rust resistances (coordinators : J. Helms JORGENSEN and A.G. MITCHELL)

The question of maintenance arose. More than 25 scientists got involved in this Working Group also linked with Working Group 3 and Working Group 1.

This question will be discussed at the next Management Committee Meeting foreseen to be held in Cambridge (UK) in December 1995.

4.5. Working Group 5 - Epidemiology parameters (coordinator : T. ENGELS)

This Working Group met in Kappel am Albis (CH) at the beginning of November 1994. Its next meeting should take place in Roskilde (DK) in October 1995 in conjunction with a Workshop and a meeting of Working Group 3.

The local organizer will be H. Ostergard. A list of Invited Speakers should be set up.

E. Limpert intervened and spoke about the Workshop held in Kappel am Albis (CH) last November.

He explained that a book - gathering 15 contributions plus an additional one from Spain - would be published by Kluwer Academic Publishers by the end of 1995 only, as some financial problems still subsist (among which the distribution of the issue).

(See Annex III : Summary - Annual report 1994)

5. Status for Study contracts and training course

* At its last Meeting held in Kappel am Albis (near Zürich) (CH) on 9 November, 1994, the Management Committee decided to introduce a "Study Contract" in order to examine the "Feasability of a database" on two synergic parts preliminary entitled "Mildew database" and "Barley resistance".

The draft technical annex for a study contract on "Development of a fast communication system for data on research on cereal pathogenic fungi and resistance genes" has been prepared by a group of experts coordinated by H. Giese.

The Management Committee Meeting,

- considering that the results expected could only be obtained by those who had already been involved in it;

- considering that the database expected would not be a commercial system;

- considering that the database would be shared by all COST countries involved in COST 817;

decided thus to request the Scientific Secretary, Jean-Pierre Masson, the introduction of a Study Contract covering the consultant and programming assistance costs.

Consultancy and programming work will be given by the Riso National Laboratory (DK) which seems to be the most appropriate place to achieve the job for a total amount of 12.000 Ecu.

* The preliminary draft of a COST 817 Training Course on "Genetic Structure of populations of powdery mildew and rust on cereals" was presented (see in Annex IV); a maximum of 25 participants is expected to attend this meeting.

After some discussion it was decided :

  - to focus and concentrate the Training Course on the goals of the COST Action 817;

  - to open the Training Course to scientists coming from the COST network especially the students and young post-doc.

It was also told that the financement of this Training Course might be done - for example - through a grant from the "Training and Mobility of Researchers" (TMR) Programme.

## 6. Discussion of representation a the Interaction Conference in Basel in October 1995

The Second Announcement of the Interaction COST Conference foreseen to be held in Basel (CH) on 9-11 October 1995 would soon be issued. The draft program can be found in Annex V.

Despite the fact that COST Action 817 was a rather young Action (C. Van Silfhout), it was nevertherless decided that H. Ostergard, Chairperson of this Action, would participate at that meeting and present a poster describing the activities of this COST Action 817.

## 7. Approval of applications for Short Term Scientific Missions

A table summarizing the situation is attached in Annex VI.

The six new applications for Short Term Scientific Missions received by the Chairperson before the deadline (20.03.1995) and examined by H. Ostergard, J. Brown and the most appropriate Working Group Coordinator were presented :

F. Felsenstein :

| | |
|---|---|
| J. ATZEMA | from Zürich (CH) to Roskilde (DK) |
| E. LIMPERT | from Zürich (CH) to Praha (CZ) |
| M. CSOSZ | from Szeged (H) to Praha (CZ) |
| K. KLEM | from Kromeriz (CZ) to Weihenstephan (D) |
| J. PROCHNOW | from Asherleben (D) to Aberystwyth and Norwich (UK) |

T. Engels :

| | |
|---|---|
| I. SACHE | from Grignon (F) to Rothamsted (UK) |

The delegates unanimously agreed on this applications.

Nevertherless, as requested by J. Brown, the future applications will have to provide more information (what ?, why ?, why there ?) and clearly precise the relations between

> the Short Term Scientific Mission and the scientific work of the applicant on the one hand

and

> the Short Term Scientific Mission and the COST 817 programme on the other hand.

In the same way the report of the applicant after the Short Term Scientific Mission will have to state more precisely the results obtained in relation with the scientific works and the COST programme.

The delegates to the Management Committee of this COST Action 817 considered that Short Term Scientific Missions had been extremely useful during this first year and unanimously requested its renewing.

Taking into account the interest expressed by National Delegates, the Management Committee decided thus to recommend the Institute

Risø National Laboratory
Environmental Science and
Technology Department
Plant Biology Section
Dr. H. Ostergård
P.O. Box 49
DK - 4000 Roskilde
Denmark

Tel. +45-46-77 41 10
Fax +45-46-32 33 83

as the most suitable Institute to administer this operation taking into consideration available administration facilities and infrastructure and its willingness to undertake the tasks.

The deadline for new applications is September 15th, 1995.

As discussed by J. Brown and H. Ostergard, the Short Term Scientific Mission should concentrate on the promotion of new experiences and the mobility of young researchers as well as the discussion on data and the way to handle them.

See "COST Short Term Scientific Mission : guide and application forms" enclosed in Annex VII.

## 8. Discussion of reimbursement procedure

As far as the reimbursement of travel expenses and daily allowance are concerned, National Delegates from the European Union as well as those from Norway and Iceland will be taken charge by the COST secretariat of the Commission in Brussels.

## 9. Discussion of budget 1995 / 1996 and account for 1994

While a total of 51.000 Ecu had been forecast for 1994, some 72.891 Ecu were spent in the frame of COST Action 817 :

| | |
|---|---|
| Support for Workshop | 8.990 Ecu |
| Short Term Scientific Missions | 11.500 Ecu |
| Management Committee Meetings | 36.154 Ecu |
| Experts, Invited Speakers, Working Groups | 16.247 Ecu |

A budget amounting 70.000 Ecu has been set up for 1995.

J.P. Masson should plan the budget for 1996 in a similar way.

## 10. Election of the Chairperson and Vice-Chairperson

H. Ostergard was unanimously re-elected (second year) as Chairperson and J.Brown as Vice-Chairman.

## 11. Any other business

The minutes of the "Mixtures" Working Group are attached in Annex IIb. It was reminded, at this occasion, that the information must be spread by the National Delegates in their own country.

## 12. Dates and places of the next meetings

A small Expert Group is expected to meet in Weihenstephan (D) on 28th April 1995 in order to learn a new technique.

As already planned, a Workshop on "Methods and models in epidemiology" will be held in Riso - Roskilde (DK) on 16-20 October 1995 in conjunction with Working Group Meetings - WG 3 on "Cereal rust and mildew genome database" and WG 5 on "Epidemiology parameters".

A meeting of the subgroup on "Fungicide resistance" is also planned to take place at the same institute on Wednesday 18th October 1995.

As foreseen, Working Group 1 "Surveys on virulence, aggressiveness and fungicide in Europe" and Working Group 4 "Nomenclature and distributin of cereal mildew and rust resistances" should meet in Cambridge on 11-12 December 1995 in conjunction with a Management Committee Meeting.

A tentative programme for 1996 is attached in Annex VIII.

* * * * * * * * * *

H. Ostergard thanked the delegates for their participation and closed the meeting at 1.00 pm.

Jean-Pierre MASSON
Seconded National Expert
COST Agriculture-Biotechnology

# LIST OF ANNEXES

EUROPEAN COMMISSION
DIRECTORATE GENERAL XII
SCIENCE, RESEARCH AND DEVELOPMENT
Direction B : RDT, Cooperation with non member countries and International Organizations
Unit XII-B-1 : European Economic Area, COST, EUREKA, International Organizations

Brussels, 13 June 1996
JPM/fs/817/96-MC5

# COST 817

# POPULATION STUDIES OF AIRBORNE PATHOGENS ON CEREALS AS A MEANS OF IMPROVING STRATEGIES FOR DISEASE CONTROL

## MINUTES OF THE FIFTH MANAGEMENT COMMITTEE MEETING

## HELD IN MAGDELENA COLLEGE, CAMBRIDGE (UK)

## ON 12 DECEMBER 1995

EUROPEAN COMMISSION
DIRECTORATE GENERAL XII
SCIENCE, RESEARCH AND DEVELOPMENT
Direction B : RDT, Cooperation with non member countries and International Organizations
Unit XII-B-1 : European Economic Area, COST, EUREKA, International Organizations

# AGENDA FOR MC-MEETING AT

# MAGDELENA COLLEGE, CAMBRIDGE, UK

# on 12 DECEMBER 1995 FROM 14.00 TO 18.00

1. Approval of the agenda

2. Approval of the minutes of the 4th Management Committee Meeting

3. Status of member countries and institutes

3 a. Summary of Interaction Conference & Technical Committee Meeting

4. Evaluation of the work in Working Groups (cf. Minutes of meetings in subgroups of WG1, in WG3 and in WG5 to be forwarded). Coordinators will be invited to present the results

4 a. Workshops

5. General discussion of management of the Action:.Are the present working groups appropriate ?
A group/subgroup on Septoria tritici has been suggested. Further information will be forwarded.

6. Status for Study Contracts on database and for Training Course

6 a. E-mail Bulletin Board = rust-mil

7. Status for Short Term Scientific Missions

8. Discussion on budget 1996 and expected account for 1995

9. Any other business

H. ØSTERGÅRD, Chairperson of COST Action 817, opened the meeting and welcomed the participants (see Annex I - List of Participants).

## 1. APPROVAL OF THE DRAFT AGENDA

It was proposed by the chair to add the following topics :

3 a. Summary of the COST Interaction Conference (Basel 9-11/10/1995) and of the COST Technical Committee in Agriculture & Biotechnology (Basel 12/10/1995).

4 a. Workshops

6 a. E-mail Bulletin Board = rust-mil

The completed agenda was approved.

## 2. APPROVAL OF THE MINUTES OF THE FOURTH MANAGEMENT COMMITTEE MEETING

The minutes of the Fourth Management Committee Meeting - held in Thiverval-Grignon (F) on Saturday 1 April 1995 - were approved.

## 3. STATUS OF THE MEMBER COUNTRIES AND INSTITUTES

14 countries actively participated to the COST Action 817 : Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Norway, Poland, Slovakia, Sweden, Switzerland, The Netherlands and United Kingdom.

Norway is to sign the Memorandum of Understanding beginning of 1996 ; the delegates will be Dr Helge SKINNES and Dr Magne GULLORD.

The Italian delegates are :
1. Prof. Antonio CANOVA (Bologna)
2. Prof. Fedele CASULLI (Bari)

**As far as non-COST Institutes are concerned.**

1. The participation of the Institute of Agriculture and Animal Husbandry of Western Region of Ukraine (Prof. V. VELECHKO) was already approved by the COST Senior Officials Committee of 7-8/12/95 (see Annex II.1).

2. The Management Committee of COST 817 requested the participation of the Cornell University (Department of Plant Breeding and Biometry) (Dr D.E. MATTHEWS) (USA) (see Annex II.2).

3. F. CASULLI pointed out the mutual benefit from a collaboration with the Plant protection Institute in Durres (Dr Fadil GJATA) (Albania).

4. It was already shown in the previous Management Committee meetings to extend collaboration to :

   - the Institute of Biology of Latvian Academy of Sciences ;
   - the Bielorussian SRI of Arable Farming and Fodder ;
   - some institutions in Israel.

5. A collaboration with an institute in Saint-Petersburg (Russia) was foreseen.

From a general point of view the Management Committee agreed to extend the network - as much as possible - in Europe ; it will be very useful at least for the "survey" part of COST Action 817.

3a. Summary of the COST Interaction Conference (Basel, 9-11/10/1995) and of the <u>COST Technical Committee in Agriculture & Biotechnology (Basel 12/10/1995)</u>

A summary of the COST Interaction Conference - as it can be found in Cordis COST - is attached in Annex III. Contact has been taken during the conference with scientists working in the field of :

- Agrometeorology

  + COST 77 Application of remote sensing in agrometeorology
  + COST 79 Integration of data and methods in agroclimatology
  + COST 711 Operational applications of meteorology to agriculture, including horticulture.

- COST 816 : **Biological control of weeds in Europe**

  A joint workshop 816-817 was viewed.

- COST 821 : **Arbuscular mycorrhizas in sustainable soil-plan systems.**

  H. ØSTERGÅRD had a deep discussion with S. GIANINAZZI, Chairman of COST 821 and Chairman of the COST Technical Committee in Agriculture & Biotechnology.

A poster on COST 817 was presented.

- During the meeting of the COST Technical Committee in Agriculture and Biotechnology, the following COST Actions (abbreviated title) were presented by their chairman :

  - COST 811 Warble Fly
  - COST 817 Airborne Cereal Pathogens
  - COST 823 Phytodiagnosis
  - COST 818 Hydrogenases
  - COST 814 Crops for Cold Wet Agriculture
  - COST 824 Gametic Embryogenesis

H. ØSTERGÅRD gave a presentation of COST 817 which was summarized by M. PARKER, Vice-Chairman of the technical Committee, in the Minutes of the Technical Committee.

This summary and the list of the members of the Technical Committee are attached (see Annex IV).

## 4. <u>EVALUATION OF THE WORK IN WORKING GROUPS</u>

The Annual Report 1994 was published and spread out by post a week before the present Management Committee and a few copies were circulated during the meeting.

The Annual Report 1995 will present aims, results and plans of COST Actions 817; in order to prepare it, all network correspondence and reports had to be sent to H. ØSTERGÅRD before end of February 1996.

As suggested by C. VAN SILFHOUT, fresh news can be published in the Rust and Powdery Mildew Bulletin.

### 4.1 Working Group 1 : Surveys on Virulence, Aggressiveness and <u>Fungicide Resistance in Europe. (Coordinator : R. BAYLES)</u>

R. BAYLES reported on the Cambridge (Magdelena College) WG1 Meeting (11-12 December 1995).

The minutes of :

- the Fungicide Sensitivity Subgroup Meeting, held in Lyngby (DK) on 18/10/95,

- the Virulence and Fungicide Sensitivity Survey Group,
  the Fungicide Sensitivity Survey Subgroup,
  the Wheat and Barley Leaf Rust Subgroup,
  the Yellow Rust of Wheat Subgroup and
  the Barley Mildew Subgroup,

held in Thiverval-Grignon (F) on 30 and 31 March 1995 are attached in Annex V.

As it was pointed out by F. FESELSTEIN, a relevant comparison of results in fungicide sensitivity needed to harmonize the standard sensitive isolates and to proceed to ring tests. The links with chemical industry were considered being essential. But, as the integrated control had to be considered as a whole, the scientists working on those topics had to be independent.

## 4.2 Working Group 2 : Variety and Species Mixtures to control Airborne Disease of Cereals. (Coordinator is M. WOLFE and M. FINCKH)

M. FINCKH reported on the Working Group meeting held in Hannover (Germany) on 17 March 1995. It was proposed to produce a comprehensive information resource base through the worldwide web - but also hard copies are available on request.

It was foreseen to hold the next Working Group Meeting in Radzikov and in Bakow (Poland) on 1 and 2 July 1996 with participants coming from Danemark, France, Sweden and United Kingdom.

## 4.3 Working Group 3 : Cereal Rust and Mildew Genome Database (Coordinator : H. GIES)

J. BROWN, Vice-Chairman, reported the work already done in RISØ (28/03/1995 to 02/03/1995 and 18/10/1995) and in Magdelena College (11-12/12/1995) on the development of a fast commu-nication system for data on the research on cereal pathogenic fungi and cereal resistance genes. The minutes of the RISØ Meeting are attached in Annex V.

The Graingenes database (National Agriculture Library, USA) was used as an example and Dr D. MATTHEWS from the Cornell University (USA) (Department of Plant Breeding and Biometry) was bringing his expertise.

Graingenes and the new European database "Pathogenes" can be used through Internet. "Pathogenes" will contain : reports, genes, pictures, genotypes, phenotypes of isolates, frequencies of virulence (combinations of virulence, etc...). It was decided to share the work into three parts :

- Pathogen genetics : leaded by H. GRIESE
- Varieties : leaded by J. BROWN
- Population : leaded by U. BRÄNDLE

### 4.4 Working Group 4 : Nomenclature and Distribution of Cereal Mildew and Rust Resistances. (Coordinator : M. HOVMOLLER)

The first year activity report of WG 4 can be found in the COST 817 Annual Report 1994. As told by M. HOVMOLLER, goals have been achieved and no new goal foreseen for the future.

It was suggested by H. ØSTERGÅRD to close this working group if necessary at the next Management Committee. J. BROWN did not see any valuable reason to leave this working group open.

Therefore, it was decided to redefine a working group on "Partial Resistance" at the next Management Committee Meeting and C. VAN SILFHOUT agreed to prepare a background paper presenting the new aim of such a working group before the next Management Committee Meeting.

### 4.5 Working Group 5 : Epidemiology parameters. (Coordinator : T. ENGLES)

T. ENGELS reported on the last Working Group Meeting in Roskilde (DK) (18-20/10/1995).

The minutes are attached in Annex V. More than 25 scientists were participating and M. JEGER (NL) and K. LEONARD (USA) will have their speech published in the "Rust and Powdery Mildew Bulletin". It was expected to share the work into 3 subject groups :

- Mlo,
- fitness parameters,
- dispersal.

It was decided that C. POPE-DE VALLAVIELLE would be the coordinator of Working Group 5 and that :

- the Mlo Subject Group would be chaired by M.F. LYNGKJAER (DK)
- the Fitness Parameters Subject Group would be chaired by C. DAMGAARD (DK)
- the Dispersal Subject Group would be chaired by I. SACHE (F)

22 members had filled in the questionnaire prepared by T. ENGELS and the next Working Group 5 Meeting was planned to be held in Wageningen on Sunday 1 September 1996 in the afternoon.

## 4a Workshops

Since the beginning of COST Action 817, two workshops had already been held in :

- Kappel-am-Albis (Switzerland) - November 1994 - on "Integrated Control of Cereals Mildews across Europe". The proceedings will be published by the European Commission. A list of addresses will be provided by E. LIMPERT and others in the next future.

- RISØ (Denmark) - October 1995 on Epidemiological parameters and associated Working Group Meetings.

For 1996, it was foreseen to plan WG 1, WG 5 and Management Committee Meetings (1-2/09/1996) just before the 9th Cereal Rusts and Powdery Mildew Conference - Wageningen (NL).

For 1997, it was suggested to focus a workshop on "Partial Resistance" and any way to come to the next Management Committee Meeting with additional ideas.

## 5. GENERAL DISCUSSION ABOUT THE MANAGEMENT OF THE ACTION

WG 1 : The next meeting was planned on Monday 02/09/1996. R. BAYLES was in charge of the coordination until the Magdalena College Meeting. Ursula WALTER accepted to do the coordination with the help of other colleagues until September 1996.

WG 4 : This working group had no coordinator.

WG 5 : C. POPE DE VALLAVIEILLE will replace T. ENGELS, coordinator of this working group.

At the beginning, it was proposed to create a WG 6 on "Fungicide". Subsequently, it was suggested to create a group, or a subgroup, on Septoria tritici with basic studies on mechanisms working partly in WG 1 and partly in WG 5. A list of people who are interested in had to be transmitted to H. ØSTERGÅRD.

J. BROWN proposed to circulate the information and to use a written procedure. Finally M. WOLFE agreed for the inclusion of this Septoria Tritici subgroup as a subgroup of the Working Group 1.

## 6. STATUS FOR STUDY CONTRACT ON DATABASE AND FOR TRAINING COURSE

- It was decided to encourage all scientists in COST 817 to use Internet and to envisage to create a homepage.

- Concerning the Training Course on "Genetic Structure of Populations of Powdery Mildew and Rust on Cereals", it was envisaged :

  - to present a "Training and Mobility Research" project (next deadline 01.03.1996) (Lisa Munk)
  - to organize a workshop on " Population Genetics" (J. BROWN) or perhaps
  - to organize a workshop with some additional lecture "like a Training Course" on some specific advanced techniques.

## 7. STATUS FOR SHORT TERM SCIENTIFIC MISSIONS

The COST 817 Management Committee has considered the Short Term Scientific Missions carried out during the first and a half year life of this COST Action had been extremely useful and the renewal of it has been requested.

After open discussion and taking into account the interest expressed by National Delegates within the Action, the Management Committee decided to recommend the Institute :

Risø National Laboratory
Environmental Science and Technology Department
Plant Biology Section
Dr H. Østergård
P.O. Box 49, Bldg 330
DK-4000 Roskilde
Denmark
Tel. : + 45 - 46 / 77 41 10
Fax : + 45 - 46 / 32 33 83

as the most suitable Institute to administer this operation taking into consideration available administration facilities and infrastructure and its willingness to undertake the tasks.

The scientific secretary will introduce a request for the 2nd Commission Grant (ECU 11,500 including ECU 10,500 for Short Term Scientific Missions sensu stricto and ECU 1,000 for administrative costs) when almost all the money of the 1st Grant will be spent.

The Information Guide for the implementation of the scheme for Short Term Scientific Missions in the COST framework programme is attached in Annex 6.

## 8. DISCUSSION OF BUDGET 1996 AND EXPECTED ACCOUNT FOR 1995

ECU 47,965 were spent at the end of 1995 for COST Action 817 :

| | | | | |
|---|---|---|---|---|
| - | Support for workshops, seminars and conferences | = | | ECU 5,500 | |
| - | Publications | = | | ECU 4,530 | |
| - | Missions, meetings (travel expenses) | = | | ECU 21,800 | |
| | | | + | ECU 16,800 | (Roskilde) |

This amount did not include the Cambridge meetings (11-12/12/1995), the costs of which are estimated at ECU 20,400.

So, the total amount of money spent in 1995 was roughly ECU 68,000. It was reminded the delegates that the budget of COST Action was on average ECU 60,000 per year.

A total amount of approximately ECU 90,000 (including Short Term Scientific Missions, Study Contracts, ..) was requested by the Scientific Secretary to take into account the size and the dynamism of this COST Action.

## 9. ANY OTHER BUSINESS

As all the points on the agenda were studied, Dr H. ØSTERGÅRD, Chairperson of COST 817, closed the meeting.

J.P. MASSON
Detached National Expert
COST Agriculture & Biotechnology

# LIST OF ANNEXES

Annex I — List of participants

Management Committee Meeting, Cambridge (12/12/1995)

Annex II — Participation of the

- 2.1 Institute of Agriculture and Stock Breeding of the West Regions (Ukraine)
- 2.2 Cornell University (Department of Plant Breeding and Biometry) (USA)

Annex III — Résumé of the COST Interaction Conference
COST (European Cooperation in the field of Scientific and Technical Research).

Annex IV — COST Technical Committee in Agriculture & Biotechnology

- 4.1 Summary of the presentation of COST Action 817 given by Dr H. ØSTERGÅRD
- 4.2 List of the members of the COST Technical Committee

Annex V — Minutes of meetings in subgroups of
WG 1, WG 2, WG 3, WG 4, WG 5 in 1995

WG 1 :

- Fungicide Sensitivity Subgroup
  18/10/1995 - Lyngby (DK)

- Virulence and Fungicide Sensitivity Survey Group
  - Fungicide Sensitivity Survey Subgroup
  - Wheat and Bailey Leaf Rust Subgroup
  - Yellow Rust of Wheat Subgroup
  - Bailey Mildew Subgroup

  30-31/03/1995 - Thiverval-Grignon (FR)

WG 2 : Mixtures Working Groups - 17/03/1995 - Hannover (G)

WG 3 : Cereal Rust and Mildew Genome Database

- Development of a fast communication system for data on the research on cereal pathogenic fungi and cereal resistance genes - 18/10/1995 - Risø (DK)
- Database group - 28/02 - 02/03/1995 - Risø (DK)

WG 4 : Nomenclature - 11/12/1995 - Cambridge (UK)

WG 5 : Epidemiological parameters - 18-20/10/1995 - Roskilde (DK)

Annex VI Short Term Scientific Missions (Information Guide for the implementation)

# Work in the Working Groups

## WGl: Surveys on virulence, aggressiveness and fungicide resistance in Europe

(coordinator 1995: Rosemary Bayles, Cambridge, UK)

In this WG the first task was to make a list of the scientists and laboratories in the associated countries, which were involved in surveys (for practical or scientific purposes) of virulence, aggressiveness and fungicide resistance in Europe. This list now includes about 30 laboratories. The collaboration on surveys takes place mostly between scientists working on the same disease. Therefore, the work has been divided into 4 subgroups defined by disease and one subgroup on fungicide sensitivity. The latter subgroup has been redefined as an ordinary working group (WG6) at the 5th MC Meeting in December 1995. At the same meeting a WG1 subgroup on *Septoria tritici* was considered.

COST 8.17

POPULATION STUDIES OF AIRBORNE PATHOGENS ON CEREALS
AS A MEANS OF IMPROVING STRATEGIES FOR DISEASE CONTROL

# - Meeting of WG 1 -

**30.03.1995 - 31.03.1995**

At: Institut National de la Recherche Agronomique (INRA)
Local organizer: Claude Pope-de-Vallavieille / Henriette Goyeau
Phone: xx33 1 3081 5353/5437
Fax: xx33 1 3081 5311/5306

Time table

**Thursday, 30'th:**

| | |
|---|---|
| $13^{00}$-$15^{00}$: | Welcome by the institute<br>Visit the institute |
| $15^{30}$-$18^{00}$: | Welcome by the Chairperson (F.G. Felsenstein)<br>(Last suggestions to the time table)<br>Short report about the status quo of WG 1 (F.G. Felsenstein).<br>Afterwards: Meeting of the different sub-groups<br>Internal discussion of the sub-groups' reports/problems |
| $20^{00}$-$21^{00}$: | Meeting of the sub-groups |
| Evening: | Informal come-together |

**Friday, 31'th:**

| | |
|---|---|
| $08^{30}$-$10^{00}$: | Plenum: Reports from the sub-group coordinators, common discussion |
| $10^{30}$-$12^{00}$: | Work in the sub-groups |
| $13^{30}$-$15^{00}$: | Work in the sub-groups |
| $15^{30}$-$17^{00}$: | Plenum: Final discussion of work in the sub-groups<br>Suggestions and decisions on future work within WG 1<br>Election of a Chairperson/Coordinator for the next period (1995/1996) |
| $17^{00}$-$18^{30}$: | Contributions: ***Interpretation of virulence frequencies as well as resistance factors towards active compounds in terms of disease control in the field.***<br>(See next page) |
| $20^{00}$-$21^{00}$: | Concluding remarks (F.G. Felsenstein)<br>Any other business |
| Evening: | Open / Informal come-together |

COST 817, WG1

Minutes of the meeting of the Virulence and Fungicide Sensitivity Survey Group in Grignon, Paris, France, March 30/31 1995

The present minutes comprise the decisions made during the plenum sessions, and the minutes made by each of the following subgroups: (1) Barley powdery mildew, (2) Barley and wheat leaf rust, (3) Wheat yellow rust, and (4) Fungicide sensitivity.

Claude Pope wellcomed the participants to the second meeting of WG1. Prof. Gaillardin gave a short introduction to INRA Paris-Grignon and to the agronomy education system in France. Afterwards the participants visited the greenhouse and laboratory at the institute.

Introduction to the work in WG1

Friedrich Felsenstein gave a short report about the present status for WG1. The number of participants is now 56; 41 from Western Europe and 15 from Eastern Europe. Hanne Østergård presented subgroup tasks, and asked the subgroups to propose progress plans for 1995-96 and evaluate the progress until now.

First plenum session

The coordinators of subgroups gave a short report about the work in the different subgroups. The coordinator of the wheat powdery mildew subgroup, Andrew Mitchell, is not able to continue, and no participants joined the subgroup meeting. The future of this subgroup will be discussed at the next WG1 meeting in December 1995. Meanwhile Rosemary Bayles will try to find a candidate as new coordinator.

Second plenum session

The coordinators gave a short summary of the conclusions of the work in subgroups, and gave minutes as hand outs (enclosed). The participants of barley and wheat brown rust subgroups decided to merge the two subgroups due to many common aspects of these host-pathogen systems.

Akos Mesterhazy had made a proposal for coordinated multiplication of differential seeds financed by COST. This is not possible within the body of the action, and the problem was discussed further in subgroups.

Here it was decided that multiplication of seed will take place as follows:
1) Barley mildew. Lisa Munk (Denmark) will undertake multiplication of Pallas near-isogenic lines in 1995, and seed is provided free. From 1996 a small charge will be claimed. Differentials other than Pallas lines will be multiplied by Dr. Gacek, Poland.
2) Wheat mildew. Michael Winzeler (Switzerland) will multiply a core set of lines. In December 1995 it will be decided how to continue the work.
3) Brown rust of wheat. Akos Mesterhazy (Hungary) will multiply seed of Lr-lines, and provide at maximum 500 seeds of each line. Further multiplication must be done by people themselves. Mesterhazy will keep a stock of pure seeds for future multiplication.
4) Brown rust of barley. Ursula Walther (Germany) multiply, store and provide seed of differentials as described for brown rust of wheat (see above).
5) Yellow rust of wheat. Cor van Silfhout (Netherlands) provide seed of differentials as described for brown rusts of barley and wheat (see above).

The rust subgroups decided to consider the possibility of submitting a EC-project to improve disease resistance to cereal rusts, with emphasis on differential varieties of wheat to yellow rust. Cor van Silfhout will coordinate initial activities for an application.

The plenum decided that the local organizer of a next meeting will act as chairperson for the working group until the meeting has been held (Rosemary Bayles, UK, is chairperson until the meeting in December 1995). Felsenstein keep an updated list of participants of the group.

The following reports were announced to the topic *Interpretation of virulence frequencies as well as resistance factors to active compounds in terms of disease control in the field.*

Mogens Hovmoller:
*Danish data on virulence frequencies in aerial populations of barley mildew, and the response of barley varieties and near-isogenic lines with the matching resistance genes.*
Friedrich Felsenstein:
*Wheat powdery mildew: trying to find thresholds of virulence frequencies in terms of disease control in the field.*
Bent Nielsen:
*Sensitivity of barley powdery mildew in Denmark and some relationships to disease control in the field.*
Eckhard Limpert:
*Significance of fungicide resistance for disease control in the field.*

Next meetings proposed:

October 1995: Fungicide sensitivity subgroup at Risø (day before WG5 meeting on epidemiology).
December 1995: WG1 meeting Monday 11 to Tuesday 12, Cambridge, UK. The British Society for Plant Pathology subsequently hold their annual presidential meeting in Warwick, UK.
March 1996: Training course for graduates in plant pathology and population genetics, Copenhagen, Denmark.
September 1996: WG1 meeting in connection with European and Mediterranean Rust and Mildew Conference, Wageningen, Netherlands.

Mogens Hovmoller
01.04.95

COST 817 meetings December 11th-12th 1995

at Magdalene College, Cambridge, UK.

## AGENDA WG1 Meeting

Opening Session:

1. Welcome
2. Outline of arrangements for meeting
3. Programme for meeting
4. Objectives of meeting

Sub-group meetings:

Agendas will be provided by sub-group co-ordinators. The following topics will be covered.

- Report of previous meeting - matters arising
- Review of progress since previous meeting - e.g. results of ring tests etc.
- Plans for future
- Preparation of report for final full session of WG1
- Update aims and objectives
- Review of membership
- Next meeting
- Any other business

Final Full Session

1. Reports from sub-groups
2. Future meetings
3. Should the fungicide insensitivity group be split from WG1?
4. A.O.B

Rosemary Bayles (Acting chairman WG1)

# Subgroup 1: Barley powdery mildew

(coordinators E. Limpert, Zürich, CH, and A. Dreiseitl, CZ)

**Aims**

To obtain comparable information of importance for population biology across Europe by discussing and coordinating differential hosts used, sampling and testing methods, methods for assessing infection types and quantitative aspects of infection, and availability of seed of differentials.

**Results**

- A questionnaire on virulence surveys of barley mildew has been filled out by 18 laboratories and the first steps to coordinate methods have been made at the WG1 Meeting in March 1995.
- Differential hosts are used to analyse the population biology of the pathogen and to support the choice of cultivars by farmers and of resistance donors by breeders. According to these aims a list of differential hosts was developed at the WG1 Meeting in March 1995.
- At the meeting in Cambridge in December, it was discussed how to include the 1995 survey results from different countries into the Internet-database.

*Cost 817, WG 1*

## Subgroup barley powdery mildew

towards comparative analyses of host-pathogen interactions

co-ordinated by

Eckhard Limpert and Antonin Dreiseitl

## Short report on aims and activities

based on the results of the meeting at Grignon, 30.3-1.4.1995

Our questionnaire had been answered by 19 laboratories (see appendix) The responses compiled (Tables 1,2) formed the basis for the discussion on the following points:

1 Comparison of differential hosts used.
2 Comparison of methods.
3 Consideration of the availability of seed of differentials.
4 Future prospects.

ad 1: The differential hosts (Table 1) are used to analyse the population biology of the pathogen and to suppport the choice of cultivars by farmers and of resistance donors by breeders. According to these aims a list of 20 differential hosts was developed. Nine differentials used most frequently were agreed to be arranged in a fixed order, thus helping, combined with the use of a pathotype code recommended, to obtain comparable information of importance for population biology across Europe, which is a main aim of the Action.

ad 2: Table 2 helped to start a comprehensive comparison of methods and it was possible to achieve some progress towards standardisation. Infection type 4 was agreed as main border between virulence and avirulence. The importance of infection frequency and spore production needs further discusion. The information on spore sampling periods should be included.

ad 3: Seed of Pallas NIL´s will be provided by Lisa Munk, Denmark, of further differentials by Edward Gacek, Poland.

ad 4: It was agreed to set up a European Barley Mildew Survey within the framework of a European Cereal Pathogen Virulence Survey to improve strategies for disease control. As a first step, subgroup collaborators will try to put the data of this season into a database during the next meeting in December 1995 in Cambridge.

For members of barley mildew working subgroup

Grignon, 30.03.1995

Dear collegues,

These three pages provide results of our efforts towards the standardisation of a set of our differential lines and methods used in the investigation of barley mildew in Europe. We hope they will serve for both an inspiration to discussion and your own work. The data could be summarized only thanks to your cooperation.

Thank you for your cooperation.

Antonín Dreiseitl and Eckhard Limpert

List of active members of barley mildew working subgroup

1 Eckhard LIMPERT and Hansjakob SCHÄRER, Zürich, Switzerland
2 Antonín DREISEITL, Kroměříž, Czech Republic
3 Friedrich FELSENSTEIN, Weihenstephan, Germany
4 Kerstin FLATH, Kleinmachnov, Germany
5 Mogens S. HOVMOLLER, Lyngby, Denmark
6 Hans Peter JENSEN, Riso, Denmark
7 Juan SEGARRA, Lleida, Spain
8 Valérie CAFFIER, Grignon, France
9 Andrew MITCHELL and Susan SLATER, NIAB Cambridge, UK
10 James K. M. BROWN, Norwich, United Kingdom
11 Peter C. MERCER, Belfast, United Kingdom
12 Adrian C. NEWTON, Dundee, United Kingdom
13 Isaak RASHAL, Riga, Latvia
14 Edward GACEK, Bakow, Poland
15 Lars WIIK, Alnarp, Sweden
16 Milan SÝKORA, Bratislava, Slovak Republic
17 Alexandre ZOUBKOVITCH, Zhodino, Byelorussia
18 Olga VRONSKA, Lvov, Ukraine
19 Amor H. YAHYAOUI, Tunis, Tunisia

Addresses of all active members of barley mildew working subgroup (for the exception of the two below) are given in a List of participants of workshop at Zürich/Kappel am Albis.

Dr. Juan SEGARRA
Universitat de Lleida
ETS Enginyeria Agraria
Dept. Produccio Vegetal
Avda Rovira Roure 177
25006 Lleida
SPAIN

Dr. Amor H. YAHYAOUI
Ministry of Agriculture
Ecole Superieure Agriculture
Le Kef 9117
1082 Tunis
TUNISIA

Table 1: Host resistance genes intended to be used in investigating the powdery mildew population on barley in various laboratories across Europe in 1995 (for simpler comparison of results among laboratories)

| Ml-gene | Differential | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a1,(Al2) | P01 | P | P | P | P | P | P | P | P | + | + | + | P | P | P | P | P | P | + | P | 19 |
| a3 | P02 | P | P | P | P | P | P | P | P | + | – | – | P | P | P | – | P | P | + | P | 16 |
| a6,a14 | P03 | P | P | P | P | P | P | P | P | + | + | + | P | P | P | – | P | P | + | P | 18 |
| a7,(No3) | P04B | P | P | P | P | P | P | P | P | + | + | + | + | P | P | – | P | P | + | P | 18 |
| a9 | P08B | P | P | P | P | P | P | P | P | + | + | + | P | P | P | P07 | P | P | + | P | 19 |
| a12,(Em2) | P10 | P | P | P | P | P | P | P | P | + | + | + | P | P | P | P | P | P | + | P | 19 |
| a13,(Ru3) | P11 | P | P | P | P | P | P | P | P | + | + | + | P | P | P | P | P | P | + | P | 19 |
| k | P17 | P16 | P | – | P | P16 | P | P | P16 | + | + | + | P | P | – | P16 | P16 | P16 | + | P | 17 |
| La | P23 | P | P | P | P | P | P | P | P | + | + | + | P | P | P | P | P | P | – | P | 18 |
| g,(CP) | P21 | P | P | – | P | P | P | P | P | + | – | + | P | P | P | P | P | P | + | P | 17 |
| mlo 5 | P22 | – | – | P | P | – | – | P | – | – | – | – | P | P | P | P | – | – | – | P | 8 |
| mlo 9 | Alexis | – | – | + | + | – | – | – | – | – | – | + | – | – | – | – | – | + | – | – | 4 |
| mlo11 | Atem or other | – | – | + | – | – | – | – | – | + | – | + | – | – | – | – | – | – | – | – | 3 |
| h | P24 | – | – | – | P | P | P | P | P | + | + | – | P | P | – | – | – | – | + | P | 11 |
| a7,(Ab) | Trumpf/Triumpf | + | – | – | + | – | – | – | – | + | + | + | + | – | + | – | + | – | – | – | 8 |
| ra | P14 | – | – | – | P | – | – | – | – | + | – | – | P | P | – | + | – | – | + | P | 7 |
| a22 | P12 | – | – | – | P | P | P | – | P | – | – | – | – | P | – | – | – | – | + | P | 7 |
| (Ab) | Lotta(=Sv83380) | + | – | – | + | + | + | – | + | + | – | – | – | – | – | – | – | – | – | – | 6 |
| at | P20 | – | P | – | P | P | P | – | – | – | – | – | – | – | – | – | – | – | + | P | 6 |
| a23 | P13 | – | – | – | P | P | – | – | – | – | – | – | – | – | – | – | – | – | + | P | 4 |
| (Ru2) | P15 | – | – | – | – | – | – | – | – | – | – | – | P | P | – | – | – | – | – | P | 3 |
| a10,(Du2) | P09 | – | – | – | – | P | P | – | – | – | – | – | – | – | – | – | – | – | – | P | 3 |
| nn | P18 | – | – | – | P | – | – | – | – | – | – | – | – | – | – | – | – | – | – | P | 2 |
| p | P19 | – | – | – | P | – | – | – | – | – | – | – | – | – | – | – | – | – | – | P | 2 |
| ? | Meltan | – | – | – | + | + | + | – | – | – | – | – | – | – | – | + | – | – | – | – | 4 |
| (St1,St2) | Steffi | – | – | – | + | + | + | – | – | – | – | – | – | – | – | – | – | – | – | – | 3 |

Genes used in one laboratory only are not indicated

P intended use of the respective Pallas line (Kolster et al. 1986: Crop Science 26, 903-907).

\+ intended use of the respective Ml-gene, however, not that one in the Pallas line

Answers to questions associated with your plans for 1995:
0 Will you use a spore sampler?
00 Are you going to use conidia from one colony directly for the inoculation of the differentials?
1a Which differentials do you intend to use in 1995? (see Table 1)
1b How will you evaluate your isolates? - using infection type
- which scoring scale of infection types are you going to use (citation)?
- using infection frequency in relative comparison to:
-the most attacked differential line (variety)
-a susceptible standard
1c What will be the border between virulence and avirulence (which minimum values?)
- in qualitative evaluation (i.t.)
- in quantitative evaluation (% of colonies)
1d Will any isolates be ignored in further evaluation or re-tested?
1e Do you intend to keep the sequence of the chosen genes as proposed (see the first part of Table 1)?
2 Will you designate pathotypes with triplet code?

Table 2: The chosen methods planned for the investigation of barley mildew in Europe in 1995

| Questions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Use of spore sampler | Y | Y | Y | - | - | - | | Y | - | - | - | | - | Y | - | Y | | - | |
| Direct use of colonies | Y | Y | Y | Y | Y | Y | | | - | - | - | | Y/- | | | - | | Y | |
| Infection types (i.t.) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | - | Y | Y | Y | Y | Y | | Y |
| Scoring scale | T | T | T | T | T | T | | M | M | M+ | M | - | T | | - - | O | | O | |
| Infection frequency(i.f.) | Y | Y | Y | Y | - | Y | Y | Y | - | | Y | Y | - | Y | | Y | Y | Y | |
| The most attacked line | Y | Y | - | - | - | - | | | - | - | - | - | - | - | | - | - | - | |
| Susceptible standard | - | - | Y | Y | Y | Y | | | Y | Y | Y | Y | Y | Y | | Y | Y | Y | Y |
| Border between V/A -i.t. | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 3 | | 2,5 | - | 3 | | | 4 | | 2,5 | 3 |
| (both min.) -i.f.% | 20 | 20 | 50 | 50 | - | - | 50 | | - | | - | | | 50 | | 50 | 50 | 50 | |
| Some re-tested or ignored | Y | Y | Y | Y | Y | Y | | Y | Y | | - | | Y | | | Y | | | |
| Proposed order of genes | Y | Y | Y | Y | - | - | Y | | - | | Y | | | Y | | Y | | | |
| Use of triplet code | Y | Y | - | Y | - | - | Y | - | - | - | - | - | - | Y | - | Y | Y | Y | - |

Y Yes (- No)
T Torp, Jensen and Jorgensen, 1978 (Royal Vet. and Agr. Univ. Yearbook, 75-102)
M Moseman, Macer and Greeley, 1965 (Trans. British Mycol. Soc., 48, 479-489), + with modifications
O Other (please state which one)

Virulence frequences and predominating pathotypes: data Europe 1995

Please prepare the data as a textfile using this font (Courier) and layout. Columns should be separated by space only

- Pathogen
- Country, sampling period
- Differential cultivar/line used (abbreviation)
- Main Ml-gene for host resistance present
- Virulence frequences (p, in per cent)
- Predominant pathotypes (numbered consecutively), Interaction on differential hosts (scale 0-4; 4 = virulent) of the five or more predominating pathotypes.

An example:
Erysiphe graminis f. sp. hordei
Switzerland, June 1995

| | P01<br>a1 | P02<br>a3 | P03<br>a6 | P04B<br>a7 | P08B<br>a9 | P10<br>a12 | P11<br>a13 | P16<br>k | P23*<br>La* | P21<br>g | Tri<br>a7+Ab | Sv83380<br>Ab | ...<br>... | ...<br>... | ...<br>... | Triplet<br>Code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P(%) | 22 | 0 | 55 | 70 | 32 | 88 | 70 | 63 | 67 | 95 | 21 | 11 | | | | |
| 1. | 0 | 0 | 4 | 2 | 0 | 4 | 0 | 2 | 3 | 4 | 1 | 2 | | | | 4401 |
| 2. | 0 | 0 | 0 | 4 | 4 | 1 | 4 | 4 | 2 | 4 | 4 | 4 | | | | 0337 |
| 3. | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 4 | 0 | 2 | | | | 1441 |
| .. | .. | .. | | | | | | | | | | | | | | |
| .. | | | | | | | | | | | | | | | | |

* to ease comparisons of results, the nine first differentials/R-genes were recommended at Grignon for common use in the order indicated.

- For some countries with obvious regional subdivision of the pathogen population, more than one table maybe most sensible for our purpose. In this case please add, after "country", sampling region and date (but you may like to reduce the number of pathotypes indicated to three).

# Agricultural Research Institute Kroměříž

P.O. Box 55, Havlíčkova 2787, CZ-767 01 Kroměříž, Czech Republic
Telephone +42 634 426139, Telefax +42 634 22725


Kroměříž
1 November 1995

Dear colleague,

As you may recall, our **barley mildew group** will meet on December 11 and 12, 1995 in Cambridge, during the meeting of WGI organized by Rosemary Bayles.

We shall try to continue along the way outlined at Grignon, towards standardisation of methods used to obtain comparable results, an aspect of fundamental importance in the Memorandum of Understanding of our Action. Further contributions will be welcome and should be announced to us as soon as possible.

One specific aim was to develop the European database and put the 1995 season data into database during the meeting. Indeed, we seem to be - for the first time - able to create European maps based on *co-ordinated* efforts in the year the data were generated! To this aim everyone is requested to prepare the data available in the way outlined on the following page.

The draft agenda is as follows:

1. State of the art — E. Limpert, A. Dreiseitl
2. Discussion on further needs for standardisation, with a contribution of E. Gacek
3. Input virulence/pathotype data 1995
4. "Phenotype and genotype of avirulence in barley powdery mildew" — J. Brown
5. Outline of the future activities of the group

Please reply as soon as possible to the address above, but not later than November 15, 1995. Thank you.

Best regards,

Antonín Dreiseitl

A. Dreiseitl, E. Limpert

# Subgroup 2: Wheat powdery mildew

(coordinators A. Mitchell/J. Clarkson, Cambridge, UK)

**Aims**

To obtain comparable information of importance for population biology across Europe by discussing and coordinating differential hosts used, sampling and testing methods, methods for assessing infection types and quantitative aspects of infection, and availability of seed of differentials.

**Results**

Dr Andrew Mitchell, the first coordinator of the group, produced a report on the objectives and methods of virulence surveys performed by members, based upon a previously circulated questionnaire.

The group met at the COST 817 WGl Meeting at Magdalene College, Cambridge, UK on 11-12 December 1995. Mr John Clarkson, NIAB Cambridge, was appointed coordinator of the subgroup in place of Dr Mitchell who had moved to a new job within NIAB.

Members showed an enthusiastic commitment to work towards an <u>integrated</u> strategy for control of wheat mildew, combining cultivar resistance and use of fungicides. There was also a desire to keep up-to-date with other relevant work on fungicide resistance, novel control methods and husbandry aspects.

The main action points for the group presented to the full WGl meeting at Cambridge were:

- To collate information from members on virulences, resistances and fungicide usage in their countries.
- To establish a 'ring test' of differential cultivars (and eventually to standardise a European set).
- To produce an annual report summarising virulence survey results.
- To maintain a list of pathogen virulence factors and host resistance genes.
- To work towards introduction of new resistance genes.

**NATIONAL INSTITUTE OF AGRICULTURAL BOTANY**
Huntingdon Road, Cambridge CB3 0LE United Kingdom
Telephone: (01223) 276381 Fax: (01223) 277707

*NIAB is a Registered Charity* *Patron Her Majesty the Queen*

**SEED PRODUCTION DEPARTMENT**

24 March 1995

Dear Colleague

**COST 817 - WHEAT MILDEW SUBGROUP**

Thank you for your response to my questionnaire on virulence surveys of wheat mildew. I have summarised the responses and enclose a copy of the report. I have tried to make the summary as complete as possible, but there are some gaps and possibly also some errors.

I have changed jobs at NIAB, and I am no longer involved in virulence survey work. Rosemary Bayles will present the report at the COST meeting in Grignon, but unfortunately you will have to find a new co-ordinator for the subgroup.

You will see from the report that there are several areas where some discussion and cooperation is required, not least on the virulences surveyed and differential varieties. I have tried to use the prosposals for designation of resistance made at Zürich, but there are some ambiguities and in a few cases contradictions in the resistances of varieties. I have pointed these out in the report.

Good luck with your work.

Yours sincerely

Andrew Mitchell

Andrew Mitchell

# WHEAT MILDEW SUBGROUP

This report summarises the objectives and methods of virulence surveys of wheat mildew carried out in Europe, using information given by the following participants in the Wheat Mildew Subgroup of Working Group 1.

## 1. List of participants

Dr Freidrich G Felsenstein
Lehrstuhl Pflanzenbau & Pflanzenzüchtung
Technische Universität München
D-85350 Freising-Weihenstephan
Deutschland

Dr Anna Strzembicka
IHAR
Cereal Department
Zawila 4a Str
30-423 Krakow
Poland

Renata Hanusova
Research Institute for Crop Production
Drnovska 507
161 06 Praha 6-Ruzyne
Czech Republic

Dr Milan Sykora
Department of Genetics, Faculty of Sciences
Comenous University
Mlynska Dol. B-1
CS-84 215 Bratislava
Slovakia

Mogens S Hovmøller
Danish Institute of Plant and Soil Science
Dept of Plant Pathology & Pest Management
Lottenborgvej 2
DK-2800 Lyngby
Denmark

Laszlo Szunics
Agricultural Research Institute of the
Hungarian Academy of Sciences
Box 19
2462 Martonvasar
Hungary

Karel Klem
Agricultural Research Institute
Havlickova 2787
CZ-767 41 Kromeriz
Czech Republic

Dr Michael Winzeler
Eidgenössische Forschungsanstalt für
landwirtschaftlichen Pflanzenbau
Reckenholz
CH-8046 Zürich
Switzerland

Dr Andrew Mitchell & Mrs Susan Slater
NIAB
Huntingdon Road
Cambridge
CB3 0LE
UK

## 2. Objectives of virulence surveys carried out by the participants

Freidrich Felsenstein

1 To obtain data for scientific research and to carry out long-term investigations of population dynamics and epidemiology
2 To provide information useful for agricultural practice and for breeders, such as choice of variety, virulence thresholds and potential for control through host resistance.

Renata Hanusova

To collect isolates for the genetic analysis of host resistance in wheat

Mogens Hovmøller

1 To study temporal and spatial changes and differences in population structure
2 To measure population size, as the density of spores in the aerial population
3 The early detection of mildew genotypes matching the resistance of new varieties, and to collect isolates for the identification of host resistance

Karel Klem

To provide information for wheat breeding, and for the diversification of wheat cultivation

Susan Slater

1 The early detection of new pathotypes matching the specific resistance of varieties, and to provide this information to farmers and breeders
2 To determine the resistance of new varieties
3 To compile a variety diversification scheme for farmers using the information on frequencies of virulence combinations

Anna Strzembicka

1 To determine the frequencies of virulences and virulence combinations
2 To select isolates for inoculation of breeding material
3 To identify useful sources of resistance for breeding programmes

Milan Sykora

1 To determine virulence frequencies
2 To monitor sensitivity to triazole fungicides and fenpropimorph

Laszlo Szunics

To determine virulence frequencies

Michael Winzeler

1 To select isolates for inoculation of breeding material
2 To determine the resistance genes in a wheat breeding programme

## 3. Geographical area of survey, sampling method, assessment scale and number of isolates tested

| Participant | Area of survey | Sampling method | Assessment scale | Approx. no. of isolates tested per annum |
|---|---|---|---|---|
| Freidrich Felsenstein | south Germany | Mobile spore trap | Relative to susceptible control, >50% = virulent | 1000 |
| Renata Hanusova | Czech Republic | Infected leaves | 0-4 | 50-200 |
| Mogens Hovmøller | Denmark | Static nursery, infected leaves | 0-4 (Hovmøller, 1989) | 100-150 |
| Karel Klem | Czech Republic | Mobile spore trap | 0-4 | 400 |
| Susan Slater | Great Britain | Infected leaves | 0-4 (Moseman *et al.*, (1965) | 200-350 |
| Anna Strzembicka | Poland | Static & mobile nurseries, infected leaves | 0-4 | 200-250 |
| Milan Sykora | Slovakia, Hungary, Austria, Czechia | Mobile nursery | Relative to susceptible control, >50% = virulent | 400 |
| Laszlo Szunics | Hungary | Static nursery | 0-4 | 250 |
| Michael Winzeler | Switzerland | Static nursery, mobile spore trap, infected leaves | 1-8 * or relative to susceptible control | 20-160 |

* 1-8 scale, where 1-4 = resistant, 5 = intermediate, and 6-8 = susceptible

## 4. Test methods and incubation conditions

| | | | Light | | | Incubation | |
|---|---|---|---|---|---|---|---|
| Participant | Test material | Benzimidazole | Source | Light/dark (hrs) | Intensity | Temp (°C) | Period (d) |
| Freidrich Felsenstein | Detached leaves | 35 ppm | White | Continuous | $10\ \mu Em^{-2}s^{-1}$ | 16-18 | 10 |
| Renata Hanusova | Seedlings & detached leaves | 35 | Fluorescent | 14/10 | 3000 lux | 12-18 | |
| Mogens Hovmøller | Detached leaves | 35 | White | 18/6 | $20\ \mu Em^{-2}s^{-1}$ | 16-18 | 10-14 |
| Karel Klem | Detached leaves | 25 | Natural | Natural | | 18-20 | 7 |
| Susan Slater | Detached leaves | 100 | Fluorescent | 16/8 | 3400 lux | 18 | 10 |
| Anna Strzembicka | Detached leaves | 35 | Fluorescent | 16/8 | | 18-20 | 10 |
| Milan Sykora | Detached leaves | 30 | | Continuous | 10000 lux | 18 | 8-9 |
| Laszlo Szunics | | | Natural + halide | | $200\ \mu Em^{-2}s^{-1}$ | 18-20 | 8-10 |
| Michael Winzeler | Detached leaves | 30 | Fluorescent | Continuous | $100\ \mu Em^{-2}s^{-1}$ | 17 | 11-14 |

## 5. Differential varieties

| Resistance [1] | F Felsenstein | R Hanusova | M Hovmøller | K Klem | S Slater |
|---|---|---|---|---|---|
| 0 | | Diana | Anja | | Cerco |
| Pm1 | Axminster x 8Cc [2] | Axminster | RO134 [3] | Axminster | |
| Pm2 | Ulka x 8Cc | Ulka | Longbow | Ulka | Galahad |
| Pm3a | | Asosan | RO136 | Asosan | |
| Pm3b | | Chul | RO137 | Chul | |
| Pm3c | Sonora x 8Cc | Sonora | Sonora x Cc8 | | |
| Pm3d | | Kolibri | Vitus Sejet (+u1) | | |
| Pm3f | | Michigan Amber | | | |
| Pm4a | | Khapli | Khapli x Cc8 | | |
| Pm4b | Armada | Zdar | Kosack | W'stephan M1 | Armada |
| Pm5 | | Regina | Kraka | Hope | Hope, Flanders |
| Pm6 | | Timgalen | Holger | | |
| Pm7 | | Transec | | Transec | |
| Pm8 | Disponent | Salzmünde 14/44 | RO133 | Salzmünde 14/44 | Clement |
| Pm17 | | Amigo | | | |
| Pm1, 4b | | | | | |
| Pm2, 6 | Maris Huntsman | Maris Huntsman | | Kenya Civet | Brimstone |
| Pm2, Mld | | | | Halle St. 13471 [4] | |
| Pm2, MlTa2 | | | | | Brock |
| Pm3d, 4b | | | | | |
| Pm4b, 6 | | | | | |
| Pm4b, 8 | | | | | |
| Pm5, 6 | | | | | |
| Pm5, MlSi2 | | | | | Sicco |
| Pm5, MlTa2 | | | | | Mercia |
| Pm6, 8 | | | | | |
| Pm8, MlHa2 | | | Haven | | |
| Pm1, 2, 9 | Mephisto | Normandie | | Normandie | |
| Pm2, 4b, 6 | | | Rendezvous | | |
| Pm2, 4b, 8 | | | | | |
| Pm2, 4b, 8, u1 | | | Hussar | | |
| Pm1, 2, 4b, 9 | | | Planet (9?) | | |
| Pm1, 4, 9, u1 | | | Sappo | | |
| Pm2, 4b, 6, 8 | | | | | |
| Pm1, 4b, 6, u1, u2 | | | | | |
| Pm1, 5, 9, u1, u2 | | | Dragon | | |
| MlAx | | | | | Axona |
| MlBr | | | | | Broom |
| Mld | | | | | Maris Dove [5] |
| MlHe2 | | | Hereward | | |
| MlSo | | | | | Wembley |
| MlTo | | | | | Tonic |
| MlAx, ?d, ?Br | | | | | Cadenza |

1 Where possible resistances have been designated according to the proposals of Boesen *et al.* (1995) at the Third Workshop on Integrated Control of Cereals across Europe', Zürich November 1994.
2 8Cc = 8 backcrosses with Chancellor
3 RO = near-isogenic line in Prins background
4 Designated Mld, mlha by Karel Klem
5 Designated Pm2, Mld by Michael Winzeler

## 5. Differential varieties, continued

| Resistance [1] | A Strzembicka | M Sykora [2] | L Szunics | M Winzeler |
|---|---|---|---|---|
| 0 | Kanzler, Nimbus | | | Kanzler, Bernina |
| Pm1 | Axminster | Axminster | Axminster | Axminster x 8Cc [3] |
| Pm2 | Ulka, Avalon | Galahad | Red Fern | Ulka x 8Cc |
| Pm3a | Asosan | | Asosan | Arosan x 8Cc |
| Pm3b | Chul | | Chul | Chul x 8Cc |
| Pm3c | Sonora | | Sonora | Sonora x 8Cc |
| Pm3d | Kolibri [4] | | | Kolibri |
| Pm3f | | | | Mich Amber x 8Cc |
| Pm4a | Khapli | | Khapli | Khapli x 8Cc |
| Pm4b | W'stephan M1 | Zdar | W'stephan M1 | Armada |
| Pm5 | Hope | Regina | Hope | Hope |
| Pm6 | | | TP 114/65 x Starke$^{2}$B | Timgalen |
| Pm7 | Transec | | Transec | Transfed |
| Pm8 | Disponent | Clement | Salzmünde 14/44 | Salzmünde 14/44 |
| Pm17 | | | Amigo | Amigo |
| Pm1, 4b | | | Rang | |
| Pm2, 6 | Brimstone, M. Hunstman | Brigand | TP 144/65A | Brigand |
| Pm2, Mld | | | Halle st. 13471 | Maris Dove |
| Pm2, MlTa2 | | | | |
| Pm3d, 4b | Kadett [5] | | | |
| Pm4b, 6 | Sorbas | | | Sorbas |
| Pm4b, 8 | Kronjuwel | Kronjuwel | | W'stephan 623-65 |
| Pm5, 6 | | | | Greif, Coker 893 |
| Pm5, MlSi2 | | | | |
| Pm5, MlTa2 | | | | |
| Pm6, 8 | | | | Albrecht |
| Pm8, MlHa2 | | | | |
| Pm1, 2, 9 | | | Normandie | Normandie |
| Pm2, 4b, 6 | | | | Rendezvous |
| Pm2, 4b, 8 | Apollo | | | Apollo |
| Pm2, 4b, 8, +u | | | | |
| Pm1, 2, 4b, 9 | Sappo | | | Sappo [6] |
| Pm1, 4, 9, u1 | | | | |
| Pm2, 4b, 6, 8 | | | | Knirps |
| Pm1, 4b, 6, u1, u2 | | | | Walter |
| Pm1, 5, 9, u1, u2 | | | | |
| MlAx | | | | Axona |
| MlBr | | | | |
| Mld | | | | |
| MlHe2 | | | | |
| MlSo | | | | Wembley |
| MlTo | | | | Spark |
| MlAx, d?, ?Br | | | | |

Where possible resistances have been designated according to the proposals of Boesen *et al.* (1995)
Milan Sykora also using Granada, Boxer and Tukan, but resistances not given
8Cc = 8 backcrosses with Chancellor
Designated Mlk by Anna Strzembicka, which is a synonym of Pm3d (Boesen *et al.*, 1995)
Considered to be identical to Cornette, with resistance MlCo3 (Boesen *et al.*, 1995; Hovmøller, 1989, Race specific powdery mildew resistance in 31 northwest European wheat cultivars. Plant Breeding 103, 228-234)
Designated Pm1, 2, 4b, 9 by Freidrich Felsenstein

## 6. Availability of results

Freidrich Felsenstein
Yearly report in German

Renata Hanusova
Reprints available on request

Mogens Hovmøller
Summaries in farmers leaflets and in 'Kornsorter', in Danish

Karel Klem
No publications to date

Susan Slater
Results published in annual report of UK Cereal Pathogen Virulence Survey, available from NIAB

Anna Strzembicka
Strzembicka-Wozniak A, Lazarska B 1994. Virulence structure of wheat powdery mildew population (*Erysiphe graminis* f.sp. *tritici*) in Poland. Hod. Rosl. Aklim. 38, 1/2, 98-107.
Wegrzyn S, Strzembicka A, Gajda Z 1994. Variability of the winter wheat breeding materials with respect to their reaction to leaf rust and powdery mildew. Proc. I International Symposium of Cereal Pathogens and stress factors interaction progress to ecological agriculture, 1994, Poznan, Poland. Genetica Polonica (in press).

Milan Sykora
Publications in Slovakian and other periodicals, and presented at international conferences

Laszlo Szunics
Regular publication in Hungarian journals with summaries in English. Results also presented at international conferences

Michael Winzeler
Data available on request

## 7. Other comments

It is apparent from the above summary that there is considerable variation in the virulences tested for and differential varieties used in surveys of wheat mildew in Europe. Discussion and exchange of information on resistances used in wheat across Europe would help in interpreting the results of surveys, and would provide a basis for a common set of virulences to be tested for in all surveys. Differential varieties and differential isolates could then be exchanged to allow material to be compared, and facilitate interpretation.

Common multiplication of differential varieties would be useful, but given the wide range of differential varieties deciding which varieties to use would be complicated.

Andrew Mitchell
NIAB, UK
March 1995

## Subgroup 3: Yellow rust of wheat (and barley)

(coordinator R. Bayles, Cambridge, UK)

**Aims**

Most yellow rust populations in Europe have some exchange with each other. The yellow rust of wheat subgroup aims to monitor populations across Europe, to provide an early warning of changes in virulence. By doing this the group will assist the improvement of genetically based disease control by breeding. The aims of the group will be achieved by standardising testing procedures and interpretation of results in participating countries, as far as is necessary to enable the results of national surveys to be collated to indicate the European situation.

**Results**

The wheat yellow rust subgroup met twice during 1995, in Grignon in March and in Cambridge in December. In addition, a small meeting for five representatives of the sub-group group was organised in Weihenstephan in April, to study a detached leaf technique developed in Dr Felsenstein' s laboratory for virulence identification of yellow rust isolates.

Progress during the year was in three main areas, 1) the completion of a comparison of the aims and methods of virulence surveys in participating countries, 2) ring tests of isolates in four countries and 3) planning and sowing of adult plant nurseries in six countries.

1) The results of the comparative study are given in the accompanying table.
2) In the ring tests, six isolates with contrasting virulence characteristics were tested in each participating country, using their normal procedures. There was generally close agreement of results between participants, but a few instances were highlighted where reactions differed. On examination, these differences could be attributed to contrasting test conditions, in particular light intensity, or to differences in the seed stock of differential cultivars.
3) Nurseries, comprising five cultivars from each of six countries, have been sown in the six countries and will be inoculated with pathotypes of importance in those countries. The cultivars were chosen for their good adult plant resistance in the country of origin. The aim is to investigate whether their resistance is effective in other countries and to compare levels of background resistance where any specific resistance is overcome. This information should be particularly relevant to breeders and cultivar evaluation organisations throughout Europe.

COST 817
VIRULENCE SURVEY WORKING GROUP
YELLOW RUST OF WHEAT SUB-GROUP

## ACTION POINTS FROM MEETING HELD AT GRIGNON ON MARCH 30/31 1995

Differential set for seedling virulence tests:

The group recognised that the current differential set for yellow rust of wheat is poor because many of the differential varieties possess additional specific resistance genes.

Until a better set can be developed, it was recommended that the following should be adopted as a core set.

| | |
|---|---|
| Kavkaz 4 x Federation | Yr9 |
| Suwon 92 x Omar | So |
| Strubes Dickkopf | Sd |
| Moro | Yr10 |
| Vilmorin 23 | Yr 3a + |
| Heines Kolben | Yr6 (?+2) |
| Lee | Yr7 |
| Chinese 166 | Yr1 |
| Kalyansona | Yr2 |
| Spalding Prolific | Sp |
| Carstens V | CV |
| Compair | Yr8 |
| Nord Desprez | Yr3a + |
| Heines Peko | Yr6,Yr2 |
| Reichesburg 42 | Yr7+ |
| Hybrid 46 | Yr3b, Yr4b |
| VPM1 | Yr17 |
| Tp981 | |
| Anza | YrA |
| T.dicoccoides G25 | Yr15 |

Exchange testing of isolates

Claude Pope will provide 5 isolates and Rosemary Bayles 1 isolate to DK, NL, UK and F in week starting April 24th. These will be virulence tested in each country using their normal test procedures and the recommended differentials. Results will be returned to Claude for collation.

| 1994/1995 | Yellow rust of wheat. Differential cultivars and frequency of corresponding virulence | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DK | | D1 | | D2 | | CZ | | F | | NL | | UK | |
| Differential cultivar | R gene/factor | | V% | | V% | | V% | | V% | | V% | | V% | | V% |
| Clement | Yr9, Yr2 | | | | | X | 2,2 | X | 2 | X | 4 | X | 2 | | |
| Suwon 92 x Omar | So | X | 4 | X | | X | 3,3 | X | 1 | X | 3 | X | 3 | | |
| Strubes Dickkopf | Sd | X | 4 | X | | X | 4,3 | X | 4 | X | 4 | X | 4 | | |
| Moro | Yr10 | X | 0 | X | | X | 0,0 | X | 0 | X | 0 | X | 0 | | |
| Vilmorin 23 | Yr3a,+ | X | 3 | X | | X | 4,2 | X | 4 | X | 4 | X | 4 | | |
| Heines Kolben | Yr6 (?+2) | X | 1 | X | | X | 2,3 | X | 1 | X | 2 | X | 2 | X | 3 |
| Lee | Yr7 | X | 0 | X | | X | 1,2 | X | 0 | X | 0 | X | 2 | | |
| Chinese 166 | Yr1 | X | 1 | X | | X | 3,0 | X | 4 | X | 3 | X | 3 | X | 4 |
| | | | | | | | | | | | | | | | |
| Heines VII | Yr2 | | | X | | X | 2,2 | X | 3 | X | 4 | X | 3 | X | 4 |
| SpaldingsProlific | Sp | X | 1 | X | | X | 1,0 | X | 3 | X | 0 | X | 0 | | |
| Carstens V | CV | X | 2 | X | | X | 3,2 | X | 2 | X | 0 | X | 3 | X | 3 |
| Compair | Yr8 | X | 0 | X | | X | 0,0 | X | 0 | X | 0 | X | 0 | X | 0 |
| Nord Desprez | Yr3a, + | X | 4 | X | | X | 4,2 | X | 3 | X | 4 | X | 4 | | |
| Heines Peko | Yr6, Yr2 | X | 1 | X | | X | 2,1 | X | 0 | X | 2 | X | 2 | | |
| Reichesberg 42 | Yr7+ | X | 0 | X | | X | 1,2 | X | 1 | X | 0 | X | 2 | | |
| Hybrid 46 | Yr3b, Yr4b | X | 4 | X | | X | 3,0 | X | 1 | X | 3 | X | 3 | X | 3 |
| | | | | | | | | | | | | | | | |
| VPM1 | Yr17 | | | | | X | *,0 | | | X | 0 | | | | |
| Rendezvous | Yr17 | | | | | | | | | | | | | X | 1/0 |
| Brigadier | Yr17+ | | | | | | | | | | | | | X | 1/0 |
| Hussar | Yr17+ | | 0 | | | | | | | | | | | X | 1/0 |
| Kavkaz 4 x Federation | Yr9 | | | | | | | | | | 4 | X | | X | 3 |
| Slejpner | Yr9+ | X | 3 | | | X | | | | X | 4 | | | | |
| Tommy | Yr7 | | | | | | | | | | | | | X | 1 |
| Triticum spelta album | Yr5 | X | 0 | X | | X | 0,2 | | | | | X | | | |
| Austerlitz | Yr6+ | | | | | | | | | X | 2 | | | | |
| Recital | Yr6 | | | | | | | | | | | | | | |
| Cappelle Desprez | Yr3a, Yr4a | | | | | X | | | | | | | | X | 4 |
| Soissons | Yr3a, Yr4a | | | | | X | | | | | 4 | | | | |
| Kalyansona | Yr2 | X | 4 | X | | X | | | | X | 4 | X | | | |
| Thesee | Yr2+ | | | | | X | | | | X | 4 | | | | |

| | | DK | | D1 | | D2 | | CZ | | F | | NL | | UK | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | V% | | V% | | V% | | V% | | V% | | V% | | V% |
| Anza | YrA+ | X | 2 | | | | | | | X | 2 | X | | | |
| Talon | CV | | | | | | | | | | | | | X | 3 |
| Hereward | CV+ | X | 2 | | | | | | | | | | | X | 2 |
| Kraka | Yr1, CV | X | 1 | | | X | *,0 | | | | | | | | |
| Haven | Yr6, Yr9 | X | 1 | | | | | | | | | | | | |
| Camp Remy | R | | | | | | | | | X | 0 | | | | |
| Tonic | R | | | | | | | | | | | | | X | 1/0 |
| Cadenza | R | | | | | | | | | | | | | X | 1/0 |
| Parade | R | | | | | | | | | | | | | X | 1/0 |
| Maris Huntsman | Yr13 | | | | | X | *,0 | | | | | | | X | 3 |
| Hobbit | Yr14 | | | | | X | *,0 | | | | | | | X | 3 |
| Gawain | Yr2, Yr13, Yr14 | X | | | | | | | | | | | | | |
| Longbow | Yr1, Yr2, Yr6, Yr13 | X | | | | | | | | | | | | | |
| Pepital | ?, APR | X | 3/0 | | | | | | | | | | | | |
| Obelisk | Yr1, APR | X | | | | | | | | | | X | | | |
| Apostle | Yr2+Yr6, APR | | | | | | | | | | | | | X | 3/0 |
| Lely | ??? | | | | | X | *,5 | | | | | X | | | |
| | | | | | | | | | | | | | | | |
| Sonalika | YrA + | | | | | | | | | | | X | | | |
| T.dicoccoides G25 | Yr15 | | | | | | | | | | | X | | | |
| Gaby | | | | | | | | | | | | X | | | |

X = differential included in tests

%V = frequency of corresponding virulence where:

0 = virulence not detected

1 = virulence rare, detected in less than 10% of isolates

2= virulence detected in 10-50% of isolates

3 = virulence detected in 50% or more isolates

4 = virulence detected in all, or nearly all, isolates

a/b = seedling / adult plant

a,b = 2 results

## COST 817 YELLOW RUST OF WHEAT SUB-GROUP

Questionnaire replies were received from the following:

Denmark (DK)
Mr Mogens Hovmoller

Germany (D1)
Dr Friederich Felsenstein

Germany (D2)
Dr Ursula Walther

Czech Republic (CZ)
Dr Renata Hanusova

France (F)
Madame Claude Pope-de-Vallavieille

NL
Dr Cor van Silfhout

UK
Dr Rosemary Bayles

The responses were discussed at the WG1 meeting in Grignon on March 30/31 1995 and amended as necessary. The results are summarised in the attached tables.

Rosemary Bayles
3 April, 1995

COST 817 Virulence Survey Working Group Yellow Rust of Wheat sub-group. Summary of Questionnaires.

| | | DK | D1 | D2 | CZ | F | NL | UK |
|---|---|---|---|---|---|---|---|---|
| **Aims** | Study of race structure / evolution of pathogen population | ✓ | | ✓ | ✓ | ✓ | ✓ | (✓) |
| | Early detection of new pathotypes | ✓ | | | | ✓ | ✓ | ✓ |
| | Collect isolates which will differentiate R genes in varieties | ✓ | ✓ | | | ✓ | ✓ | (✓) |
| | Provide information and inoculum to plant breeders | | | | ✓ | ✓ | ✓ | ✓ |
| | Provide information and inoculum for official variety evaluation | | | | | ✓ | ✓ | ✓ |
| | Comparison of tests using leaf segments and whole plants | | ✓ | | | | | |
| | Variety diversification schemes for farmers | | | | | | ✓ | ✓ |
| | | | | | | | | |
| **Sampling** | Leaf samples from specific varieties in variety trials and breeders' plots | ✓ | | | | | ✓ | ✓ |
| | Leaf samples from the field | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| | Samples from new resistant varieties when foci found | ✓ | | | | ✓ | ✓ | ✓ |
| | Leaf samples from common varieties from various areas | | | | ✓ | ✓ | | |
| | | | | | | | | |
| **Differentials** | See Table | | | | | | | |
| | | | | | | | | |
| **<u>Seedling Tests</u>** | | | | | | | | |
| **Inoculation stage** | Leaf 1 | | ✓ | ✓ | ✓ | | ✓ | |
| | Leaf 2 partly emerged | ✓ | | | | ✓ | | ✓ |
| | | | | | | | | |
| **Inoculation technique** | Wet finger / spores | | | | ✓ | | | |
| | Wet finger / spores+talc | | ✓ | | | | | |
| | Spores + talc - puffed or blown | | | ✓ | | ✓ | | ✓ |
| | Settling tower | ✓ | | | | ✓ | | |
| | Oil | | | ✓ | | | ✓ | |

| | | DK | D1 | D2 | CZ | F | NL | UK |
|---|---|---|---|---|---|---|---|---|
| **Growing conditions before inoculation** | same conditions as after inoculation (see 'subsequent' below) | ✓ | | | | | ✓ | |
| | Glasshouse, approx. 15°C, in filtered chamber, supplemetary lighting | | | | | ✓ | | |
| | Glasshouse, fluctuating, filtered compartment, supplementary lighting | | | | | | | ✓ |
| **Incubation conditions** | | | | | | | | |
| **- immediate post-inoculation** | 36 hrs at 8°C dark | | | ✓ | | | | |
| | 7/8°C, with or without light, 100% RH, 24-48hrs | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| | 10-15°C, high RH, 48hrs | | | | ✓ | | | |
| **-subsequent** | Glasshouse, 16-18°C, min daylength 18hrs (supplementary lighting) | ✓ | | | | | | |
| | 11°C, 70-80%RH, 24hr daylight | | ✓ | | | | | |
| | 16°C for 7 days then 20°C | | | ✓ | | | | |
| | 15°C for 7 days, then 15-20°C in glasshouse + supplementary lighting | | | | ✓ | | | |
| | 14°C 8hrs dark / 17°C 16hrs light | | | | | ✓ | ✓ | |
| | 11°C, 8hrs dark / 18°C 16hrs light | | | | | | | ✓ |
| **- light intensity** | $180 \mu E m^{-2} s^{-1}$ | | | | | | ✓ | |
| | $200 \mu E m^{-2} s^{-1}$ | | ✓ | | | | | |
| | $300 \mu E m^{-2} s^{-1}$ | | | | | ✓ | | |
| | 6,000 lux | | | ✓ | | | | ✓ |
| | 10,000 lux | | | | | | | |
| **Leaves assessed** | Leaf 1 | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Leaves 1 and 2 | ✓ | ✓ | | | (✓) | | (✓) |
| **Assessment scale** | 0-9 | ✓ | | | | ✓ | ✓ | |
| | 0-4 | | ✓ | ✓ | ✓ | | | ✓ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Colony number | | ✓ | | | | | |
| | | **DK** | **D1** | **D2** | **CZ** | **F** | **NL** | **UK** |
| **Adult plant tests** | | | | | | | | |
| **Differentials** | See Table | | | | | | | |
| | | | | | | | | |
| **Test type** | Field nurseries | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Polythene tunnels | | | | | | | ✓ |
| | | | | | | | | |
| **No. of isolates - field** | | | | | | 2 | 12 | 6 |
| **tunnels** | | | | | | | | 18 |
| | | | | | | | | |
| **Inoculation technique** | transplant infected seedlings | | | | | ✓ | | |
| | ultra low volume spray / oil | | | | | | ✓ | |
| | spore/talc mixture applied with puffer to spreader rows and plots | | | | | | | ✓ |
| | | | | | | | | |

# COST Action 817, WG 1: Sub-group meeting

**Subgroup of virulence surveys of yellow rust of wheat**

Place: Institute of Agronomy and Plant Breeding, Freising-Weihenstephan, Germany
Time: April 28th, 1995; 9.00-17.30
Local organizer and meeting secretary: Dr Friedrich G Felsenstein

**Purpose of the meeting: To study a new technique for assessing virulence and specific resistance to yellow rust of wheat.**

Agenda:

1. Welcome and introduction to the resistance laboratory
2. Demonstration of materials and methods
3. Presentation and discussion of results
4. Exchange of seeds and rust isolates for ring test
5. Any other buisness

Participants:

| | |
|---|---|
| France: | *Marc Leconte*, Laboratoire de Pathologie Vegetale, INRA, Thiverval-Grignon |
| Britain: | *Phil Stigwood*, National Institute of Agricultural Botany, Cambridge |
| Netherlands: | *Marjon Krüger*, Res. Institute for Plant Protection, Wageningen |
| Denmark: | *Mogens Hovmöller*, Danish Institute of Plant and Soil Science, Lyngby |
| Germany: | *Stefan Streng* and *Friedrich G Felsenstein*, Institute of Agronomy and Plant Breeding, Freising-Weihenstephan |

Meeting minute:

Dr Felsenstein and co-workers made a short introduction to the mildew and rust work at the 'resistance laboratory' of the Institute of Agronomy and Plant Breeding, Weihenstephan. A detailed demonstration of the new technique of using detached leaves for analysing yellow rust was given, and each participant practiced all techniques involved. Results of prepared test sets were evaluated and advantages and disadvantages compared to existing methods were discussed.

Stefan Streng, who has developed major parts of the new method, gave a presentation of his results obtained through his thesis work. The results were produced under varying environmental conditions, and comparisons between methods were discussed in detail. Also experience with storage of isolates were discussed, and gave useful information for the participants.
The results of the new method are confidential until they have been published.

A number of isolates and differential varieties were exchanged for setting up a ring test between the participating laboratories, and results obtained will be compared.

Finally, the participants thanked the organiser and his co-workers for the very well organized and valuable meeting.

Mogens Hovmöller 28.04.1995

**Cost 817. WG1 - Yellow rust sub-group. Exchange of winter wheat varieties for inclusion in adult plant inoculated tests .**

The following is a list of those who have indicated that they would like to participate in the exchange of varieties for testing. Each participant is invited to submit a maximum of five varieties.

Would you please send the quantities of seed indicated to each participant at the addresses given below, making sure that your seed packets are clearly labelled with the names of the varieties and your own name.

| | **Name** | **Address** | **Amount of seed requested for each variety** |
|---|---|---|---|
| 1. | Michael Winzeler | Swiss Federal Research Station for Agronomy<br>FAP-Reckenholz<br>CH 8046 ZURICH<br>Switzerland | 20g |
| 2. | Ursula Walther | Federal Centre of Breeding Research on Cultivated Plants<br>Institute of Epidemiology and Resistance<br>Theodor-Roemer-Weg 4<br>06449 Aschersleben<br>Germany | 200 seeds |
| 3. | Mrs Baumgarten | BBA<br>Institute of plant protection in agriculture and green land<br>Messeweg 11-12<br>38104 Braunschweig<br>Germany | 200 seeds |
| 4 | Mogens Hovmoller | Danish Institute of Plant and Soil Science<br>Department of Plant Pathology and Pest Management<br>Lottenborgvej 2<br>DK - 2800 LYNGBY<br>Denmark | 50g |
| 5 | Ole Andersen | Pajbergfonden<br>Gersdorffslundvej 1, Hou<br>8300 Odder<br>Denmark | 20g |

| | | | |
|---|---|---|---|
| 6 | Renata Hanusova | Research Institute of Crop Production<br>Drnovska 507<br>Praha 5 - Rusyne<br>161 06 Czech Republic | 100 seeds |
| 7 | Claude Pope-de Vallavielle | Laboratoire de pathologie vegetale<br>INRA<br>78 750 Thiverval-Grignon<br>France | 150g |
| 8 | Rosemary Bayles | National Institute of Agricultural Botany<br>Huntingdon Road<br>Cambridge CB3 7LE<br>UK | 20g |

With best wishes

Rosemary Bayles
7 September, 1995

# Subgroup 4: Leaf rust (brown rust) of wheat and barley

(coordinators P. Bartos, Praha, CR and U. Walther, Aschersleben, D)

**Aims**

The general aim of the subgroup for wheat leaf rust including participants from UK, F, D, P; CZ, SK, H, I, is to elaborate the basis for the most effective breeding for leaf rust resistance of wheat. For this purpose the collaborators will develop a common procedure for a virulence survey which will enable the identification of resistant germplasm for resistance breeding in a large geographical area and thus make our epidemiological data comparable.

**Results**

The first meeting of the subgroup took place in Thiverval Grignon, March 30-31. At the beginning of the year a questionnaire was sent to the participants. Obtained data were summarized and distributed in Thiverval Grignon (Enclosure 1). The main objective was to gather information on main aims of virulence/race surveys, methods of sampling, methods of seedling and adult plant tests, on reactions of near-isogenic lines with Lr genes in the participating countries and to propose a core set of differentials for virulence surveys. During the meeting in Thiverval Grignon (Enclosure 2) participants agreed to use a core set of 20 differentials (NILs). Dr. Mesterházy promised to send the seed to the participants. Samples were supplied in the autumn. Collaborators agreed to share germplasm containing specific resistance genes and to participate in the adult plant resistance tests. Dr. Winzeler distributed seed for these field tests with winter wheat cultivars in the autumn. At the same time resistant germplasm was exchanged.

The second meeting of the subgroup took place in Cambridge, December 11/12,1995. Before the meeting a questionnaire was sent to the participants. Obtained data were summarized and distributed in Cambridge (Enclosure 3). The main objective was to gather information on the incidence of wheat leaf rust in the participating countries, on new sources of leaf rust resistance in the grown cultivars, on the most frequent virulence combinations found in 1995 and on the total virulence to the tested NILs with Lr genes. Further suggestions aimed at a joint postulation of genes for resistance according to reactions to selected leaf rust pathotypes, additional suggestions for unified scoring system and nomenclature (Enclosure 4). During the meeting results on virulence surveys obtained in 9 participating countries were presented and discussed. Further progress has been achieved in unifying the core set of differentials, the scoring system and experimental conditions and in cooperation in the joint tests.

During the meetings participants interested in barley leaf rust discussed the set of differentials, designation and nomenclature of pathotypes as well as the scoring system. Data on frequencies of virulence on Pal, Pa2, Pa4, Pa2+Pa6, Pa8, Pa7, Pa2+Pa5, Pa3, Pa9, Trumpf, Hor.1132 sel and HOR 500-1 as well as on resistance genes in the grown barley cultivars in Germany (1974-1995) were presented. Trap cultivars used in Germany will be also tested in the U.K. The scoring system will be documented by slides.

# Summary of the questionnaire on wheat leaf rust

Aims of the virulence/race survey :

Almost all participants consider the application of the virulence survey in the wheat breeding/growing as the main objective. This activity includes determination of the most widespread virulences and their frequency in connection with grown cultivars in different areas of the country, determination of new virulences-isolates from sources of resistance used or with potential use in the breeding and from resistant cultivars that lost resistance. Collections of isolates with various virulences and their combinations are used in studies of resistance genes , in greenhouse and field tests carried out by the researcher or by breeders at plant breeding stations or by organizers of State Varietal Trials. Only one participant (Germany) put the study of rust population dynamics and epidemiology on the first place.

Rust sampling :

Most participants collect rust samples in the field or receive rust samples on leaves. Samples originate from grown cultivars and cultivars/lines with known resistance genes. Spore traps were or are used in Germany, France and Switzerland.

Methods :

Seedling tests:

Most participants use tests on seedlings. Leaf segments are used only in Germany. Temperatures used in seedling tests vary between 10 and25$^{\circ}$C. Low temperatures are usually during incubation (1-2 days). Two temperature regimes were used in France (10 and 25$^{\circ}$C) and United Kingdom. Light intensity varies in France and Switzerland between 280-350 uE/m$^{2}$.s$^{-1}$, in the tests on leaf segments in Germany only 20 uE/m$^{2}$.s$^{-1}$. Photoperiode is usually 16 hrs light, 8 hrs dark, in Poland 12/12 hrs. Classification of infection is mostly based on infection type, in Germany on infection type and frequency, in Switzerland scale 1-8 is used.

Adult plant tests :

In most countries adult plant resistance is studied in the field under conditions of natural or more often artificial infection with a mixture of the most important pathotypes. In France adult plant resistance is studied also in the greenhouse with 10 isolates at 15-25$^{\circ}$C. Field tests including about 50 entries are being carried out with 3 pathotypes. In the U.K. several field tests (hill plots) inoculated with single isolates are organized, comprising wheat cultivars on Recommended List, in Recommended List Trials and standard wheat leaf rust reference cultivars. For classification of field trials scales used in State Varietal Trials are usually applied. In Hungary modified Cobb scale and data transformation into the Average Coefficient of Infection Values (ACI) is used.

Differentials :

Seedling tests :

In most countries Lr-near-isogenic lines (NILs) are used, in Hungary, Poland and Czech Republic in addition to old standard differentials (Malakoff etc.). About 30-35 Lr-NILs are used in Germany and Switzerland, about 20 in Hungary and Czech Republic, about 10 in France and the U.K. where a larger number of supplemental mostly commercial cultivars is used. Lr-NILs used in participating countries include Lr1 - Lr34. Most commonly used Lr-NILs are as follows : Lr1, Lr2a, Lr2b, Lr2c, Lr3, Lr3Ka, Lr3Bg, Lr9, Lr10, Lr11, Lr15, Lr16, Lr 17, Lr19, Lr21, Lr23, Lr24, Lr26, Lr

Following additional differentials are used : France (from 1994):Carat, Clement, Ecrin, Feuvert, Frandoc, Galahad, Galaxie, Granada, M.Huntsman, Moulin, Promentin, Tarasque and 15 commercial cultivars. United Kingdom : Clement (WBR-1), Fundin (WBR-2), Norman (WBR-2), Hobbit (WBR-2),Sappo (WBR-3), Halberd (WBR-4), Gamin (WBR-6) Sterna (WBR-7), Sabre (WBR-7). Switzerland : Sappo, Rendezvous, Kalyansona K.4.2., Trap, Mango, Partizanka. Poland : Kolibri. Czech Republic : Salzmünder Bartweizen, Germany : Salzmünder Bartweizen, Weique.

Adult plant tests :

In most countries field tests are used for the determination of resistance of economically important cultivars (grown or used in the breeding). Sometimes some Lr-NILs are included. In the U.K. standard wheat brown rust reference cultivars with resistance expressed only during later growth stages are included in the trials : Huntsman (WBR-5), Ranger (WBR-8) and Avalon (WBR-9). In France following differential set is used: Austerlitz, Broom, Clement, Ecrin, Fidel, Frandoc, Gala, Gerbier, Hobbit Lr12,Lr13,Lr22,Lr33+Lr34, M.Huntsman, Moulin, Pernel, Recital, Renan, Thésée, Virtue. In Switzerland the set comprises Lr-NILs including those with APR genes.

Leaf rust reactions on the most commonly tested Lr-NILs :

RESISTANT REACTION PREVAILED ON Lr1 (except in H,P), Lr2a (except in D,H,P), Lr2b (except in D,H,CH,P), LrBg (except in D,H,F), Lr9, Lr15 (except in D,/H/), Lr19, Lr24, Lr28 (except in D). Susceptible reaction prevailed on : Lr2c, Lr3, Lr3Ka (except F,GB,S.IRL.), Lr10 (except in H), Lr11, Lr16, Lr17 (except in/H/), Lr21 (except in/H/), Lr23 (except in H), Lr26 (except in F,CH).

Table 1 - LEAF RUST REACTIONS ON NEAR ISOGENIC LINES - SEEDLING TESTS

| | D 1 | D 2 | H 1 | H 2 | H 3 | CZ 1 | CH 1 | F 1 | B 1 | GB 1 | S.IRL 1 | F | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lr1 | R | R/S | R/S | S/R | S/R | R/S | R/S | R/S | R | R/S | R/S | R(S) | S/ |
| Lr2a | S/R | R/S | R/S | S/R | S/R | R/S | R/S | R/S | R | R | R | R(S) | S/ |
| Lr2b | S/(MR-R) | R/S | R/S | S | S/R | R/S | S/R | R/S | R | R/S | R/S | | S( |
| Lr2c | S/R | | | S | S | S/(R) | | | | | | S | S/ |
| Lr2d | S/R | | | | | | | | | | | | S/ |
| Lr3 | S/(MS) | | | S | S | S/R | | | | R/S | | S/R | S/ |
| Lr3Bg | S/(MR-R) | S/R | S/R | | | | R/S | R/S | R/S | R/S | R | S/R | |
| Lr3Ka | S/(R) | S/R | S/R | S/R | S/R | | S/R | R/S | R/S | R/(S) | R | S/R | |
| Lr9 | R/(S?) | | | R/(S) | R/S | R | | | | R/(S) | | R(S) | R( |
| Lr10 | S/R | | | R/(S) | R/S | S/R | | | | | | | S/ |
| Lr11 | S/(MR-R) | | | | | S/(MR) | | | | | | | S( |
| Lr12 | S | | | R/S | R/S | R/S | | | | | | | |
| Lr13 | S | | | S | S/R | | | | | | | | S( |
| Lr14a | S/(MR-R) | | | S/R | S/R | | | | | | | | S( |
| Lr14b | S/(R) | | | S/(R) | S/(R) | | | | | | | | |
| Lr15 | S/(R) | S/R | S/R | R | R | | R/S | R/(S) | R/S | R/(S) | R | R(S) | R/ |
| Lr16 | S/(MR) | | | S/R | S/R | S/R | | | | | | | S( |
| Lr17 | S/(R) | | | R/S | S/R | S/MR | | | | | | | S/ |
| Lr18 | S/(MR-R) | | | S/R | S/(R) | S/MR | | | | | | | S/ |
| Lr19 | R/(S?) | | | R/S | R/S | R | | | | R | | R | R( |
| Lr20 | | | | S | S/R | R/S | | | | | | | R/ |
| Lr21 | S/(MR-R) | | | R/S | S/R | S | | | | | | | |
| Lr22A | S | | | S | S/(R) | | | | | | | | S( |
| Lr23 | S/(MR-R) | | | R | R | S/MR-R | | | | | | | S( |
| Lr24 | | | | R | R | R | | | | R | | R | R |
| Lr25 | | | | R/S | R/S | R/S | | | | | | | |
| Lr26 | S/(R) | S/R | S/R | | | S/R | R/S | S/R | S/R | S/R | S | R/S | S( |
| Lr27 | | | | | | S/R | | | | | | | |
| Lr28 | S/R | R/(S) | R | | | R | R | R/S | R | R/(S) | R/(S) | | |
| Lr29 | | | | | | R | | | | | | | S/ |
| Lr30 | S/R | | | | | | | | | | | | S( |
| Lr30+Lr29 | R/(MR) | | | | | | | | | | | | |
| Lr32 | | | | | | R/S | | | | | | | |
| Lr33 | S/R | | | | | | | | | | | | S |
| Lr34 | S/(R) | | | | | | | | | | | | |
| Lr CIFF | | | | S | S | | | | | | | | |
| Lr T | | | | | | S/R | | | | | | | |
| Weique | S/R | | | | | | | | | | | | |
| Lr33+34 | | | | | | | | | | | | | S/ |

R/S resistance prevails
R/(S) " " , susceptibility rare
S/R susceptibility prevails
S/(R) " " , resistance rare

Table 2 - DIFFERENTIALS USED IN VIRULENCE SURVEYS
(P = PROPOSED DIFFERENTIALS)

| | GB 1 | CH 1 | F 1 | D 1 | H 1 | CZ 1 | P 1 | Proposed by CH | field |
|---|---|---|---|---|---|---|---|---|---|
| Lr 1 | x | x | x P | x | + x P | x + | + P | P | P |
| Lr 2a | x | x | x P | x | + x P | x + | + P | P | P |
| Lr 2b | | x | | x | + x P | + | + P | P | P |
| Lr 2c | | x | x P | x | + x P | x + | + P | P | P |
| Lr 2d | | | | x | P | | P | | |
| Lr 3 | x | x | x P | x | + x P | x + | + P | P | P |
| Lr 3bg | x | x | x P | X | | | | P | P |
| Lr 3ka | x | x | x P | x | x | | | P | P |
| Lr 9 | x | x | x P | X | X P | X | P | P | P |
| Lr 10 | | x | | x | x p | x | p | P | P |
| Lr 11 | | x | | x | + P | x + | + P | P | P |
| Lr 12 APR | | | | x | x P | X | | | P |
| Lr 13 APR | | | | x | x P | | P | | P |
| Lr 14a | | x | | x | x P | | P | P | P |
| Lr 14b | | x | | x | x p | | | P | P |
| Lr 15 | x | x | x P | x | x p | | P | P | P |
| Lr 16 | | x | | x | x p | x | P | P | P |
| LR 17 | | x | P | x | x p | x | P | P | P |
| Lr 18 | | | | x | x p | x | P | P | P |
| LR 19 | x | x | x | x | x p | x | P | P | P |
| LR 20 | | | | | x p | x | P | P | P |
| Lr 21 | | x | | x | x p | x | P | P | P |
| Lr 22 APR | | | | x | x p | | P | | P |
| Lr 23 | | x | | x | x P | x | P | P | P |
| Lr 24 | x | x | | | x P | x | P | P | P |
| Lr 25 | | x | | | x P | x | | P | P |
| Lr 26 | | x | P | x | P | x + | P | P | P |
| Lr 27 | | | | | P | x | | P | P |
| LR 28 | | x | | x | | x | | P | P |
| Lr 29 | | x | | | | x | P | P | P |
| Lr 30 | | x | | x | P | | P | P | P |
| Lr 30 + Lr 29 | | | | x | | | | P | P |
| Lr 32 | | | | | | x | | P | P |
| Lr 33 APR | | x | | x | | | P | | P |
| Lr 34 | | x | | x | P | | | P | P |
| Lr 33 + Lr 34 | | x | | | | | P | P | P |
| Lr T | | | | | | x | | P | P |
| Kolibri | | | | | | | +P | | |
| Clement | x | | | | | | | | |
| Fundin | x | | | | | | | | |
| Norman | x | | | | | | | | |
| Hobbit | x | | | | | | | | |
| Sappo | x | x | | | | | | | |
| Halberd | x | | | | | | | | |
| Gamin | x | | | | | | | | |
| Sterna | x | | | | | | | | |
| Sabre | x | | | | | | | | |
| Rendezvous | | x | | | | | | | |
| Kalyansona K.4.2. | | x | | | | | | | |
| Trap | | x | | | | | | | |
| Mango | | x | | | | | | | |
| Partizanka | | x | | | | | | P | P |

\+ standard differentials (i.e. Malakoff etc.)

References to the tables

Table 1

D-1 Walther, U.: Personal communication.

D-2, H-1, CH-1, F-1, B-1, GB-1, S.IRL-1 Felsenstein, F.G., Fischbeck,G.: Erste Ergebnisse zur grossräumigen Differenzierung der Virulenz des Weizenbraunrosts gegenüber den Resistenzgenen Lr1, Lr2a, Lr2b, Lrbg, Lrka, Lr15, Lr26 und Lr28. Vorträge für Pflanzenzüchtung, 28, 1994. 171-174.

H-2 "Virulence/avirulence of leaf rust isolates on near isogenic lines (seedling stage), Xerox from Szeged, September 1994.

H-3 "Frequencies of virulence to wheat leaf rust on seedlings of near isogenic Lr lines during 1990-1992". Xerox from Szeged, September 1994.

CZ-1 Bartoš,P., Stuchlíková,E., Hanušová,R.: (Physiologic specialization of wheat leaf rust /Puccinia persistens Plow. var.triticina (Eriks.)Urban et Marková/ in Czechoslovakia in the years 1987-1990).Genet. a Šlecht.,28, 1992, 103-119 Orig.Czech.

Table 2

GB-1 Jones,E., Clifford,B.: Brown rust of wheat and barley. In: First information pamphlet... COST Action 817.

CH-1 Winzeler,M.: In: First information pamphlet... COST 817.

F -1 Goyeau,H.: Personal communication.

D -1 Walther,U.: Personal communication.

H -1 "Frequencies of virulence to wheat leaf rust on seedlings of near isogenic Lr lines during 1990-1992". Xerox from Szeged, September 1994.

CZ-1 Bartoš,P. at al. see reference to Table 1.

P -1 Strzembicka,A.: Personal communication.

COST 817, WG 1
Subgroup 'Wheat and barley leaf rust'

**Minutes of the subgroup meeting held in Thiverval Grignon, March 30th - 31rst 1995**

1- Collaborators agreed to use a common core of 20 differentials for the virulence survey on seedlings in the respective countries. The set of differentials includes the differentials used in the U.S. and Canada.

Core differentials are: *Lr 1, Lr 2a, Lr 2b, Lr 2c, Lr 3, Lr 3bg, Lr 3ka, Lr 9, Lr 10, Lr 11, Lr 15, Lr 16, Lr 17, Lr 19, Lr 21, Lr 23, Lr 24, Lr 26, Lr 28, Lr 30.*

50 grams of each differential will be provided to each participant by Dr Mesterhazy by the end of September.

2- Conditions (temperature, light, photoperiod) of the seedling tests cannot be standardized because of different facilities available for each collaborator. However, the conditions should be always stated together with the results.

3- All the results of the virulence surveys should be sent to Dr Bartos, who will then redistribute it to all collaborators.

4- All results about the presence of leaf rust resistance genes in European varieties or breeding lines should be sent to Dr Walther, who will redistribute it on request.

5- The collaborators agreed to share germplasm containing specific resistance genes against leaf rust.

6- More effort should be put on the characterization of adult plant resistance genes. For this purpose, the collaborators agreed to establish an adult plant resistance nursery for wheat leaf rust. Each collaborator should provide up to 5 varieties or breeding lines with pure adult plant resistance in the respective country. The seeds (100 grams for each entry) should be sent to Dr Winzeler, FAP-Reckenholz, CH-8046 Zurich, Switzerland, by the end of August each year. Dr Winzeler will send the nursery to each collaborator by the end of September. The nursery should be grown under natural disease pressure, or with artificial inoculation with leaf rust races which are representative for the respective countries. In order to estimate the disease pressure, each collaborator grows 1 to 2 susceptible local standards together with the nursery. Dr Mesterhazy will send 100 grams of seeds of the near-isogenic Thatcher lines with adult plant resistance genes to Dr Winzeler. These lines will be included in the nursery.

7- Every collaborator will present his scoring system for seedling and adult plant tests at the next meeting in December. The standardized scoring system for virulence survey and field tests will be discussed during the next meeting.

8- Every collaborator will prepare a list of available leaf rust isolates until the next meeting.

9- Statistical procedures to analyse virulence survey data were discussed. During the next meeting, the results of the different surveys will be compared, and the possibility of a common data analysis will be discussed. Dr Ciccarone offered to analyse virulence data on a European scale.

10- More attention should be payed on virulence data on durum wheats. Dr Goyeau will collect data about virulence and resistance on durum wheat.

11- Exchange of susceptible standard cultivars is recommended. Such an exchange can be organised together with the entries of the adult plant resistance nurseries.

Dr. Bartoš, Dr Winzeler.

COST 817 WG 1 Wheat leaf rust sub-group XII. 1995

Summary of the questionnaire

Incidence of wheat leaf rust in 1995 :

U.K. low number of samples received, F-average, D-high but late
I-low, P-average, CZ-average, locally late and high, SK-average,
H-average

New sources of leaf rust resistance :

U.K.-Brigadier, Hussar, Hunter, Genesis, Hereward, Spark,Beaufort,
Dynamo, Flame, Promessa, Chablin, Shiraz,
CZ-lines from crosses with Soldur, Amigo, W48

Genes for leaf rust resistance in the grown cultivars :

U.K.-see the grouping of cultivars
F-Lr3,Lr26
D-Lr26(13cvs.)
I-Fiocco, Maestra (Lr26)
P-Lr3, Lr26, Lr13? (from U.K. cultivars)
CZ-Lr3,Lr26 + undetermined
SK-Lr3, Lr26 + undetermined

Suggestions for postulation of resistance genes

U.K.
F-Ritmo, Forby, Rossini, Eureka, Sideral
D-Lambros, Xanthos, Transit, Batis, Campus
I-Creso, Fenice (T.durum), Elia
CZ- Estica, Contra, Konsul, Agent, Vlada, Siria, Greif
SK- Barbara, Rada, Sana, Solida

Suggestions for unified scoring system

U.K.-two temperatures: $10^{\circ}$and $25^{\circ}$C, IT . Field: % on flag leaf,IT
F-after Stakman (1962), IT
D-IT O; -4 . Field % of leaf area, ADPC transformed to 1-9
I-
P-
CZ-IT O;-4. Field : % leaf area
H-modified Cobb scale. ACI-average coefficient of infection

Suggestions for unified nomenclature

U.K.-based on Lr lines
F-octal system after Brian or North American System
D-triplet code : special, additional, local sets
I-
P-
CZ-triplet code
S-

Other suggestions

F-are all 20 lines useful? Comparison of whole leaf and leaf segment method by ring test. Addition of Lr34, problem of temperature for testing.

Results of the pathotype/virulence survey

(U.K. 1994-low virulence on Lr1 and Lr2a, avirulence on Lr9,Lr19, Lr24.Races virulent on Lr9 at 10°C available)

F-Low virulence on Lr1 and Lr2a. On Lr2c usually 100% virulence. Problem on 95 seed stock? Most isolates have same reactions on all Lr3 alleles. All isolates were avirulent on Lr9 and Lr19; Lr24 and Lr28 were not tested. Most isolates were avirulent on Lr2b, Lr23 and Lr26 and virulent on Lr30.

D-Relatively low virulence on Lr1 (27%), prevailing virulence on Lr2a. Hihg virulence on other Lr lines except Lr9. On Lr19 surprisingly one third of isolates virulent. Reaction on all Lr3 alleles identical, only 2.2% isolates avirulent. Surprising is virulence on Lr28 (100%).

I-Very low virulence on Lr1, no virulence on Lr2a, low virulence on Lr2b and Lr15. Reactions on Lr alleles identical except one isolate. No virulence found on Lr9, Lr19, Lr24 and Lr28. Avirulence also prevails on Lr17 and Lr26.

P-Virulence on Lr1 is surprisingly high (89%). No virulence was found on Lr9, Lr19 and Lr24.

CZ-Low virulence on Lr1, Lr2a and Lr 2b. No virulence on Lr9, Lr19, Lr24, Lr28.

SK-Low virulence on Lr1, Lr2a and Lr2b. No virulence on Lr9, Lr19, Lr24 and Lr28.

Summary

Prevailing virulence on Lr2c, Lr3 alleles, Lr10, Lr11, Lr15 (except Italy and France), Lr16, Lr17 (except Italy), Lr21, Lr23 (except France), Lr26 (except Italy and France) and Lr30.

Prevailing avirulence on Lr1, Lr2a, Lr2b.

No virulence on Lr9, Lr19, Lr24, Lr28 (except D-Lr19-33.3%,Lr28-100%

Similarities : F with I, D with P, CZ with SK

Leaf rust isolates available for exchange (number)

UK-4, D-7, F-12+, I-19, P-1, CZ-7

Summarized by P. Bartoš

COST 817, WG 1

Subgroup "Wheat and Barley Leaf Rust"

Minutes of the Subgroup meeting held in Cambridge, U.K., December 11-12, 1995.

*A) Wheat leaf rust*

**1. Review of progress since previous meeting**

-Seeds of the differentials for wheat leaf rust (Thatcher NILs) have been distributed to all collaborators by Dr. Mesterházy.

-A common nursery for adult plant resistance to wheat leaf rust has been set up and distributed to all collaborators that sent in seeds of entries. The future of this nursery was discussed. More entries will be added from France, U.K. and Germany. Short description of the entries (pedigree, genes for seedling resistance) will be appreciated.

-Results of virulence surveys in the different countries were compared. Differences in virulence frequencies are pre sent for several genes. Results were summarized and distributed to the participants.

-Some new data about the presence of resistance genes in the grown cultivars were presented.

-Germplasm with new resistance genes was exchanged.

**2. Core differentials, nomenclature of pathotypes and methods**

-The collaborators agreed to use a common set of 15 differrentials Lr1, Lr2a, Lr2b, Lr2c, Lr3, Lr9, Lr11, Lr15, Lr17, Lr19, Lr21, Lr23, Lr24, Lr26, Lr28. The set was reduced by 5 differentials compared with the previous year.

### 3. Plans for the future

The work in the future will focus on the composition of data from virulence surveys across Europe. Investigation of genes present in the grown cultivars will be carried out across Europe. Gene identification with specific pathotypes will be established using the agreed methods and pathotype descriptions. Sources of resistance will be exchanged. Some collaborators will compare the methods with intact seedlings versus detached leaves.

### 4. Review of membership

Dr. Unger from Langenstein (Nordsaat, Germany) was participating for the first time. He will especially take part in the adult plant resistance nursery.

### 5. Next meeting

Next meeting will be held at Wageningen during the Cereal rusts and powdery mildews conference between September 2 and 6, 1996.

## 2. Barley leaf rust

1. Differentials for barley leaf rust were discussed and the following set has been agreed :

| Cultivar | Pa gene | Code |
|---|---|---|
| Sudan | 1 | $2^0 = 1$ |
| Peruvian | 2 | $2^1 = 2$ |
| Simon/Estate | 3 | $2^2 = 4$ |
| | | |
| Gold | 4 | $2^0 = 1$ |
| Magnif | 5 | $2^1 = 2$ |
| Bolivia | 6+2 | $2^2 = 4$ |
| | | |
| Cebada Capa | 7 | $2^0 = 1$ |
| Egypt | 8 | $2^1 = 2$ |
| Hor. 2596 | 9 | $2^2 = 4$ |
| | | |
| Triumph | 10 | $2^0 = 1$ |

The last triplet code is open for new genes of resistance. This set of differentials will be tested in 1996.

Total virulence in %

Wheat leaf rust

| Lr \ country | UK.* | F. | D. | I. | P. | CZ. | SK. | CH. | D.d | CH.** |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 9 | [illegible] | 1.2 | 89 | 6,1 | 4,8 | 2 | 10,4 | [illegible] |
| 2a | 0 | 0 | [illegible] | 0 | 85 | 6,1 | 4,8 | 77 | 70,1 | [illegible] |
| 2b | – | [illegible] | [illegible] | 3,6 | 98 | 9,7 | 14,3 | 94 | 97,0 | [illegible] |
| 2c | – | 57 | [illegible] | [illegible] | 98 | 93,7 | 95,2 | [illegible] | 62,6 | [illegible] |
| 3 | 9 | 50 | [illegible] | 62,2 | 99 | 98,8 | 95,2 | 56 | 64,2 | [illegible] |
| 3bg | 9 | 50 | 86,7 | 59,7 | – | 98,8 | 95,2 | [illegible] | 62,6 | [illegible] |
| 3ka | 6 | 50 | 86,7 | 56,1 | – | 98,8 | 90,5 | 50 | 62,6 | [illegible] |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | [illegible] |
| 10 | – | 50 | 100,0 | 73,2 | 76 | 69,5 | 90,5 | 72 | 100,0 | [illegible] |
| 11 | – | 50 | 100,0 | 56,1 | 91 | 100 | 95,2 | 75 | 100,0 | 85,2 |
| 15 | 3 | 0 | 97,6 | 3,6 | 87 | 87,8 | 80,? | 37 | 88,6 | [illegible] |
| 16 | – | 50 | 100,0 | 100,0 | 100 | 100 | 100 | 82 | 100,0 | 87,0 |
| 17 | – | 10 | 100,0 | 28,0 | 100 | 100 | 85,7 | 65 | 97,0 | 59,8 |
| 19 | 0 | 0 | [illegible] | 0 | 0 | 0 | 0 | 0 | 32,8 | [illegible] |
| 21 | – | 0 | 100,0 | 63,4 | – | 98,8 | 100 | 75 | 100,0 | 72,0 |
| 23 | – | 25 | 68,? | 75,7 | 100 | 100 | 100 | 41 | 44,2 | [illegible] |
| 24 | 0 | – | – | 0 | 0 | 0 | 0 | 1 | – | 7,9 |
| 26 | – | 25 | – | 29,3 | 90 | 95,1 | 95,? | [illegible] | 92,5 | 41,3 |
| 28 | – | – | 100 | 0 | – | 0 | 0 | 0 | 92,5 | 4,6 |
| 30 | – | 75 | 100 | 76,8 | 98 | 98,8 | 100 | 71 | 98,5 | 76,8 |
| Salzm. B. | | | 91,1 | | | | | | | |
| [illegible] | | | 91,1 | | | | | | | |
| note | | | | a) | | | | | | |

Barley leaf rust

| Pa | D. |
|---|---|
| 1 | 100 |
| 2 | 82-100 |
| 4 | 100 |
| 2+6 | 32,5-100 |
| 8 | 100 |
| 7 | 0 |
| 2+5 | [illegible] |
| 3 | 79,1 |
| 9 | 100 |
| Tr. | 98 |
| H^b | 2,7 |
| H^c | 91,5 |

* 1994, results of 1995 not available in Dec.1995

** average of last 15 years

– not tested

a) on Lr10, Lr17 and Lr23 many reactions are MR or MS

b) HOR 1132 sel.

c) HOR 500-1

d) final results of 1995

Tr Trumpf

# Subgroup 5: Fungicide sensitivity

(coordinators: F. Felsenstein, Weihenstephan, D, and B. Nielsen, Lyngby, DK)

**Aims**

Coordination of european research with fungicide sensitivity of airborne pathogens. A first step is to make results comparable by exchanging and ring testing of isolates. Methods will be exchanged and if appropriate coordinated. Furthermore, a compilation of data on resistance factors of various fungicides in Europe will be made. The final goal is to provide the results to practice and hence to improve anti-resistance strategies for disease control.

A network has been established between 9 research groups in Europe working with sensitivity surveys on cereal mildews.

**Results 1995**

There have been three subgroup meetings in 1995: Grignon, France, march 30th-31st, Lyngby, Denmark, october 18 and Cambridge, UK december llth-12th. On the basis of a questionnaire, working plans and methods have been listed for the different european groups. Methods have been discussed and problems identified. The first step in the ring test was carried out with exchange of standard and selected isolates. Test methods and preliminary results were evaluated.

The group identified specific goals for the comming two years:

1996 Ring test of standard and selected isolates continued. Evaluation of results. Discussion of methods on calculating ED50 values and resistance factors.

1997 Publication of the ring test. Recommendation on methods for calculating ED 50 values and resistance factors. First step on database on resistance factors. Collection of available data on fungicide efficacy under field conditions and corresponding sensitivity of mildew populations. Interpretations of resistance factors in terms of disease control in the field.

On the MC meeting in Cambridge, UK december 1995 it was decided that the fungicide sensitivity subgroup should continue as an ordinary working group. From 1996 the name is **working group 6, Fungicide sensitivity.**

# Subgroup 5: Fungicide sensitivity

(coordinators: F. Felsenstein, Weihenstephan, D, and B. Nielsen, Lyngby, DK)

**Aims**

Coordination of european research with fungicide sensitivity of airborne pathogens. A first step is to make results comparable by exchanging and ring testing of isolates. Methods will be exchanged and if appropriate coordinated. Furthermore, a compilation of data on resistance factors of various fungicides in Europe will be made. The final goal is to provide the results to practice and hence to improve anti-resistance strategies for disease control.

A network has been established between 12 research groups in Europe working with sensitivity surveys on cereal mildews.

**Results 1995**

There have been three subgroup meetings in 1995: Grignon, France, march 30th-31st, Lyngby, Denmark, october 25 and Cambridge, UK, december 8th-12th. On the basis of a questionnaire, working plans and methods have been listed for the different european groups. Methods have been discussed and problems identified. The first step in the ring test was carried out with exchange of standard and selected isolates. Test methods and preliminary results were evaluated.

The group identified specific goals for the comming two years.

1996 Ring test of standard and selected isolates continued. Evaluation of results. Discussion of methods on calculating ED50 values and resistance factors.

1997 Publication of the ring test. Recommendation on methods for calculating ED 50 values and resistance factors. First step on database on resistance factors. Collection of available data on fungicide efficacy under field conditions and corresponding sensitivity of mildew populations. Interpretations of resistance factors in terms of disease control in the field.

On the MC meeting in Cambridge, UK december 1995 it was decided that the fungicide sensitivity subgroup should continue as an ordinary working group. From 1996 the name is working group 6, Fungicide sensitivity.

Minutes from meeting in COST Fungicide Sensivitity Survey Subgroup (CFSS), Grignon, France. March 30th-31st 1995

Participating in meeting: T. Engels, F. Godet, F. Felsenstein, M. Sykora, S. Plesnik, B.J. Nielsen and A. Mesterhazy (some of the discussions)

1. CFSS.- questionnaire

A questionnaire was sent out in March (Bent J. Nielsen) and answered by 9 institutions. Copies are sent to those not participating in the Grignon meeting. The questionnaire was only briefly discussed and any comment, changes etc. can be sent to Bent J. Nielsen. A revision will be given out at the next meeting.

List of active members in the CFSS-group are enclosed.

2. Aims and working plans

Aims and working plans for the group was discussed and presented on the plenum meeting (enclosed).

It was decided to test each others standard isolates.

The aim is to exchange standard isolates and some interesting isolates with high resistance factors and test them in the different laboratories to make results more comparable.

A more detailed working plan for the subgroup was decided:

*Working plan*

*1995*

| | |
|---|---|
| *April:* | Group members which were not present at the Grignon meeting are asked whether they are interested to participate in the ring test. |
| *April-May:* | Isolates are sent to the different group members (list will be provided by Bent J. Nielsen).<br><br>*Barley:* DK, Munich, Slovakia and possibly: Czh, UK, Giessen, Scotland.<br>*Wheat:* DK, Munich, Neth, Slovakia and possibly: Czh, UK, Scotland. |
| *Summer:* | Test of standard isolates on the following fungicides:<br>1. fenpropimorph<br>2. epoxyconazole<br>3. propiconazole<br>4. other fungicides can be included |
| *Sep.-October:* | First results are send to F. Felsenstein to make summary |
| *October 18* | Meeting. Riso, Denmark. Before the COST epidemiology meeting.<br>Discussion of results of standard isolate test. Discussion on the database project.<br>Discussion of meeting in Slovakia in march-april.. |

| | |
|---|---|
| *December* | Meeting. Cambridge. During the next "official" WG 1 Cost meeting. Continuation of standard isolate test. Plans for database project. |
| *1996* | |
| *March-April* | Meeting. Slovakia. Only the fungicide sensitivity survey sub group. Final decision about this meeting will be taken at the Risø meeting, october 1995. |
| Other activities : | Continuation of ring test. New fungicides will be discussed<br>Comparability of data.<br>Start on database on fungicide sensitivity (based on resistance factors).<br>Collection of available data on fungicide efficacy under field conditions and sensitivity of mildew populations. |
| *September* | Meeting. Wageningen, Netherlands. Rust/mildew conference |
| *1997* | Interpretation of resistance factors in terms of disease control in the field. |
| *Autumn* | Meeting. Pragh, WG 1 meeting (?) |
| *1998*: | Database available for practice. European information map on sensitivity of important cereal fungicides<br><br>Defining anti resistance strategies improving disease control in the field. |

3. Information exchange

It was decided to exchange important information in the sub group regarding fungicide resistance in cereals (e.g. anti resistance strategies, use of fungicides, new publications, publications in "local" journals etc.) to keep the group informed about the development in the different countries.

4. Meetings

| | |
|---|---|
| October 18, 1995 | Risø, Denmark. Before the COST meeting in the epidemiology. |
| December 1995 | Cambridge. During the next "official" WG 1 Cost meeting. |
| March-April 1996 | Slovakia. Only the fungicide sensitivity survey sub group. |
| September 1996 | Wageningen, Netherlands. Rust/mildew conference. |
| Autumn 1997 | Pragh WG 1 meeting. |

06.04.1995
Bent J. Nielsen

osemary Bayles
ational Institute for Agricultural Botany
untingdon Road
K-Cambridge CB3 OLE
nited Kingdom
el.: 44 223 27 63 81
ax: + 44 223 27 76 02
-mail:

Karel Klem
Agricultural Research Institute Kromeriz, Ltd.
Havlickov 2787
P.O. Box 55
CZ 767-41 Kromeriz
Tel.: 42 634 426 139
Fax: + 42 634 227 25
E-mail:

Friedrich G. Felsenstein
Institut für Pflanzenbau und Planzenzüchtung
Technische Universität München
Weihenstephan
D-85350 Freising
Tel.: + 49 8161 71 3562
Fax: + 49 8161 71 4511
E-mail:

J.G. Engels
epartment of Phytopathology, WAU
innenhaven 9, P.O. Box 8025
'00 EE Wageningen
ne Netherlands
el.: + 31 8370 83121
ax: + 31 8370 83412
il: ENGELS@RCL.WAU.NL

Milan Sykora
Department for Genetics
Faculty of Natural Sciences
Mlynska Dolina B-1
SK-842 15 Bratislava
Tel.:
Fax: + 42 77 29 064
E-mail:

Francoise Godet
Laboratorie de résistance
Service Régional de la Protection des Végétaux
93 rue de Curembourg, B.P. 210
F-45403 Fleury les Aubrais France
Tel.: ~~[illegible]~~ 38221115
Fax: + 33 1 38 84 19 79
E-mail:

ona J. Burnett
ottish Agricultural College Crop Science and
chnology Department
est Mains Road, Edinburgh
19 3JG United Kingdom
l.: 44 31 667 1041
x: + 44 31 667 2601
mail:

Jörn Pons
Biometry and Population Genetics
Giessen University
Ludwigstr. 27
D-35390 Giessen, Germany
Tel.: + 49 641 702 9731
Fax: + 49 641 702 9724
E-mail: gh72@agrar.uni-giessen.de

Bent J. Nielsen
Danish Institute of Plant and Soil Science
Depart. of Plant Pathology and Pest Management
Lottenborgvej 2
DK-2800 Lyngby, Denmark
Tel.: + 45 45 87 25 10
Fax: + 45 45 37 77 07
E-mail: dipsafpr@inet.uni-c.dk

# Meeting of the Fungicide Sensitivity Subgroup WG1 (COST 817)
## Wednesday 18 October, Lyngby, Denmark

**Present:** F. Felsenstein (D) B. Nielsen (DK) R. Bayles (UK) A. Engels (NL) M. Jahn (D) J. Pons (D) F. Godet (F) K. Klem (CZ).

### 1. Fungicide sensitivity studies in Denmark

B. Nielsen presented a short introduction to the use of fungicides to control cereal powdery mildew in Denmark and fungicide sensitivity studies.

### 2. Exchange of isolates for 'ring test'

Participants exchanged isolates to be used in the fungicide sensitivity 'ring test'. Details of the isolates are given in Tables 1 & 2. Participants provided at least one standard sensitive isolate, being the one(s) used in all tests to represent base-line sensitivity before selection. A number of isolates with reduced sensitivity were also exchanged.
It was agreed that it would be vital to compare and harmonise the standard sensitive isolates in order to enable comparison of results between countries and build up a European picture of fungicide sensitivity. Without this critical step it would remain impossible to communicate effectively between workers.

### 3. Visit to facilities for fungicide sensitivity testing at Lyngby (B. Nielsen).

The facilities for fungicide spraying and the maintenance of pure isolates were demonstrated. During this visit there were detailed discussions on various aspects of the operations and comparisons were made with techniques used in other countries to achieve the same objectives. Throughout, it was recognised that techniques will continue to vary and that harmonisation can only be achieved through the 'standard' isolates.

### 4. Calculation of $ED_{50}$ and Resistant factors

It was agreed that a factor of 2 for fungicides dose rates was most effective for determining $ED_{50}$ values. As many as 10 rates might be required, depending on the sensitivity span of the pathogen population. Probit analysis was the standard method for fitting the dose-response curve.
J. Pons agreed to analyse the ring test data using the probit analyses available in the statistical packages SPSS and SAS. Participants should send him their results as soon as possible.
A. Engels offered to distribute a Lotus 1-2-3 based program for determining $ED_{50}$'s, written at Wageningen, to members of the group.

## 5. Plans for future work.

The stages envisaged were:

(I) achieve comparability of results by ring tests of standard isolates.
(II) publish ring test results
(III) compare resistance factors across Europe from data provided by group members
(IV) if appropriate, develop collaborative research proposals

## 6. Data and place of next meeting

Data: 2 days in late May 1996
Place: either Giessen# (local organiser: J. Pons)
or Munich ## (local organiser: F. Felsenstein)

# first choice
## second choice

Table 1: Wheat mildew isolates exchanged for ring testing

| Country | Isolate Code | Description | $ED_{50}$/ level of insensitivity | | |
|---|---|---|---|---|---|
| | | | FPM# | EPOX | PCZ |
| D | Be | sensitive standard | 0.15 | 0.03 | 0.10 |
| | W 72 | sensitive standard | 0.14 | 0.04 | 0.10 |
| NL | LH | sensitive standard | 1.5 | - | - |
| | 67 | sensitive standard | 1.5 | - | - |
| F | SLO | sensitive standard (bulk) | 10 | - | - |
| | W72 | | 25 | - | - |
| | BE | | 2 | - | - |
| CZ | I280 | sensitive standard | - | 0.118 | - |
| UK | WC/14 | sensitive standard | sensitive | - | - |
| | WC/122 | | low | - | - |
| | W94/71/3 | | higher | - | - |
| | W94/17/4 | | higher | - | - |

# FPM Fenpropimorph
EPOX Epoxiconazole
PCX Propiconazole

Table 2: Barley mildew isolates exchanged for ring testing

| Country | Isolate Code | Description | $ED_{50}$ / level of insensitivity | | | | |
|---|---|---|---|---|---|---|---|
| | | | FPM[##] | EPOX | PCZ | TDM | ETH |
| D | GI | sensitive standard | 0.13 | 0.03 | 0.08 | - | - |
| | Ru 2 | sensitive standard | 0.13 | 0.03 | 0.08 | - | - |
| | GI 11.11 | | - | - | - | 348.34[#] | 6.59[#] |
| | GI 16.11 | | - | - | - | 173.21[#] | 12.41[#] |
| | GI 16.14 | | - | - | - | 7.40[#] | 10.74[#] |
| | GI 16.15 | | - | - | - | 140.57[#] | 257.12[#] |
| UK | CC/1 | | - | - | - | - | insensitive |
| | CC/67 | | - | - | - | low | - |
| | CC/148 | | low | - | - | - | - |
| | B94/34/3 | | higher | - | - | - | - |
| | B94/112/3 | | higher | - | - | - | - |

[#] seed treatment

[##] FPM Fenpropimorph
EPOX Epoxiconazole
PCX Propiconazole
TDM Triadimenol
ETH Ethirimol

## WG2: Variety and species mixtures to control airborne diseases of cereals

(coordinators M. Wolfe and M. Finck, Zürich, CH)

**Aims**

- To maintain and improve cooperative and networking links among interested research groups in Europe and other parts of the world.
- To organise and conduct cooperative research on the utility and feasibilityof growing mixtures, particularly for control of airborne diseases.
- Exchange and training of scientists working on mixtures. (Note: the main interest at the oment is in cereal variety and species mixtures, but this is not exclusive - involvement with other crops is welcomed).

**Results of work in 1995**

- Second Working group meeting held in Hannover Germany on March 17 1995, succeeding the German workshop on Saatgut und Sortenwesen where cultivar mixtures were the main topic.
- A questionnnaire on the use and distribution of cereal mixtures in Europe and elsewhere was discussed and will be distributed in April 1996 so results will be ready for the third working group meeting. The questionnnaire will form the basis for a WWW home page on mixtures.
- Working group meeting 1996 in Poland established combined with extended field visit to the experimental sites in Poland where cultivar and species mixtures are investigated.

Eidgenössische Technische Hochschule Zürich
Ecole polytechnique fédérale de Zurich
Politecnico federale di Zurigo
Swiss Federal Institute of Technology Zurich

*Institut für Pflanzenwissenschaften*
*Bereich Phytomedizin/Pathologie*

*Martin S. Wolfe,*
*Maria R. Finckh*
*Phone: (41-1) 632 38 47/ 48 or 632 22 55*
*Fax: (41-1) 632 11 08*
*E-mail: MFINCKH@IPW.AGRL.ETHZ.CH*

*Phytomedizin/Pathologie*
*ETH Zentrum/LFW*
*Universitätstr. 2*
*CH-8092 Zürich*

Dr. Hanne Ostergard
Plant Biology Section Riso National Laboratory
P O Box 49
DK-4000 Roskilde

Denmark

**Population Studies of Airborne Pathogens on Cereals as a means of Improving Strategies for Disease Control**

**COST Action 817**

**Mixtures Working Group. Chair: Martin S. Wolfe and Maria R. Finckh, Zürich, Switzerland**

Zürich, 24. March 1995

Dear Colleague,

Please find enclosed the minutes of the mixtures working group meeting that took place on the 17 March 1995 at the University of Hannover, Germany. Also, please take note that the phone number and e-mail address for us have changed (see letter head).

This letter is being distributed to all the persons that expressed their interest in the Diversification in Crops directory to Adrian Newton in 1992. In order to keep the mailing costs and especially the work involved to a minimum we would like to know from you if you are still interested in receiving the information from our group (minutes of meetings, relevant reports, address list, etc). If you are indeed interested, please take a minute to return the stub at the end of the minutes with the address information we have included to us indicating any corrections you wish to make. If we do not receive this stub from you by May 30 1995, we will remove your name from the mailing list until we learn otherwise from you.

With our best regards,

M.S. Wolfe M.R. Finckh

enclosures: Minutes of meeting, Information about rust and mildew network, Information about WWW interface for mixture information base

**Mixtures Working Group. Chair: Martin S. Wolfe and Maria R. Finckh, Zürich, Switzerland**

**Population Studies of Airborne Pathogens on Cereals as a means of Improving Strategies for Disease Control**

**COST Action 817**

MINUTES OF WORKING GROUP MEETING

17. MARCH 1995, HANNOVER, GERMANY

**Agenda:**

1. Introduction and objectives of the meeting (M.S. Wolfe)

2. Discussion of workshop of the Working Group on Seed Production and Varietal Matters preceeding this meeting in Hannover.

3. Up-dating of research results and other activities (all participants)

   a) Individual projects

   b) Joint projects/ research proposals

   c) Information on EU proposals

4. Next meeting

5. Any other business

Martin Wolfe chaired the meeting. Representatives from England, Denmark, Poland, Czechia, France, and Switzerland attended the meeting.

**ad 1.Objectives**

Martin Wolfe presented the main objectives to discuss:
a) Meeting of the Working Group on Seed Production and Varietal Matters
b) up-dating
c) future plans

**ad 2. Working Group on Seed Production and Varietal Matters**

This working group is composed of breeders, other scientists and administrators from the German-speaking part of Europe who come together periodically for discussion. The meeting was concerned with variety mixtures and multilines which since the unification of Germany has been an important topic of discussion. The reason is, that before unification over 90% of the barley production in former east Germany was done in variety mixtures with great success as well in feed as in malting barley production. Since unification, growing of mixture has almost ceased.

Martin Wolfe gave an overview over the topics that were discussed:

A) Pathological aspects of mixtures
- i) Forecasting of mixture performance (disease)
- ii) Non-specific diseases
- iii) Control of other pest (insects, weeds) in mixtures
- iv) induced resistance (only discussed periferal)

B) Scientific aspects besides pathology
- i) Other effects, especially yield and yield components and quality (malt, baking)
- ii) Yield stability analysis
- iii) Mixing ability analysi
- iv) yield structure
- v) species mixtures

There was disagreement as to how similar cultivars or breeding lines should be to make them good mixing partners. One speaker argued that mixing partners should not differ in their developmental stages to prevent possible problems of preemptive competitive interactions among cultivars, e.g. for nutrients. Another point of view was that niche differentiation in timing could be beneficial, especially if slow-release fertilizers were used. There was general agreement that mixtures possess greater yield stability than pure stands and that yield increases are usually small to non-existing but also no decreases.

C) Administrative aspects
- i) Multiplication/ marketing of mixed seed
- ii) Differences in promotion of mixing strategy in different countries
- iii) Quality

The most difficult problems about mixtures appeared to be of administrative nature. In former east Germany mixtures were multiplied as mixtures for one generation before selling them as seed. Thus, the exact proportion of the different components was unknown. This was argued by the administrator from the Bundessortenamt is an insurmountable problem as it is not clear how to distribute royalties and the product cannot be labeled exactly. Also, EU rules prohibit the sale of 1st year mixture seed. On the other hand, it was argued that mixing after pure line production is too cumbersome to be practical. L. Munk reported, that in Denmark mixtures are put together after seed multiplication for sale as such. The seed board has to allow specific mixtures based on the resistances of the components, however, to insure best possible disease reduction effects. Another curious problem is the quality issue because several independent studies clearly showed that superior or adequate malting or baking quality can be achieved when compatible cultivars are mixed together. Despite this, the industry (millers and malsters) appears to have difficulties in accepting mixtures for processing.

**ad 3, updating**

a) Individual projects.
There is some work going on on non-specific diseases: A. Newton in England works on Rhynchosporium and mixtures. This project is to be terminated next year. In Switzerland, M. Wolfe's group is working on the Septorias on wheat.
E. Gacek has found some generally weed suppressive effects in some species mixtures in Poland. They are in the process of setting up experiments with cultivar and species mixtures and their effects on weeds and insect pests in addition to diseases.
M. Finckh discussed the analysis of competitive interactions in cereal mixtures on a temporal basis. This can be done because grasses have a distinct tillering and seed production phase. The number of tillers is determined early on whereas the seed size is determined later in the season. Both parameters can be measured without destructive sampling on the same plants/plots. They

can be influenced by competitive interactions and the timing of fertilizer availability. Especially in low-input systems with organic nitrogen sources applied only once in slow-release form, such interactions might become very important.
M. Wolfe and M. Finckh presented and discussed different methods that are available to determine yield stability. It appears that there are still no generally good methods available to determine yield stability unambiguously. By applying several analyses to the very extensive data sets of E. Gacek and H. Czembor from Poland, it was possible, however, to show that over years and locations, mixtures exhibited much greater stability than pure stands.

b) joint projects and proposals.

The **Rust/Mildew network** has been established on the internet as a news group since early January this year. The information on subscription etc is included in this letter so anyone interested can subscribe. **Please spread this information to people that might be interested as the total use of the newsgroup will decide if it will continue existing after 6 months.**

Martin Wolfe proposed to produce a comprehensive **information resource base** about the current mixture situation. The information that we need would be among others:

- Who is growing mixtures, what kind of mixtures, how much of it?
- What are the results of the mixtures grown?
- What are the problems?
- Anecdotal information

This information could be collected on a per country basis and should be dated.
The purpose of this resource base would be to help all of us during disuccions, presentations and writing of publications. Also, many of us are approached by journalists and writers and it is often difficult to provide the kind of data they would need for their purpose. If we had this information available this could help us in the promotion of the mixture and diversification issue in general.
M. Wolfe and his group volunteered to draft a first letter and questionnaire that could serve as a beginning for this resource base.
Adrian Newton volunteered to look into the possibilities to have the information accessible through the World Wide Web and he already produced the necessary information about the approximate cost and the outline for us. This is appended to this letter. To set up the www network connection willcost approximately 2000 ECU until 31. July 1996.

c) EU proposals. There have been a number of proposals submitted in which different groups are participating. Because of the confidential nature of these projects we will only be able to report on funded projects once the decision has been made in Brussels.

**ad 4. Next meeting**

H. Czembor and E. Gacek have kindly invited us to have the next group meeting in the summer 1996, probably in June in Poland. This would allow us to visit their field trials as well in Radzikow, near Warsaw as in Bakow, further south. As these are some of the largest cultivar and species mixture trials currently going on this is especially exciting.

**ad 5. Varia.**

Lisa Munk reported on plans by the Danish group and James Brown et al from Norwich, England to conduct a one-week **Training course on the genetic structure of populations.** The course will allow for 25-30 participants. No time or place for the course has been set so far.

**Membership in this working group.** With the last minutes you received the list which was accidentally titled "COST-list" instead of "list of interested persons". Only persons from EU member and associated states that are working on air-borne pathogens can be official members of the COST working group per se. This means, they might be eligible for some reimbursement of travel costs (two persons per country usually). However, as we are all well aware of interactions in the real world we very much appreciate interactions with anyone who is interested in the different aspects of crop diversification.

**If you wish to remain on our mailing list please cut off this stub and make any corrections if necessary and return it to us by May 30 1995. Also, if you know of someone who would like to be added to the list, please ask them to send their information to us.**

..................................................................................................................................►

**I would like to remain on the mailing list for the European mixtures working group:**


Dr. Hanne Ostergard
Plant Biology SectionRiso National Laboratory
P O Box 49
DK-4000 Roskilde
Denmark
Tel: +45 46-77 4111
Fax:+45-46-32 3383
e-mail:hanne.ostergard@risoe.dk.
Telex:43116

Maria R. Finckh
Phytomedizin/Pathologie
ETH Zentrum/LFW
Universitätstr. 2
CH-8092 Zürich

SWITZERLAND

**Cost 817 Mixtures Working Group WWW interface•**

•

All things are possible according to our network manager. He can arrange password protection, and anonamous and password protected ftp. All he needs is his time paid for to set it up, plus my time to set up the files. •

•

I envisage the homepage to look something like this:•

----------------------------------------------------------------------------•

Title: Mixtures•
Working group of Cost Action 817, Title.....•

----------------------------------------------------------------------------•

Mixtures are... (statement about mixtures and their advantages)•

----------------------------------------------------------------------------•

LOGO - Members of the working group (hypertext link to file)•
LOGO - Research interests of working group members (hypertext link•
to further menu, hypertext link from menu to separate files)•
LOGO - Case studies of mixtures usage in different countries•
(hypertext link to further menu, hypertext link from menu to•
separate files) Password protected ftp.•
LOGO - Minutes of previous working group meetings (hypertext link•
to further menu (password protected), hypertext link from menu to•
separate files) Password protected ftp.•
LOGO - Anecdotal mixtures information (hypertext link to further•
menu (password protected), hypertext link from menu to separate•
files) Password protected ftp.•

-----------------------------------------------------------------------•

I envisage this taking quite a few days to set up everything, so we have come up with a costing of stlg1,435 (= 1,795 ECU) until 31 July 1996. For this we would:•

•

- 1) establish a cost817 URL for the mixtures working group (or wider if required) These could be: http//www.scri.sari.ac.uk/cost817 or: http//www.scri.sari.ac.uk/mixtures which would get you to the homepage menu (something like the above, but much smarter)•
- 2) establish links to other relevant documents with appropriate graphics, eg BSPP, ISPP, bionet.newsgroups•
- 3) make specified text files available through anonymous ftp (file transfer)•
- 4) re-format and write in html (hypertext mark-up language) documents for on-line browsing•
- 5) password protect selected documents to members of the cost working group only•
- 6) password protect ftp of specified text documents•
- 7) regular backup of all documents•
- 8) maintain security and access specificity of all documents•

Adrian•

•

Dr Adrian C Newton •
SCOTTISH CROP RESEARCH INSTITUTE•
Invergowrie, Dundee DD2 5DA, Scotland, UK•
Telephone: (UK) 01382 562731 : (International) +44 1382 562731 Fax +44 1382 562426•
E-mail: a.newton@scri.sari.ac.uk•

## WG3: Cereal rust and mildew genome database

(coordinator H. Giese, Risø, DK)

In 1995 the database group has suceeded in getting "Pathogenes", a database containing information on virulence spectre of barley- and wheat- powdery mildew on the Internet. This has only been possible with the help of David Mathews from Cornell University whom we expect soon to be a full member of our group.

We have held two meetings during 1995, one from 28th -2nd march at Risø where we discussed the implementation of the database and the kind of data we wanted in it. David Mathews and a programmer from Risø, Kjell Nilson, build up the structure of the database during a two week period on the basis of these discussions. All information on barley powdery mildew isolates at Risø was collected and transferred to a datasheet. In addition information on wheat powdery mildew isolates were collected in Germany.

In the autumn the second meeting was held, 18 October 1995 at Risø, to demonstrate the database for other members of the COST action outside the working group. David Mathews and Kjell Nilson worked hard for three days to implement the database and set up connections to the Internet facilitating an active workshop. A teaching room at Risø with ten computers with Internet connection was available for the participants of the workshop. David and Kjell acted as teachers and showed people how to access the database. Different option were tried and a few bugs identified.

The workshop was concluded with a round table discussion on how to proceed and how to solve immidiate problems. It is clear that the base is a success in terms of user interest but the lack of financing for the implementation is a severe problem.

**Minutes the meeting in the COST 817 database group, Risø, 28th February to the 2nd March.**

Participants: James Brown (Cambridge Laboratory), Ahmed Jahoor (Lehrstuhl für Pflantzenbau and Pflantzenzüchtung), Urs Brändle (Institut für Planzenwissenschaften ETH), David Mathews (Cornell University), Kjell Nilsson (Risø) and Henriette Giese (Risø)

Agenda for the workshop:

*Tuesday*, 28 February

Demonstration of the Graingene database, David Mathews.

Identification of data relevant for Graingenes.

How do we draw the line between Graingenes and our own database.

*Wednesday*, 1 March

Identification of the data we wish to have in the database, with reference to discussions in Kassel and study contract proposal.

Discussion of the structure of the database.

Agreement on how we implement the database.

How should people submit data.

*Thursday*, 2 March

Demonstration of an expert system for Mycorrhiza, Søren Rosendahl.

*Tuesday*

The participants introduced themselves and their particular research interests. David Mathews demontrated Graingenes and the way ACEDB database software works. The data in Graingenes relating to cereal genetics and diseases is comparable to the type of data we wish to enter into our mildew database. The demonstration gave a good idea of how our data could be presented and connected in the database. Our requirements for the structure of the mildew database can be satisfied by the ACEDB software.

Our data on resistance genes and varieties from which the genes are derived is of immediate interest to Graingenes. James Brown has organized his data in dbase and we discussed how to transfer this data into Graingenes. James Brown will be responsible for this transfer. Ahmed Jahoor who has similar information will submit his data to Graingenes via James Brown. The database will automatically associate entries with the same names. This may create some problems as barley and wheat varieties may have identical names, Ace was a good example. In USA varieties have a number but this is not necessarily the case in

Europe. This problem was discussed in some detail, David Mathews suggested that we use the numbers employed by the gene banks. This seemed a good idea and was accepted.

Next we had some discussions on the collections of isolates and their characteristics, especially their virulence spectre. Ahmed Jahoor and Henriette Giese has data on this topic. This information is not of great interest for the Graingene users although some breeders are interested in information on mildew isolates that can differentiate resistance genes. In this connection Urs Brändle was asking for the possibility of connecting the Graingene database to another database for crossreference. That is, whether it would be possible to click from Graingenes into our database for information on the fungal isolates. Dave Mathews said that this technology is under development but not presently operating in a satisfactory way.

In this connection we discussed how to express virulence spectre, on the basis of the gene name or infection types. We were in favour of gene names rather than infection types. In certain cases it may be necessary to refer to a variety rather than a gene if the resistance genes in the test variety has not been properly characterised.

James Brown mentioned that mildew is relatively easy since we have good information on single gene determined resistance but diseases such as brown and yellow rusts are more complicated due to multigenic resistance. In this case we may have to decide on a different system. Also the facultative pathogens such as *Septoria* may present some problems. David Mathews mentioned that these problems occurred when dealing with data on quantitative traits in the cereals. But that he was presently working on ways to deal with this kind of data. We also briefly touched the problem of diseases that develop differently under varying environmental conditions.

James Brown asked how textfiles could be updated, it seem most practical with a new disc with the all data updated. David Mathews said that the data has to be submitted in a very strict format.

The conclusion from the first day´s discussions were that the ACEDB database was suitable for our requirements and type of data. Graingene has direct interest in our data on resistance and germplasm information and this should be included in the Graingene database. Some Graingene users would be interested in our data on virulence spectre and isolate availability but that this data should probably only be in the mildew database.

*Wednesday*

We started up by summarising decisions from the previous evening. The resistance sources and germplasm information should go to Graingenes while fungal data should go into the mildew database. We had a brief technical discussion on the creation of load files for individual laboratories before data is submitted to David Mathews. David Mathews suggested that the members of this work group should get an account number at Cornell for submitting data.

In agreement with the Contract Study proposal we reaffirmed that James Brown would be responsible for the resistance gene data and germplasm in consultation with Ahmed Jahoor, Urs Brändle for the population data and Henriette Giese for the fungal genetics.

Our next topic was fungal genetics. We decided that information on crosses between different isolates of the powdery mildew fungus would be of interest to people. When available the whole dataset from mapping populations should be entered into the database. We already have some data from James Brown and Henriette Giese. Maps of the fungal chromosomes should also be presented. With regard to RFLP and RAPD markers some have been scanned in from parents of one of Henriette Giese´s crosses. The polymorphic bands are identified by lower case letters which correspond to locus designations. In Graingenes bands are identified by molecular weight but both system will work. Information on cleistothecia from different crosses should also be included in the database.

Before we discussed mildew populations we agreed it was important to define the scoring for infection type. James Brown has a suitable set of pictures illustrating the scoring for particular infection types. These should be included in the base.

Studies on population genetics should be included in an abbreviated form. Gene frequencies including haplotype frequency could be presented and the test varieties described. Also the locality and date should be given as well as a reference to the researcher in order to get the whole dataset.

In connection with population and linkage studies it would be valuable to have information on how informative different markers are. A list of tested RAPD markers and RFLPs could be made and given a score to indicate how much polymorphism was detected between different isolates.

Henriette Giese has most of the information on available libraries of fungal DNA and will include this in the base. This concluded the list of topics that had been identified at the Kassel meeting.

The whole afternoon was dedicated to design models for the different parts of the database. For each datatype we tried to design suitable parameters to accommodate the properties/problems we could foresee. This was extremely fruitful and we discovered a number of problems that we had not initially thought of.

*Thursday*

The presentation of Søren Rosendahl´s expert system was interesting. The system as such including the database and culture collection is similar to our project.

The workshop was a success as we now have defined our areas of interest and how we wish to present them. David Mathews will set up the structure for the base with Kjell Nilsson and Henriette Giese. A system will be set up at Risø for recieving data from members of the working group.

Minutes from the working group meeting:

# "Workshop on the development of a fast communication system for data on the research on cereal pathogenic fungi and cereal resistance genes"

COST 817, Risø, 18-10-1995.

In the morning David Mathews gave an introduction to ACEDB database software and how it is used in Graingenes to a wide audience. The contents of Graingenes were of interest to all of the participants as it contains information on resistance genes in cereals. We have also supplied data to this database. The structure of the database was explained by giving examples of all the different types of information in the base from genetic maps to particular resistance genes and molecular markers. It is possible to select items from one table and just by clicking get futher information on the particular character. The aim was to give people an impression of how easy it is to access the database and extract valuable information. The codes for entering the most useful access lines on the internet was provided.

Following the Graingenes demonstration David Mathews assisted by Kjell Nilsson showed what has been done on the mildew database. A huge chart of infection types of barley powdery mildew isolates has been entered into a database which has been constructed using the same software as Graingenes. In addition information on genetics and images of RFLP and RAPD markers were demonstrated.

The Internet will have gained some new users after this mornings demonstrations.

## Workshop

After lunch we had a proper workshop for about 12 people with special interest in working with the pathogen database. The teaching room at Risø with 8 computers linked up to the Internet was used so that everybody could test and become familiar with the databases.

## Participants in the workshop

David Mathews, Kjell Nilsson, Ole Andersen, Christian Damgaard, Henriette Giese, Mogens Hovmøller, Edgar Schliephake, Jannie L. Atzema, Ursula Walther, Claudio Ciccarone, Urs E. Brändle and James Brown, Ahmed Jahoor unfortunately was unable to attend.

David Mathews and Kjell Nilsson acted as instructors and helped everybody to understand and find their way in the database. The query functions were tested and it became clear that one important search failed. The database was unable to identify isolates with a particular combinations of virulence genes which is one of the central requirements for the base. After about two hours of practical work we ajouned to discuss the contents and the future of the database.

The structure of the database still needs to be adjusted in a way that permits an early selection for the pathogen of interest and separation into information on the pathogen or the host. Also we need to clarify the connection to Graingenes in terms of information on germplasm and resistance genes. At present we have germplasm information in Graingenes and in the pathogen database, some are the same, others different. Graingenes is also interested in information on the virulence spectre of individual pathogen isolates, at present data is available on rust and mildew. It was agreed that this type of information could be in both databases. More specific data on the pathogens such as marker information, maps, fungicide resistance, population studies and surveys should be in the pathogen database.

The big dataset on virulence spectre of barley powdery mildew was discussed. It was this set which created the problem with the query function. Different possbilities for correcting this problem were discussed. James and Christian came up with solutions to the problem which will be implemented by Kjell as soon as possible.

In the evening we concentrated on identification of priority areas. The first priority area was information on isolate collections like the mildew and rust examples already in the database. Once a template has been developed it will be relatively easy for other people to follow the same system. Examples of how the data should be formatted should be given to people who wish to enter data into the base, in order to minimize the problem of converting files for entry into the database software. Once the bug in the present setup is corrected it sould be possible to give this information. James, Christian and Henriette in consultation with J. Helms Jørgensen who supplied the data should sort out the problem.

The next priority was information on germplasm/varieties. Again as above an example of how the data should be formatted should be send out. Data should contain information on source/year/-development site/ release. We already have this type of information and we can send out examples of how to do this. This type of data is already in Graingenes. Information from Gene Banks should be set up on individual servers and linked up to Graingenes.

Fungicide information was selected as the third priority. This will give information on resistances in the different isolates in the culture collections. The chemical name and the brand designation should be given. James will make a draft for a format for this type of data in the beginning of next year.

It was decided that visual presentations of pathogens and infection spectre were important and a relatively easy task to enter into the database. Because of the subjectivity in scoring the degree of infection and the different scales used by different researchers, it would be useful to have a presentation of the infected leaves together with the recorded disease scores. The images should be linked to an introduction to the individual pathogens in the database. In addition it was decided to try and get pictures of the developmental stages and the infection structures. James was interested in doing part of this work.

Molecular markers as diagnostic tools would be of interest to a wider range of people and Graingenes may also want this type of information. Urs has developed SCARs for barley powdery mildew. Images of the banding pattern obtained using these probes could be linked to isolates in a culture collections. Henriette will deal with information on crosses and RAPD and RFLP markers used in connection with these and Urs with the SCARs.

Population and survey data are available but are probably only of interest to a limited number of people. It was decided that this type data was probably best dealt with in the form of brief reports in a newsletter form. Update of virulence frequencies are important and for most people it is important to have the results from the most recent surveys. Urs and Mogens in collaboration with David would try to figure out a way to present this type of data.

The lack of funding for this project was discussed. It was greatly lamented that no funding has so far been given. Only the funding from Risø for Kjell and access to the Risø computers as well as the fantastic help from David Mathews has made it possible to start at all. It seems such an important task to collect and make available all this information that funding somehow has to be found. We discussed the possibility of finding a student who could work for a year to develop the formats for the different types of information and the tools to enter them into the database. David would be willing to have a student with some knowledge of Unix for a 3 month period to learn the basics of the database system. Risø is unable to continue financing a programmer to implement the base and futhermore Kjell is leaving by the end of November. David believed that after a year if all the format were designed the task would be much reduced as it would take the form of updating rather than designing the system. Henriette, James and David will write a project description to be posted in relevant university environments to find a suitable candidate.

Last but not of least importance we decided to name the database "Pathogenes" as we found that it would be a shame to limit the database to just information on mildews and rusts as there are number of other serious diseases on cereals.

The working group for the database will consist of David Mathews, James Brown, Urs Brändle, Mogens Hovmøller, Edgar Schliephake, Christian Damgaard, Ahmed Jahoor, Henriette Giese. It would be great value if the COST Action 817 project could have David Mathews institute, Department of Plant Breeding and Biometry, Cornell University, as an associated partner in the future.

# WG4: Nomenclature and distribution of mildew and rust resistance genes

(Acting chairman: Mogens Hovmøller, Danish Institute of Plant and Soil Science, Lyngby, Denmark)

**Aims**

- To define common cereal mildew resistance and virulence gene designations to promote the flow of relevant and precise information among researchers, breeders, variety testing institutions, agricultural advisory services and farmers in Europe.
- To promote the publication of an updated and extended list of European commercial barley and wheat varieties and the the powdery mildew resistance genes indentified in them.

**Results 1995**

The proposal comprising principles for and lists of recommended designations of barley and wheat powdery mildew resistance genes, the corresponding virulence genes and previous designations has been refined for publication in the proceedings of the cereal mildews and rusts workshop held in Zürich, November 1994, and the Ceral Rusts & Powdery Mildews Bulletin.

The recommendations are being implemented in national lists of cereal varieties in the countries producing information about powdery mildew and rust resistance genes. The results have already improved communication among researchers, breeders and the advisery service in member countries.

The catalogue of barley mildew resistance genes is being updated, and further developed into a database available on the internet. This part of the work is coordinated with the activities in Working Group 3 (Genome database).

As many of the goals in WG4 have been achived so far, the Management Committee meeting, Cambridge, December 12, 1995, decided to make a call for new activities related to host resistance to cereal mildews and rusts that could take place within the frame of WG4. Suggestions indicating aims, subjects, tasks and persons who are interested will be discussed at a Management Committee meeting in 1996.

## Minutes of COST 817 WG 4:

**Nomenclature and distribution of cereal mildew and rust resistance genes**
**Meeting held in Cambridge, December 11, 1995**

Participants: Slater (UK), Manninger (H), Unger (D), Walther (D), Flath (D), Fedele (I), Pasquini (I), Clarkson (UK), Szunics (H), Huszak (Slovakia), Limpert (CH), Hanusova (CZ), Gacek (PL), Dreiseitl (CZ), Czembor (PL), Jalli (SF), Skinnes (N), Wiik (S), Winzeler (CH), Bartos (CZ), Mesterhazy (H), Andersen (DK), Boesen (DK), Hovmøller (DK).

Acting chairman: Mogens Hovmøller

1. Welcome
2. Current status and results 1994-95
3. Nomenclature of powdery mildew resistance and virulence
   - Implementation of recommendations in WG4 member countries
   - Publication of results
4. Updating terms of reference of the working group
5. Continuation of the working group
6. Election of new chairperson
7. Review of membership
8. Next meeting
9. Any other buisness

Wellcome

Mogens Hovmøller (MH) opened the meeting as acting chairman and told that Andrew Mitchell, UK, who was elected as chairman at the previous meeting in Kappel, CH, had left the group as he had changed job. MH announced that he was not able to continue the task of being chairman after this meeting because his main research activities do not fall within activities in WG4.

Helge Skinnes kindly volunteered to take notes on which this minute is based.

Current status

MH gave a report on the current status and the results obtained in 1994-95: A proposal comprising principles for and lists of recommended designations of barley and wheat powdery mildew resistance genes, the corresponding virulence genes and previous designations has been made. The proposal was discussed and approved at a mildew workshop in Zürich, November 1994.

A catalogue of barley mildew resistance genes is being updated, and further developed into a database available on the internet. This part of the work is coordinated with the activities in Working Group 3 (Genome database).

Implementation and publishing

Reports on the implementation of designations of barley and wheat powdery mildew resistance genes were given by national representatives. The most comprehensive report was given by Birgitte Boesen, DK, who presented the work on mildew resistance gene identification in commercial varieties in

Denmark, and demonstrated how the new nomenclature has improved communication among researchers, breeders and the advisery service. In conclusion, the new nomenclature seem to have been implemented to a large extent in the different countries.

It was stressed that in case new resistance *genes* are identified based on by appropriate genetic analysis, the specific naming of *genes* should be in accordance with the procedure given by Bob McIntosh, Australia (wheat) and Helms Jørgensen, Denmark (barley).

The proposed designations of barley and wheat powdery mildew resistance genes, and the corresponding virulence genes, will be published in the proceedings of the workshop held in Kappel, November 1994, and in the Cereal Mildew and Rust Bulletin.

<u>Updating terms of reference and continuation of the working group</u>
The working group has been very successfull and the goals have to a large extent been fulfilled.

New terms of references were discussed. Some of the participants expressed the need for a forum where people mainly working with variety evaluation for resistance could meet. Others had the opinion that host resistance activities could be coordinated through the ongoing work in WG1 and WG3.

Nobody were able to chair the working group at present, and no further tasks were identified at the meeting. The continuation of the working group will therefore be dicsussed at a Management Committee meeting in 1996. No new meeting date was made.

Lyngby, 18.01.1996

Mogens Hovmøller

Addendum: Mogens Hovmøller presented at the Management Committee meeting, Cambridge, December 12, 1995, the present status for WG4 and the results which have been achieved so far. The Management Committee decided to make a call for new activities related to host resistance to cereal mildews and rusts that could take place within the frame of WG4. Suggestions should be sent to the Management Committee (Hanne Østergård, Risoe, DK), indicating aims, subjects, tasks and persons who are interested. The suggestions will then be discussed at the next Management Committee meeting sceduled to take place in Wageningen, September 1996.

These minutes are distributed to participants in the working group meeting and other members of the working group.

# WG5: Epidemiological parameters

(coordinator A.J.G. Engels, Wageningen, NL)

**Aims**

Coordination of epidemiological research in the area of cereal rusts and powdery mildews. Collecting information on methods for estimating fitness parameters and on modelling epidemics. Connecting groups working in this area with specific interests, e.g. mlo-aggressiveness, fungicide sensitivity. Establishing common methods to study epidemiological parameters. Studying epidemiological parameters will lead to an increase of knowledge about disease development. By understanding the behaviour of these pathogens better, improved strategies will be defined to control these diseases.

**Results**

Workshop on Epidemiological parameters at Roskilde Denmark with 45 scientist from 12 European countries and USA on 19 and 20 October. Topics:

- Epidemiological parameters and estimation of fitness components
- Influence of temperature on the composition of pathogen populations
- Mlo-resistance/virulence
- General epidemiology - models of dispersal
- Cultivar mixtures
- Evolution of fungicide resistance

Two WG5 meetings (18 and 20 October): Roskilde, Denmark. Three topics for further study were chosen and item - groups were defined which will prepare item discussions at the next WG5 meeting:

- Mlo
- Fitness parameters
- Dispersal

A new chairperson for WG5 was appointed: Claude Vallavieille-Pope (F).

**Minutes of the COST ACTION 817 Working Group 5**
**Epidemiological parameters**

Meeting held in Roskilde, Denmark,
on Wednesday 10.18 and Friday 10.20.1995 at 8-10 p.m.
Chairman: Tonnie Engels

Participants:
Jannie Atzema CH, Fedele Casulli I, Claudio Ciccarone I, Christian Damgaard DK, Antonin Dreiseitl CZ, Tonnie Engels NZ, Friedrich Felsenstein D, Edward Gacek PL, Francoise Godet FR, Marga Jahn D, Karel Klem CZ, Eckhard Limpert SZ, Michael Lyngkjaer DK, Klara Manninger H, Lisa Munk DK, Adrian Newton UK (taking notes), Bent Nielsen DK, Bob O'Hara UK, Hanne Oestergaard DK, Jorn Pons D, I.D. Rashal LAT, Ivan Sache F, Claude de Vallavieille-Pope F, Lubomir Vechet CZ, Lars Wiik S.

Tonie Engels welcomed members of WG5 and encouraged other attendees to become members. A list of official members was presented. The summary of the questionaire of member interests was presented. The assessment of the following parameters is conducted either in field or controlled conditions: competitive ability, quantitative measures of the infection cycle (germination, latent period, conidia production, infection efficiency) and density dependence, spread of disease, spore dispersal, fungicide resistance. The modelling aprroach deals with population genetic, spatio-temporal progression of epidemics, dispersal.

The meeting was then organised into 5 small groups for « brainstorming sessions » to derive « operational aims » of the working group. It was decided not to get organised according to parasite subject (rust or powdery mildew), but according to common research interest. Hanne Oestergaard listed features of other COST actions to guide our thoughts. The aim was to present a future strategy by answering the questions:
When should we meet again?
What should we do then?
What should we do in the meantime?

Group 1 presented ideas for a meeting on relating field data to laboratory data; analysis techniques, methods etc.

Group 2 presented a list of ideas: standardisation of methods; discussion of 'half-baked' ideas; explaining statistical analysis techniques; discussion on strengths and weaknesses; discussion of ideas and concepts; exchange of information between working groups.

Group 3 suggested scientific aims rather than theory and tools should be the subjects for discussion. They preferred topic-based working group meetings such as quantitative resistance. Collaboration and joint publication should be a high objective of working groups.

Group 4 suggested specific topics: experimental design; partial resistance; induced resistance; fitness parameters; modelling parameters. Three meetings in two years was suggested, divided into smaller subject groups at each meeting. Collaboration in funding applications should be encouraged.

From these groups it was decided to have the next WG5 meeting consisting of several smaller « subject groups ». Initially these were grouped into six: Mlo and quantitative resistance; induced resistance; pathogen spread in time and space; comparison of field and glasshouse experiments; fitness components; and crop loss assessment.

Following break-up into these groups for discussion only three of these had a viable number of people wishing to participate: Mlo (dropping the quantitative resistance aspect), fitness, and pathogen spread / dispersal. The composition and chair of each group was as follows:

List of participants of the mlo subject-group:

| | | |
|---|---|---|
| Jannie Atzema | CH | |
| Antonin Dreiseitl | CZ | |
| Friedrich Felsenstein | D | |
| Edward Gacek | PL | |
| Marga Jahn | D | |
| Michael Lyngkjaer | DK | Chair |
| Adrian Newton | UK | |
| Hanne Oestergaard | DK | |
| I.D. Rashal | LAT | |

List of participants of the fitness parameters subject-group:

| | | |
|---|---|---|
| Christian Damgaard | DK | Chair |
| Tonnie Engels | NZ | |
| Francoise Godet | FR | |
| Karel Klem | CZ | |
| Eckhard Limpert | CH | |
| Lisa Munk | DK | |
| Bent Nielsen | DK | |
| Jorn Pons | D | |

List of participants of the dispersal subject-group:

| | | |
|---|---|---|
| Fedele Casulli | I | |
| Claudio Ciccarone | I | |
| Bob O'Hara | UK | |
| Ivan Sache | F | Chair |
| Lubomir Vechet | CZ | |
| Lars Wiik | S | |

Each group set a deadline for participants to give details of their contribution to the chair: may 1996. The purpose is to present and discuss preliminary results, protocole, experimental designs, analysis technics. The meeting would have the format of the three subject groups followed by a plenary session. The number of subject group is not fixed and will be discussed at the next meeting.The date of the next WG5 meeting was provisionally set for the Sunday before the meeting of the Cereal Rusts and Powdery Mildews Conference in Wageningen in August 1996. It will be arranged with the local organiser Cor van Silfvout at the next management commitee. It was hoped that joint work, collaboration and suggestions for national as well as international grant applications would come from these meetings. There was discussion of joint meeting with other COST Action groups, particularly the mycorrhizas group who had requested a joint meeting. This would be investigated by Claude Pope and Hanne Oestergaard .

Persons interested in joining the working group 5 should contact the new chairman: Claude de Vallavieille-Pope (FR) and fill the questionnaire.

Official Members WG 5: Vechet (CZ), Damgaard, Hovmoller, Lyngkjaer, Nielsen, Oestergaard (DK), Lannou, , Sache, de Vallavieille-Pope (FR), Appel, Felsenstein, Hau, Jahn, Pons, Scheid (GER), Engels (NL), Atzema, Limpert (SWI), Brown, Goleniewski, Newton, O'Hara (UK).

Dr Claude de Vallavieille-Pope
Laboratoire de Pathologie Vegetale, INRA,
78850 Thiverval-Grignon, France

Telephone: (International) +33 130815227
Fax: (International) +33 130815306
E-mail: pope@grignon.inra.fr

# Publications


Airborne pathogens on cereals
Population studies of airborne pathogens on cereals as a means
of improving strategies for disease control
Cost 817
Agriculture and Biotechnology .
Dec 93 - Dec 98

The Action COST 817 coordinates national research and management aimed at improving integrated strategies for use of resistance genes and fungicides to control cereal diseases. It focuses on major diseases caused by airborne plant pathogens spread by wind throughout Europe: powdery mildews and rusts of barley and wheat. In this way COST 817 will support European agriculture in its attempt to produce healthy and high quality cereal crops at a low input and in an environmentally safe way.

## COST 817 coordinates

- virulence and fungicide sensitivity surveys and testing methods
- research on crop variety mixtures and other management strategies based on resistance genes and fungicides
- build up of a database of plant pathogen genetic information
- exchange of information on resistance genes and fungicides between scientists, breeders, variety testing authorities, agricultural services and farmers
- research on epidemiological parameters.

*Spore samples are collected using trap plants placed at a specific site or using a mobile spore trap mounted on a car*

*Spores of wheat powdery mildew in the air infect host leaves and new spores are released within few days*

*Stock collections of powdery mildew isolates are kept for long term storage in isolation at low temperature*

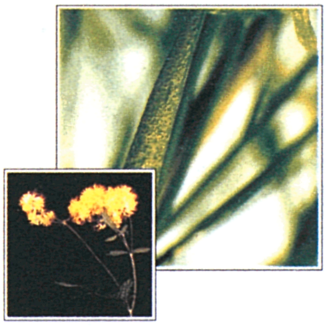
**Results obtained the first two years:**

- establishment of an European network of scientists involved in surveys and population studies of powdery mildews and rusts on barley and wheat
- recommendation on nomenclature of powdery mildew resistance genes in barley and wheat
- initiation of an Internet database of molecular markers and virulence data of the barley powdery mildew fungus
- E-mail bulletin board on the bioscience server designated rust-mil.

### Surveys

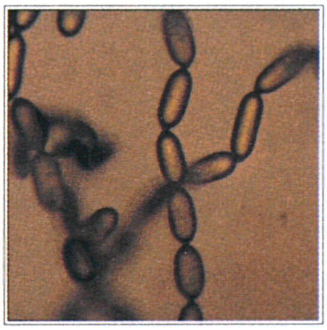
Virulence of fungal populations varies across Europe in response to the resistance genes present in local varieties. Fungicide sensitivity varies in response to fungicide applications. Surveys of virulence genes, aggressiveness and fungicide sensitivity of powdery mildews and rusts are performed nationally throughout Europe to predict disease development. Inter-European surveys are, however, essential to establish an effective early warning system of break down of particular resistance genes and fungicides. In COST 817, sampling and testing methods are standardized, surveys are coordinated and an European distribution and interpretation of results are promoted. The work is organized into 5 subgroups defined by disease and methodology.

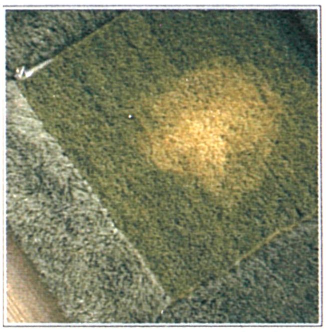
*New pathotypes of leaf rust on wheat may arise by recombination on an alternate host, e.g. meadow rue.*



*Leaves infected with wheat yellow rust may die prematurely and this causes reduction in quality and grain yield*

*Fungicides destroy the metabolism of fungi, and thus the capability of e.g. powdery mildew to produce new spores*

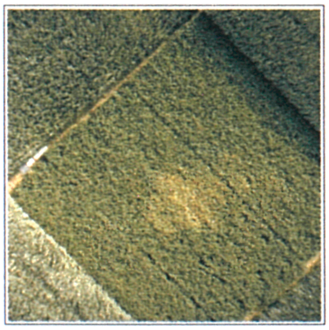


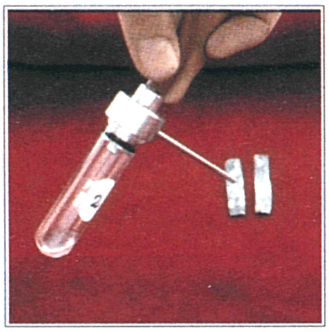


*Focal development of disease in a field plot of a pure line of wheat inoculated with yellow rust at the centre*

**Variety and Species Mixtures**
Traditional farming practise in most European countries is based on highly uniform varieties grown in monoculture. This intensifies the selection on the pathogen population towards increased virulence. Mixtures of varieties slow down the disease development. The results from coordination in COST 817 of research and experiments on mixtures will promote the basis for making a common European strategy for the use of such management methods.

*Disease development of yellow rust in a field plot of a mixture of wheat varieties with different resistance genes*

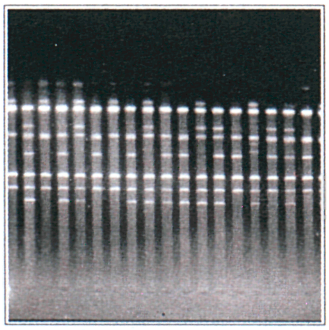




*Powdery mildew spores are harvested for DNA analysis and for estimation of spore production.*

**Pathogen Genome Database**
Detailed knowledge of the genomic organization of the pathogens is needed to obtain optimal control of the disease. This information is obtained in national research programmes and made accessible European-wide by COST 817. Build up of an Internet database containing information on genes for virulence, fungicide tolerance and other epidemiological parameters as well as DNA markers is coordinated and implemented.

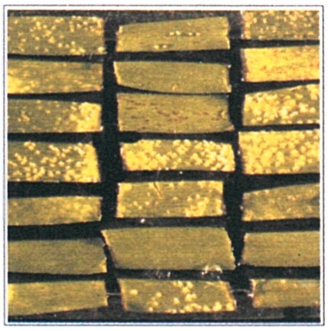
*Variation in patterns of DNA among isolates described by Restriction Fragment Length Polymorphism*



*Field plot testing for disease resistance of different barley lines in search for new, effective resistance genes*

**Host Resistance Genes**
The use of resistance genes in one country in Europe influences the structure of the pathogen population in that country and in adjacent countries. A common European description of powdery mildew resistance genes has been recommended by COST 817. An efficient flow of information concerning distribution of resistance genes in grown varieties is in COST 817 secured by modern information technology.

*A spectrum of symptoms is possible when one powdery mildew isolate attacks different varieties of barley*



*Germination of a barley powdery mildew spore on a susceptible host, 12 and 24 hours after deposition, respectively*

**Epidemiological Parameters**
The degree of virulence of a rust or powdery mildew population is determined by the number of spores produced from each infection. This number depends on the frequency in the population of virulence genes, genes of fungicide sensitivity and genes for aggressiveness. Methods for measuring fitness under laboratory as well as field conditions are under development in different laboratories. These efforts are coordinated by COST 817.

Edited by H. Østergård

Slides are kindly provided by:
P.Bartos, H.Giese,
M.S.Hovmøller,
J.H.Jørgensen,
M.K.Lyngkjær,
L. Munk,
C.Valleveielle Pope.

# Organization

**Management Committee**
Chairman: *Hanne Østergård, DK*

Risø National Laboratory, P.O. Box 49
DK-4000 Roskilde, DENMARK
Phone +45 46 77 41 11 Fax +45 46 32 33 83
E-mail: hanne.ostergard@risoe.dk

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Participating Countries - about 30 institutions from:
CH, CZ, D, DK, F, FIN, H, I, NL, PL, S, SK, UK

RISØ

Environmental Science and
Technology Department

COST-Action 817

# Workshop on Epidemiological Parameters

19-20 October 1995, Roskilde, Denmark

COST

**Programme / Abstracts / List of Participants**

# Workshop on Epidemiological Parameters

## PROGRAMME

### THURSDAY 19 OCTOBER

<u>Morning session 9.00 to 12.00</u>
<u>Coffee break approx. 10.30</u>

**Epidemiological parameters**

<u>Kurt J. Leonard</u>
Competition and density dependent fitness of wheat stem rust isolates.

<u>Christian Damgaard</u>
Effects on density on infection efficiency and spore production of the *Erysiphe graminis* f.sp. *hordei*.

<u>Ivan Sache</u>
Effect of lesion density on the dynamics of sporulation in three cereal leaf rust fungi.

<u>Lisa Munk</u>
Nitrogen induced changes in the development of barley powdery mildew.

**Discussion on estimation of fitness components.**
Introduction by Kurt J. Leonard

<u>Afternoon sessions 14.00 to 18.00</u>
<u>Coffee break about 16.00</u>

**Influence of temperature**

<u>Eckhard Limpert</u>
Evidence for ecotypes of the barley mildew pathogen from a transcontinental view.

<u>Lubomir Vechet</u>
Effect of temperature on the susceptibility of wheat cultivars to yellow rust under field conditions.

<u>Fedele Casulli</u>
Effects of weather conditions on leaf rust epidemiology in Italy.

**Discussion on influence of temperature on the composition of pathogen populations.**
Introduction by Eckhard Limpert

**Mlo-resistance/virulence**

Adrian Newton
Temporal breakdown of Mlo resistance in spring barley by sudden relief of soil water stress.

Michael Lyngkjær
Some aspects of Mlo-resistance and Mlo-virulence.

Hanne Østergård
Evolution of Mlo-virulence.

Jannie Atzema
The cost of Mlo-resistance. (poster)

**Discussion on Mlo-resistance/virulence.**
Introduction by Adrian Newton

**Dinner Party at 18.45**

## FRIDAY 20 OCTOBER

**Morning session 9.00 to 12.00**
**Coffee break approx. 10.30**

**General epidemiology**

Mike Jeger
An epidemiological model for host pathogen interactions following a gene-for-gene system.

Bob O'Hara
Dispersal gradients and contact distributions: What do they mean for the pathogen?

Claudio Cicarone
Time/space domain: Modelizing wheat-leaf rust epidemics in Daunia.

Lars Wiik
Disease assessment: Frequency or/and area?

Bo Secher
The use of risk indices based on weather data to adjust decisions on crop protection. (poster)

**Discussion on models of dispersal.**
Introduction by Mike Jeger

**Afternoon sessions 14.00 to 18.00**
**Coffee break about 16.00**

**Cultivar mixtures**

Claude Vallavieille-Pope
Induced resistance in field experiments on wheat yellow rust: Pure stands and varietal mixtures.

Maria Finck
Experimental work in Poland with cultivar and species mixtures 1987-1995 and onwards.

Klara Manninger
Studies of induced resistance of wheat against rusts.

Josef Sebesta
Induction of resistance to crown rust in oat. (poster)

**Discussion on effect of cultivar mixtures on epidemic development.**
Introduction by Claude Vallavieille-Pope

**Fungicide resistance**

Francoise Godet
How is the sensitivity of a bulk sample of the wheat mildew pathogen, compared to the composition of single colony isolates?

Jörn Pons
Selection of genotypes influenced by fungicides during a powdery mildew epidemic.

Tonnie Engels
Effect of split applications of fenpropimorph containing fungicides on disease control and sensitivity of *Erysiphe graminis* f.sp. *tritici*.

Marga Jahn
Mildew spore production in different winter wheat cultivars after different treatments.

Karel Klem
A simulation model of the fungicide efficacy against powdery mildew at reduced doses. (poster)

**Discussion on evolution of fungicide resistance.**
Introduction by Bent Nielsen

**Dinner at 18.00**

# COMPETITION AND DENSITY DEPENDENT FITNESS OF WHEAT STEM RUST ISOLATES

Kurt J. Leonard(1), Miriam R. Newton(2), and Linda L. Kinkel(2)
(1) U.S. Department of Agriculture, Agricultural Research Service, Cereal Rust Laboratory, University of Minnesota, and (2) Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108, USA

Urediniospores of orange- and gray-spored mutants of *Puccinia graminis* f.sp. *tritici* were inoculated onto leaves of wheat seedlings singly and in a 1:1 mixture at four inoculum concentrations from $5 \times 10^5$ to $5 \times 10^7$ spores per ml. Inter- and intra-strain competitive interactions and their effects on fitness were quantified by determining numbers of uredinia formed and numbers of urediniospores produced per leaf at each inoculum density. A two-part mathematical model was developed to describe the relationships between uredinial formation and inoculum dose and between spore production and uredinial density. The first part of the model is based on the multiple infection transformation. The second part relates to sporulation and employs a monomolecular equation for spores produced per leaf vs. uredinia per leaf. The parameters infection efficiency, carrying capacity in uredinia per leaf, sporulation efficiency, and maximum sporulation per leaf were calculated from data from single-strain inoculations. Competition coefficients for uredinial formation and sporulation were calculated by fitting the density response data from mixed-strain inoculations to the model using the four single-strain fitness parameters. Thus, competitive ability was measured as a separate component contributing to overall fitness of *P. graminis* strains in mixed infections. The gray-spored mutant, SR41, had greater competitive ability than the orange mutant, SR22, for both uredinial formation and spore production. SR22, however, had greater fitness because of its significantly greater infection efficiency and carrying capacity for uredinia per leaf. The fitness advantage of SR22 was greatest at low inoculum densities and declined as numbers of uredinia per leaf increased at higher densities. The model was used to simulate competition between hypothetical *P. graminis* strains differing only in single components of fitness to determine the effect of each component over a range of inoculum densities. The simulations indicate that a fixed advantage in infection efficiency provides a constant fitness advantage from low to high inoculum density. Advantages in carrying capacity and the uredinial competition coefficient provide little fitness advantage at low densities, but increasingly contribute to greater fitness at higher densities. The same is true for advantages in maximum numbers of spores that can be produced per leaf and in the competition coefficient for sporulation. Greater sporulation efficiency, which can be related to sporulation per uredinium in the absence of competition (i.e. single uredinia per leaf), provides a high fitness advantage at low densities but little or no advantage at high densities. When the competition coefficients for either uredinial formation or sporulation differ between competing strains, fitness becomes frequency dependent in the model, particularly at high population density.

EFFECTS ON DENSITY ON INFECTION EFFICIENCY AND SPORE PRODUCTION OF *ERYSIPHE GRAMINIS* F.SP. *HORDEI*

C. Damgaard and H. Østergård
Environmental Science and Technology Department, Plant Genetics Section, Risø National Laboratory, 4000 Roskilde, Denmark

One of the observations in all ecological systems is the dependency of fitness components on density, and for the barley powdery mildew fungus (*Erysiphe graminis* f. sp. *hordei*) several studies have shown effects of density on spore production and other fitness components. The two main fitness components of *Egh* is infection efficiency and spore production as a function of time, which were modelled mathematically and their relationship with density were examined in experiments.

The infection process was assumed to be dependent on three parameters: Germination frequency ($k$), an intrinsic death rate ($d$) which is independent of density, and a density dependency coefficient ($j$). If the number of surviving individuals (infections) on a leaf area at time $t$ is called $V(t)$, then $V(T)$ is the number of colonies after the latent period ($T$) and can be expressed as:

$$V(T) = \frac{V(0)k\exp(-dT)}{1 + V(0)k\left(1 - \exp(-dT)\right)\frac{j}{d}}$$

The influence of density on the infection efficiency was examined in an experiment with one *Egh* isolate on four barley cultivars with variation in inoculum density. It was found that i) Infection efficiency decreased with inoculum density ($j > 0$). ii) There were significant differences in $d$ and $j$ among cultivars. iii) $d$ and $j$ were negatively correlated. iiii) There was no apparent relationship between infection efficiency on cultivars and the partial resistance of the cultivars.

Spore production per colony per day was analysed using a differentiated Gompertz growth curve and the "Volterra" equation in an experiment of one *Egh* isolate on four barley cultivars with variation in colony density. It was found that i) On all cultivars the latency period decreased with inoculum density. ii) On cv. Archer the colonies at high densities produced their spores earlier than colonies at low density, and had a significantly higher potential exponential growth rate. iii) Opposite, on cv. Golden Promise, Pallas, or Proctor, the colonies at low densities produced their spores earlier than colonies at high density, and had a significantly higher potential exponential growth rate. iiii) There was no apparent correlation between spore production on cultivars and the partial resistance of the cultivars.

We suggest that, reduced latent period and early spore production at high colony density is caused by insufficient capacity of the resistance mechanism to "control" disease development, when *Egh* is present at high densities. The mechanisms behind resistance are unknown, however, one could speculate on various explanations for the phenomenon. i) The host plant has evolved a resource allocation strategy which reduces resistance to leaves with high colony density. ii) Self-intoxicating side effects of too much resistance in a leaves. iii) Increased respiration in leaves with a high colony density acts as a strong sink for host resources which allocates relatively more resources to high density leaves.

EFFECT OF LESION DENSITY ON THE DYNAMICS OF SPORULATION IN THREE CEREAL LEAF RUST FUNGI

I. Sache
Laboratoire de Pathologie Vegetale, INRA, 78850 Thiverval-Grignon, France

Models of disease spread usually assume a constant daily rate of sporulation for lesions. Various fungi, especially rusts and powdery mildews, have been shown, however, to exhibit time-dependent sporulation patterns including one or more sporulation peaks. An other, often underestimated factorinfluencing sporulation is the density of lesions. I present here a tentative model of integration of both time and density effects on sporulation in three cereal rusts.The first leaf of wheat, triticale, and rye susceptible seedlings was inoculated with a settling tower, giving a range of 40 densities (one pot with two leaves per density, 1-80 lesions.cm-2). Spores were collected every 2-3 days and counted with a Coulter CounterA8.In a first step of analysis, the accumulated spore production (y) on different dates (t) was related to the lesion density (d). Although sporulation began 8-9 days after inoculation, there was no effect of lesion density on the accumulated spore production before 13-15 days after inoculation. Later on, and for every collection time, a log-log model correctly fitted the sporulation data: $\ln(y) = a_o - b_o . \ln(d)$ In a second step, the parameters $a_o$ and $b_o$ were related to the time using a monomolecular model: $a_o = ma - \exp(ca - fa . n)$. Combining the two equations estimated the accumulated spore production as affected by time after inoculation and lesion density. Sporulation curves were correctly described by the model for wheat and triticale, and, to a lesser extent, for rye. Parameter estimation yielded very close values for the three rusts.The results clearly demonstrated the effect of time and density on sporulation in the selected rust fungi. The model yielded equations that may be used in demographic predictive models (e.g. based on Leslie matrices) of population growth. Density decreased the sporulation rate per lesion only after one week of active sporulation. The first week of sporulation, during which the most infectious spores are produced, is, however, the key factor for the multiplicative growth of the fungal population. It can be concluded that lesion density would only affect marginally the unrestricted theoretical population growth.

# NITROGEN INDUCED CHANGES IN THE DEVELOPMENT OF BARLEY POWDERY MILDEW (*ERYSIPHE GRAMINIS* F.SP. *HORDEI*)

Jensen, B. & L. Munk
Plant Pathology Section, Department of Plant Biology, The Royal Veterinary and Agricultural University, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark

Barley powdery mildew (*Erysiphe graminis* f.sp. *hordei*) is one of the most important barley diseases in Europe and many resources are spent on control measures. Application of nitrogen fertilizers has significantly contributed not only to high yields, but also to a general increase in powdery mildew susceptibility. In the present study, experiments were conducted under controlled conditions to investigate how N supply affects the epidemiological parameters infection frequency, latent ratio, latent period and spore production as well as the primary infection processes. The experiments were carried out using attached first leaves of cultivars with different genetic background and virulent isolates of powdery mildew.

The infection frequency measured as colonies per $cm^2$ was significantly increased with increasing application of N (30, 60, 120 and 240 mgN/pot) on six cultivars, and significant interaction between N and cultivar was demonstrated. An important result was that on two of the tested cultivars, the infection frequency was unaffected at low to intermediate N levels. The different reactions of the cultivars could not be ascribed to lack of N uptake. Increasing N application, in general, enhanced the cumulative spore production per colony (CSC), ir-respectively of increased infection frequency. The cumulative spore production per $cm^2$ leaf (CSCM), which expresses the combined result of N effects on infection frequency and CSC, strongly increased with N application on all cultivars. No interaction between N and cultivar was found for this component. The increase in CSCM closely corresponded to the increase in N content and fresh weight of non-inoculated leaves. The latent ratio (the ratio of colonies six days after inoculation relative to the maximum number of colonies) decreased and the latent period (number of days to reach final number of colonies) was prolonged at low N supply, but were not significantly affected by further increase in N supply. The results suggest that infection frequency is relatively more influenced by N that the latent ratio and latent period on barley seedlings.

The effects of two levels of N supply on distinct morphological stages in the primary infection processes were examined on parlodion impression films 72 hours after inoculation on three cultivars. The first stages - germination of conidia and formation of appressoria - were slightly increased by N application. However, the percentage of appressoria formating secondary elongating hyphae (ESH) was strongly increased at high N on two of the cultivars, whereas ESH formation was unaffected by N supply on the third cultivar. As the relative effects of N on ESH and infection frequency were very similar, this indicates that N induced changes in infection are mainly due to the ability of the fungus to penetrate the host and establish a functional host-pathogen relationsship within 72 hours after inoculation.

It is concluded that the N induced changes in the epidemiological parameters infection frequency, sporulation capacity, sporulation rate and latency measured in monocyclic seedling tests can explain the main part of the increasing effect of N fertilization on powdery mildew development in the field. The results also suggest that it may be possible to breed for or select barley cultivars with low impact of N on powdery mildew development.

# EVIDENCE FOR ECOTYPES OF THE BARLEY MILDEW PATHOGEN FROM A TRANS-CONTINENTAL VIEW

Eckhard Limpert
Phytopathology, Institute of Plant Sciences, Swiss Federal Institute of Technology, Universitätstr. 2, CH-8092 Zürich, Switzerland

Understanding population genetics and evolution within species requires recognition of variation within and between populations and the ability to distinguish between the potential causes of an observed distribution of variation. Of outstanding importance for population genetics is gene flow which is supported by migration but reduced by the formation of ecotypes. However, if migration affects large geographic areas, ecotypes may even be difficult to recognise. This seems to be particularly true for species well spread by wind like the cosmopolitan cereal mildew fungi.

A hypothesis in favour of the existence of climatic ecotypes of the barley mildew pathogen, Erysiphe graminis f.sp. hordei, is advanced from deductive and inductive reasoning. Based on random spore samples and on large scale investigations across Europe, centres of certain subpopulations of this pathogen were recognized in the south and in the north. For example, the subpopulation carrying Va3, that is virulence enabling the pathogen to specifically overcome gene Mla3 for mildew resistance in the host, is supposed to originate in warmer climates in South Europe and North Africa. In contrast, Va9 seems to have been first selected in the cooler north, in the Baltic region, in Sweden and Denmark.

Evidence for the existence of climatic ecotypes comes from combining such knowledge with results showing how the composition of the pathogen population changed with changing temperature. Published data from other investigators from different parts of Central Europe, obtained during the 1980s, show that the Va9-subpopulation was particularly favoured during periods of cool and inhibited during periods of hot weather. The opposite was true for Va3. These and further data are in line with the selection of ecotypes under certain environments and with there subsequent spread across Europe.

There may be several consequences for phytopathologists, population geneticists and breeders. Within the disease triangle, pathogen-climate interactions are well recognized and have been considered in strategies for disease control, but pathotype-climate interactions may need more consideration. Another general conclusion seems to be that the more a species is nomadic, the larger has to be the area needed to be considered for ecotypes to become evident. A consequence for gene deployment strategies could be that resistance derived from a hot area should be used in a cold area, and vice versa. In this way the amount of initial inoculum able to overcome the resistance would be much reduced and adaptation of the pathogen would be more difficult.

As in most studies of population genetics, the data leading to the hypothesis were based on changes of relative frequencies. Thus, it is not yet known in which way one or the other of the subpopulations compared changed absolutely. Neither is known within a subpopulation how the components, pathotypes or clones, may have interacted with temperature in absolute terms. This remains to be elucidated. However, these considerations do not seem to impair the general points of the hypothesis made.

Biologically, it seems quite plausible that climatic ecotypes would exist. For plant pathogens this may be particularly true for ectoparasites like the powdery mildews. Controlled environments should allow to compare types originating from different climates and to determine their parameters of relevance for fitness. Genetic investigations could help to clarify in how far associations of genes could be related to ecotypes. In general this would lead to a better understanding of population biology and epidemiology, of ecology and evolution, not only of plant pathogens.

# EFFECT OF TEMPERATURE ON THE SUSCEPTIBILITY OF WHEAT CULTIVARS TO YELLOW RUST UNDER FIELD CONDITIONS

Vechet Lubomir
Research Institute of Crop Production, Prague - Ruzyne, Drnovska 507, Czech Republic

The study was carried out to investigate the influence of temperature on the susceptibility of the chosen (11) cultivars of winter wheat (from 23 evaluated) to Puccinia striiformis - race Clement (virulent to gene of resistance Yr 9) under field conditions in 1992, 1993, 1994 years.

The infection with the rust was provided on the susceptible cultivar Michigan Amber (1992 - 1.4., 1993 - 5.4., 1994 - 15.4.) with urediospores of yellow rust. Infected plants were bedewed and enclosed in glass cylinders for 3 days. From this inoculated focus the infection was disseminated to other plants of tested cultivars (five rows). Susceptibility of the host and disease severity was evaluated in growth stage 65. Infection types were evaluated in a 9 point scale. The degree of infection was evaluated by a 9 point assessment scale and was expressed as a percentage of leaf area affected on the average on one leaf. Average daily temperatures were expressed at ten days intervals from 11 April to 30 May, every year. The number of days with maximum temperature higher then 20°C were expressed in the same intervals. The cultivars Danubia, Livia, Iris, Mona, Sparta, Senta, Sophia have gene for resistance Yr9, the cultivar Hana has the gene Yr2, the cultivars Ilona, Solida, Samanta have undetermined genes for resistance.

The year 1993 was much warmer in the period from 11 April to 30 May. Colder year was 1992 and the most cold one was year 1994. Also a number of days with maximum temperature higher then 20° C was the highest in 1993, essentially lower in 1994 and the lowest in 1992. The year 1993 was unfavourable for development and spreading of infection. The occurrence of yellow rust and infection types were very low. The highest disease severity was in 1994 and lower in 1993. Four cultivars (Rada, Senta, Sophia, Solida) had infection type higher in 1994 then in 1992. Two cultivars (Danubia, Sparta) had infection type in both years the same. Five cultivars (Hana, Ilona, Iris, Samanta, Mona) had infection types higher in warmer year 1992. The most drop in infection types in 1993 against these in 1992 and 1994 had the cultivars Ilona, Iris, Rada, Samanta. A course of temperature during growth period may change infection type of host plant to the pathogen. We can suppose that the cultivars in which in 1993 infection type dropped have another genetic system of resistance which is effective at higher temperature.

# EFFECTS OF WEATHER CONDITIONS ON LEAF RUST EPIDEMIOLOGY IN ITALY

Casulli F.
Dipartimento di Protezione delle Piante dalle Malattie, University of Bari, Italy

Although the wheat crop in Italy has been undergoing a constant gradual reduction during the past 30 years, it still covers a surface of 2,403,000 ha with approximately 2/3 durum wheat (Triticum durum Desf.) and 1/3 bread wheat (Triticum aestivum L.). Until 15 years ago, rusts, mainly leaf rust (Puccinia recondita f.sp. tritici), appeared yearly and their severity caused losses and instability in wheat yield. Since 1974, many durum and bread wheats have been tested annually in about 15 of the most important cereal growing areas. The aim of these "nurseries" is, among others, to monitor and establish disease development and to determine the environmental components that limit or confine disease spread and development. During the last fifteen years, stem rust has nearly disappeared; yellow rust has appeared sporadically on some of the most susceptible varieties in Northern Italy and the frequency and severity of leaf rust has decreased year by year. The cause of this disease reduction is mainly due to the weather changes during the last few years. In fact, the data published every year show a positive correlation between rainfall, wheat yield and leaf rust severity. In Italy, from 1955 to 1994 rainfall has gradually decreased and so has temperature. In one of the most important Italian cereal growing areas (Foggia), the average rainfall in the period 1955-64 was 582.31 mm per year, while in the last ten years the average has been 474.17 mm/year, with a decrease of 108 mm per year. Also the frequency of rainy days has gone down drastically. Forty years ago there were 98.4 days of rain per year while now there are 68.6 days/year (1/3 less). During the same period, the average monthly temperature has fallen by about 1°C. The fall in temperature and the reduction in the quantity and frequency of rainfall, on the one hand, influenced leaf rust frequency, severity and its overseasoning; on the other, it becomes impossible to evaluate the in-field behaviour of adult plants belonging to the new wheat varieties in relation to diseases. This situation does not diminish the importance of rusts but probably increases the risk of unexpected epidemics. This risk is made more real by the introduction and extensive cultivation of French wheat varieties rather susceptible to leaf rust and with a longer vegetative period. For leaf rust development, besides rain, also temperature and relative humidity, which depend on altitude and latitude, are important. In fact, trials in 3 different cereal growing areas located at 5, 76 and 380 m o.s.l. show that leaf rust appears early and with heavy infections in fields along the coast where the temperature and humidity are higher in winter and spring. Furthermore, in those areas it is easy for this rust to overseason and to evolve new races thanks to the presence of alternate hosts such as Thalictrum flavum and Anchusa italica. In areas where wheat irrigation is practicable, no significant variation in the leaf rust development has been observed.

TEMPORAL BREAKDOWN OF MLO RESISTANCE IN SPRING BARLEY BY SUDDEN RELIEF OF SOIL WATER STRESS

A.C. Newton[#] W.T.B. Thomas[$], R Jeffries* , I.M. Young* *and* D.K L. MacKerron*
[#]Fungal and Bacterial Plant Pathology Department, *Unit of Integrative Bioscience, Cellular and Environmental Physiology Department and [$]Unit of Barley Genetics, Cellular and Molecular Genetics Department, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland, UK

Seedlings of spring barley genotypes expressing *mlo* genes for resistance to mildew (*Erysiphe graminis* f.sp. *hordei*) in different background genotypes were subject to degrees of water stress under different nutrient and soil conditions under glasshouse conditions. Breakdown of resistance occurred when stress treatments were relieved. Differences in the degree of breakdown were attributable to nutrient status, soil compaction and genetic background of the *mlo* gene, but did not appear to be due to the different *mlo* alleles. This was further investigated using progeny of segregating crosses from spring barley genotypes expressing *mlo* genes. These were sown in the field under 'normal' and 'low' fertiliser levels and protected from natural rain by mobile rain shelters. Plants were either maintained at field capacity by trickle-irrigation, or allowed to dry to one of three different soil moisture deficits before restoration to field capacity. Again following relief of stress several genotypes broke down but these were again clearly attributed to genetic background and not to any particular *mlo* allele. The genetic basis of the liability to resistance breakdown will be investigated in further rain shelter trials.

SOME ASPECTS OF MLO-RESISTANCE AND MLO-VIRULENCE

Michael Lyngkjær and Hanne Østergård
Environmental Science and Technology Department, Risoe National Laboratory, 4000 Roskilde, DK

Resistance against penetration of the host epidermal cell wall is common in most host - fungal pathogen relationships. Normally, the resistance is associated with the formation of papillae beneath the cell wall at sites of attacking fungal appressoria. The exact mechanisms of the resistance are not known, but timing of papillae deposition, and accumulations of callose in the papillae and phenolics in cell wall, beneath and around the attempted penetration sites are important. The resistance responses are induced by germination of the fungus on the leaf surface, and are independent of the genotype of the fungus.

In barley, generally 50 - 80% of the infection attempts, of the barley powdery mildew fungus, are stopped at penetration, despite the further compatibility or incompatibility of the interaction (the gene-for-gene relationship). A special case of resistance against penetration is in barley lines lacking the wild type Mlo gene. These lines seem to increase their resistance responses, by rapid formation of large papillae. Barley lines carrying an mlo resistance allele, are thereby highly effective in preventing mildew from penetrating the plant epidermal cell wall. The efficacy of the resistance is somewhat dependent on epidermal cell type. Long epidermal cells, located over vascular tissues, are totally resistant, while short cells (e.g. interstomatal cells) are infected occasionally. Stomatal subsidiary cells, the very small epidermal cells which lie adjacent to guard cells, are infected with a slightly greater frequency.

Genetic variation controlling the ability of the barley powdery mildew fungus to cause disease does exist. In the laboratory, two powdery mildew isolates (HL3/5 and RaceI), with somewhat improved penetration efficiency, and the ability to infect all epidermal cell types, have been described and designated as Mlo-virulent isolates. On a barley isoline with an mlo resistance allele, the penetration efficiency of HL3/5, which was selected by E. Schwarzbach (1979), is about 3% on long epidermal cells and 17 % on short epidermal cells. Its Mlo-avirulent progenitor isolate (GE3) was not able to infect long epidermal cells and the penetration efficiency on short epidermal cells was less then 1%. On an susceptible barley isoline the penetration efficiency of both isolate were about 5% on long and 40% on short epidermal cells.

Systemic induction of resistance toward Mlo-virulent isolates are effective in Mlo-resistant barley lines. In an experiment, pre-inoculation of one side of Mlo-resistant leaves, with either an Mlo-avirulent *E. graminis* isolate or a non pathogenic *E. cichoracearum* isolate, and the other side six hours later with an Mlo-virulent isolate, strongly reduced the development of colonies compared to controls. This was in contrast to an susceptible barley isoline were pre-inoculation only gave insignificant reduction of the development of colonies.

Inhibition of callose formation and phenolic compound synthesis may lead to increased susceptibility. Differential effect on the penetration efficiency of the HL3/5 and GE3 isolates were obtained when these factors were inhibited in an Mlo-resistant barley line. It seems that the progenitor isolate was unable to overcome a component in the Mlo-papilla that was associated with callose formation, and therefore remain unable to attack leaves treated with an inhibitor of the phenolic compound synthesis. The HL3/5 isolate, by contrast, was able to overcome this component and are therefore more able to attack leaves treated with the inhibitor of phenolic compound synthesis.

# EVOLUTION OF MLO-VIRULENCE

Hanne Østergård, Christian Damgaard, and Michael Lyngkjær
Environmental Science and Technology Department, Risø National Laboratory, DK-4000 Roskilde Denmark

EVOLUTION OF MLO-VIRULENCE

Hanne Østergård, Christian Damgaard, and Michael Lyngkjær
Environmental Science and Technology Department, Risø National Laboratory, DK-4000 Roskilde Denmark

The genetic basis of Mlo-virulence in the barley powdery mildew fungus was examined by comparing the selection experiment of Schwarzbach (1979) to simulations in a population genetic model. The model is based on an infinite haploid asexually reproducing population with mutations in a variable number of genes of advantage for Mlo-virulence. The model assumes no 3rd order mutations and no back mutations. The fitness of an individual is assumed to increase with the number of mutations it possess. The relation between number of mutations and absolute fitness of an individual is a function of the epistatic interactions among the mutations.

In the Schwarzbach selection experiment, the number of elongating secondary hyphae (ESH) resulting from 100 spores taken from the selected population was counted. The selected population was growing for the first 30 generations (asexual) alternating on an Mlo-resistant variety and on a susceptible variety whereas the last 22 generations (asexual) were on the Mlo-resistant variety. The alternation may induce a bias in the experiment. The fitness of spores of any genotype may be higher in the beginning as indicated by an experiment made in addition to our simulations. Taking this into account as well as a general increase in fitness during the experiment due to refinements of the growing conditions, the change in number of ESH per 100 spores observed by Schwarzbach might be explained by mutation at one major locus. However, it might as well be explained by mutations at five synergisticly acting loci. Therefore, experiments under highly controlled conditions are needed to further elucidate the mechanisms of Mlo-virulence.

THE COST OF MLO-RESISTANCE (poster)

J.L. Atzema and M.S. Wolfe
Swiss Federal Institute of Technology, Department of Plant Science, Universitätsstrasse 2, CH 8096 Zürich, Switzerland

Mlo-resistance in barley against barley powdery mildew is different from other described resistances. After inoculation with the pathogen, the plant forms large papillae as a mechanical defence barrier. It is possible that this reaction uses more energy than a race specific reaction to inoculation, for example with Mla13.

Harding (pers. comm.) compared the biomass production of 5 Mla13-varieties and 5 Mlo-varieties, either inoculated or not inoculated with an avirulent isolate. Among the Mla-varieties, there was no difference in biomass in the presence or absence of the avirulent isolate. The biomass of the Mlo-varieties was reduced, however, as a result of inoculation and triggering of the defence reaction.

We carried out two more extensive experiments in a glass-house to compare the effect of inoculation with an avirulent mildew isolate on the biomass production of Mlo- and Mla13-varieties. Plants in pots were inoculated two weeks after sowing in both experiments.

In the first experiment 5 varieties of each group were used and the plants were harvested 8 weeks after sowing.

In the second experiment, 7 varieties of each group were used. Half of the pots were harvested after 8 weeks to determine fresh and dry weight, the other half were kept in the glass-house till harvest to determine the grain yield and the thousand grain weight.

In the first experiment, a highly significant effect of inoculation was found on the fresh weight of the Mlo-varieties. On the other hand, no effect of mildew inoculation was found with the Mla13-varieties. In the second experiment differences in fresh weight were found for both Mlo- and Mla13-varieties. The difference between experiments might be due to the high inoculation pressure in the second experiment.

The grain yield and the thousand grain weight were determined only in the second experiment. There was a significantly lower thousand grain weight within the Mlo-varieties, which was not found within the group of Mla13-varieties.

It seems that there was an energy cost due to mildew resistance in the Mlo-plants, which affected both fresh weight and thousand grain weight, but this appeared to have been compensated by increased grain number in the final yield. Under conditions of high inoculation pressure the Mla13-varieties suffered a loss in fresh weight, but not in grain yield or thousand grain weight.

The variety effect was large. Some varieties reacted in the same way between the experiments, but others varied considerably.

# AN EPIDEMIOLOGICAL MODEL FOR HOST-PLANT PATHOGEN INTERACTIONS FOLLOWING A GENE-FOR-GENE SYSTEM

M.J. Jeger
Department of Phytopathology, Wageningen Agricultural University, P.O.B. 8025, 6700 EE Wageningen, The Netherlands

Mathematical models of host-plant pathogen interactions following a gene-for-gene system have largely been proposed from a population genetics perspective with assumptions based on relative fitness, selection coefficients, costs of resistance/virulence, and frequency-dependent selection. More recently, additional attention has been given to some of the life-history or ecological parameters that may determine the long-term outcome of such systems, including host birth and death rates, intrinsic growth rates, carrying capacities, and competition coefficients. Only rarely have plant disease epidemiologists contributed to or complemented these analyses though incorporating disease dynamics into gene-for-gene models. The purpose of this paper is to construct a general model for a gene-for-gene system which integrates distinctive elements of population genetics, life history and epidemiological approaches.

Firstly, a basic epidemiological model is established in which a growing host population is partitioned into healthy and diseased components. The resulting equations bear similarities to density-dependent forms of the Lotka-Volterra predator-prey model; and from these equations is derived the basic reproductive rate (most properly number) which gives the number of diseased units caused by one infectious unit in an otherwise healthy population. Next the host and pathogen populations are partitioned according to a simple one-locus-two allele system for each in which there is specific recognition between the resistance and avirulence alleles. This give a standard compatibility or interaction matrix, which is converted to incorporate population dynamic aspects by labelling the host intrinsic growth rates and carrying capacities according to genotype with no assumptions made on their relative selective values. Similarly the epidemiological parameters describing disease dynamics are labelled according to the possible genotypic interactions.

For the basic genotype model a set of six linked differential equations results which to some extent is amenable to standard qualitative analysis. For example conditions for the persistence of the avirulence allele is obtained in terms of the basic reproductive number on the homozygous susceptible host. Analysis is simplified if the genotype model is reduced to a phenotype model by assuming no heterozygote advantage (or disadvantage) in the life history or epidemiological parameters. A full qualitative analysis is then achieved. A key conclusion is that for the resistant phenotype to persist then the basic reproductive number of the avirulent phenotype on the susceptible host must be greater than that of the virulent phenotype on the susceptible host. One interpretation of this finding is that the avirulence allele itself is involved in pathogenicity on the susceptible host.

This general model can be made more applicable to the following specific circumstances:

(1) long-term dynamics of host and pathogen in natural populations where growth of each is entirely clonal or vegetative;
(2) within-season dynamics dependent on initial conditions set by an annual sexual cycle in the pathogen and/or host;
(3) long-term dynamics in natural populations with a rare sexual cycle in host and/or pathogen which is not limited by seasonality;
(4) long-term pathogen response to host-imposed selection through resistance deployment.

DISPERSAL GRADIENTS AND CONTACT DISTRIBUTIONS: WHAT DO THEY MEAN FOR THE PATHOGEN?

R.B. O'Hara and J: K. M. Brown
Cereals Research Department, John Innes Centre, Colney Lane, Norwich, Norfolk, NR4 7UJ, UK

The mathematics of dispersal and invasion has been well studied by biometricians.

Despite the complexity of spatial models, a lot has been done to develop our understanding of the rates at which plant diseases (to pick a purely arbitrary example) spread. Some of this work can be applied to the dynamics of population genetic structure in established populations. Some of the theoretical results that have been obtained are useful in understanding the development of agricultural epidemics.

Mollison (1977) analysed a class of spatial models called spatial contact models where the dispersal of propagules is described by a 'contact distribution' (a theoretical analogue of the dispersal gradient). He showed that how an expanding population develops is determined by the type of contact distribution - it will either advance at a constant rate as a single wave ("exponentially bounded"), or it will advance in leaps and bounds, as secondary foci are produced and establish before being engulfed by the main body of the epidemic ("leptokurtic").

These models have implications for the development of populations beyond the initial invasion. I will review the current understanding of the effects of different types of contact distribution on the advance of epidemics, and then discuss the effect that different types of gradient have on the patchiness of genetic structure of populations, and the implications that this has for the movement of epidemics. The ideas presented will be used to help interpret the results of both field trials and computer simulations of epidemics, helping to casting light on the importance of other factors (such as clonal diversity) in the development of epidemics of mildew. The use of these ideas in understanding the effectiveness of guard rows and also the development of variety mixtures will also be discussed.

**References**

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TIME/SPACE DOMAIN: MODELIZING WHEAT-LEAF RUST EPIDEMICS IN DAUNIA

C. Ciccarone
Instituto di patologia vegetale de l'universitá de Bologna, Via Filoppora 8, I-40126 Bologna, Italy

Daunia is one of the most important wheat areas in Italy. The peculiar settling as regards to orographic and climatic factors stimulates studying multifactorial models in order to predict strategies adopted by part of leaf-rusts in epidemiological events.

The large landed estates, the quasi-monovarietal prolonged repetitions of durum wheat, the very low lucrativity of this production encourage the planning of waste expanses statistics.

Leaf rusts, in this environment, are not among the most worrisome parasites: they spread in the fall of the production cycle (late June) but they never approximate the threshold for treatment.

So the model should fit the fading and supine field epidemiological ethology of rusts which is described by soft parametric systems which are affected by high-level greyness, low level accessibility and low definition.

The author plans to realize a MIMO Model primarily based on spectral-analysis of space/time domain.

It should be endowed with good separability, mean/high validability, optimized generalizability, working on populations of rusts as not segregated biophases.

Dioramas, digital sampling, validated knowledge from bibliography and DB, original observations, experimental work should chain models to real systems.

Above all, this work should produce a structure for a multi-purpose, multi-factorial modelization which could consider more than one simultaneous phenomenon in stratified layers.

# PHYTOPATHOMETRY, DISEASE ASSESSMENT: INCIDENCE OR INTENSITY?

Lars Wiik
Swedish University of Agricultural Sciences, Department of Plant Protection Sciences,
Box 44, S-230 53 Alnarp, Sweden

Disease assessment can be made in different ways due to the purpose of the research. Host resistance studies require measurement of infection types and epidemiological parameters. In crop loss assessment studies and when developing threshold values for chemical treatment, it is useful to know the intensity or the absolute disease attack (i.e. the percentage of the leaf area attacked) on different leaf levels at different growth stages. For advisory service a faster assessment of incidence or frequency of plants or leafs attacked (i.e. the percentage number of plants or leafs attacked) may be sufficient.

In order to support supervised control by prognosis and warnings in Sweden, different pests and diseases are surveyed or recorded once a week in a number of fields on an incidence basis by the National Board of Agriculture. A good correlation between intensity and incidence could be useful, e.g. in estimating crop loss from incidence data. It would also facilitate tedious leaf area assessments.

Results from field trials in spring barley 1983-1986 have been reevaluated. The first appearance of powdery mildew was at tillering. The logistic phase of the epidemic started rather late during booting and ear emergence. The average maximal attack on leaf 1-3 was ~ 13 % in the flowering and ripening growth stages. The best curve fit for growth stage (DC, decimal code, x-axis) against intensity (% leaf area attacked, y-axis) is described with an exponential function. Logistic growth or the S-shaped curve is not possible to choose in the applied program (Excel, version 5.0). The best curve fit for growth stage (DC, x-axis) against incidence (% number of leafs attacked, y-axis) is described with a linear function. The best curve fit for incidence (x -axis) against intensity is described with an exponential function.

Early in the epidemic, disease measured as incidence seems to demonstrate differences better than disease measured as intensity. The slope of the linear curve or the rate of the disease development, described by the linear function of the incidence data, may be a good estimator of disease attack. Still intensity data gives a more complete picture of the epidemic.

A more comprehensive validation is required to answer the question if it is possible to replace intensity data with incidence data in crop loss assessment studies and in the development of threshold values for chemical treatment.

# THE USE OF RISK INDICES BASED ON WEATHER DATA TO ADJUST DECISIONS ON CROP PROTECTION (poster)

Bo JM Secher
Danish Institute of Plant and Soil Science, Lottenborgvej 2, DK-2800 Lyngby, Denmark

In the Danish decision support system PC-Plant Protection decisions on crop protection against Powdery mildew (*Erysiphe graminis*) on cereals are mainly based on field observations of the disease incidence. Recommendations are therefor based on disease levels describing the situation at least one latent period back in time. To improve the recommendations and to pull the moment of decision up to the present time (or the future using a 5 day weather forecast) a risk index has been developed to describe potential disease development based on hourly local weather data. As a preliminary validation of the risk index a positive relation was found between risk indices and growth rates of P. mildew.

**Index validation**

Data on disease development were obtained from trials carried out in 1993 and 1994, totalling 10 trials from 3 localities. Disease severity were assessed weekly on the top leaves separately and on whole plants. A growth rate, GR, were calculated, using the following equation:

$$GR = Ln(DS_t(100-DS_{t0})/(DS_{t0}((100-CF)-DS_t)/(t-t_0)$$

DS = Disease severity, t = time for disease observation, $t_0$ = time for previous observation, CF = correction factor, correcting for changes in the crop canopy relating to new growth and dying green area. CF is depending on the growth stage of the wheat.

A daily index was calculated based on the probability for sporulation and infection using hourly weather records measured on weather stations placed at the same locality as the trials. Index has values from 0 to 5, where 0 indicates no risk and 5 a high risk. The index calculation do not take into account the amount of inoculum present in the field.

An average index was calculated in a period (t-180°d to t-90°d, latent period = 90°d) preceding the period for growth rate calculation. The average index was related to the growth rate.

A regression on the whole data set did not show any relation between the average index and GR. Omitting GR if disease was not present at $t_0$ resulted in a positive correlation. Since index only take into account sporulation and infection, this seemed reasonable. A significant and positive correlation was found when relating index to the GR corrected for new growth and dying green area. A simple regression gave the following equation:

$$\text{Growth Rate} = 0{,}00405 * \text{Average Index} + 0{,}001743$$

N = 348, $R^2$ = 0,064, P > F(Model) = 0,0001, P > F(Regr. coeff.) = 0,0001

**Implementation of risk indices in the decision support system**

The study indicated that the risk index could be used to correct the observed disease level in the field according to the "weather conduciveness" in the latest latent period. With such corrections the index can be a tool to adjust the threshold values and the dosage calculation in the decision support system. Similar indices are being developed for Yellow rust (*Puccinia striiformis*), *Septoria* spp. and *Rhyncosporium secalis* in barley. A field validation of weather adjusted recommendations has been carried out in 1995.

# INDUCED RESISTANCE IN FIELD EXPERIMENTS ON WHEAT YELLOW RUST: PURE STANDS AND VARIETAL MIXTURES

C. de Vallavieille-Pope, H. Goyeau, A. Calonnec
Laboratoire de Pathologie Vegetale, INRA, 78850 Thiverval-Grignon, France

The main factor accounting for disease reduction in variety mixtures is the low density of susceptible plants. However, induced resistance could explain part of the mixture efficacy in field varietal mixtures as shown by computer-simulated epidemics (Lannou et al., in press). There have been very few field experiments on induced resistance (Chin and Wolfe, 1984). The aim of our study was to determine to which extent induced resistance could be a factor in controlling yellow rust epidemics in wheat cultivars grown in pure stands and in wheat varietal mixtures.

In plots of 1x5m, one variety was edged on both sides by another variety increasing a race avirulent for the variety tested. The virulent race was inoculated at one end of the plot. Induced resistance restricted the disease intensity on the two cultivars tested in pure stand by 43% and 57%, respectively. The disease gradient differed between the protected and non protected plots.

Cross protection was studied in varietal mixture by comparing 3 treatments: susceptible cultivar in pure stand, susceptible cultivar mixed with a totally resistant cultivar, and susceptible cultivar mixed with a cultivar increasing an avirulent race for the cultivar studied. The plots (9x18m) were inoculated by planting sporulating seedlings with the virulent race at the extremity of the plot and seedlings with the cross-protecting race dispersed in the plots. The severity of the disease was assessed on the susceptible cultivar. The mixture effect calculated using area under the disease progress curve was 83%, 58% being attributed to reduced density of susceptible host and 26% to cross protection. Disease gradients differed between the 3 treatments at 11-13 weeks after inoculation. Spatial progression was assessed by comparing isopath: 10% severity. The 3 treatments differed at the 3 dates, except at 13 weeks after inoculation when both the susceptible in pure stand and the susceptible mixed with the totally resistant had reached the end of the plot (18m and 17.4m, respectively). For the isopath: 20% severity, the 3 treatments differed till the end of the epidemic.

In another experiment, the maximum severity reached by the susceptible cultivar in pure stand was only 12%. However the mixture effect was 63%, 48% due to reduced density of susceptible host and 17% to cross protection. The distances reached for the isopath: 1% severity differed between the 3 treatments, except at the end of the epidemic (12 weeks after inoculation), the non protected plots were equivalent to the pure stands.

In both experiments with variety mixtures, the experimental designs were made to test the potential effects of cross protection. The production of the cross protecting race in a far larger amount than the virulent race, reduced significantly the epidemics on the susceptible cultivar by cross protection. The next step would be to test a mixture, each component being able to produce an avirulent race for the other component with equivalent proportions of the races.

# EXPERIMENTAL WORK IN POLAND WITH CULTIVAR AND SPECIES MIXTURES 1987-1995 AND ONWARDS

Edward S. Gacek[1], Maria R. Finck[2], and Martin S. Wolfe[2]
1: Experimental Plant Breeding Station of the IHAR, PL 46-233 Baków. 2: Institut für Pflanzenwissenschaften, Gruppe Phytomedizin, Eidgenössische Technische Hochschule Zürich, Universitätsstraße 2, CH 8092 Zürich

Six experiments involving spring barley mixtures and two with winter barley mixtures were conducted in Poland between 1987 and 1995. Experiments included between four and seven cultivars and were repeated between three and twelve times over time and location. Mixtures of all possible combinations of three cultivars and pure stands were grown and assessed for yield and powdery mildew severity. Other diseases were assessed if they were of importance. In addition, two experiments were conducted with two-way mixtures of the same spring barley cultivars that were used in the three-way mixtures to evaluate effects of number of cultivars in mixtures.

Except for mlo virulences to all used resistance genes were prevalent in the Polish mildew population throughout the years. Some of the experiments have been evaluated for disease and yield effects. Mildew was reduced between 12 and 43% with three-way mixtures reducing disease significantly more than two-way mixtures. Even mixtures containing the same major resistance reduced disease. A complication is however, that we still do not know all the resistances in the different cultivars. A generally greater yield stability was observed in mixtures as compared to their pure stands.

Experiments are currently underway to study mechanisms of plant-plant-pathogen interactions in barley mixtures in detail. A first experiment deals with density and frequency effects of the host plants. A second experiment deals with the temporal dynamics of competition. The experimental plans will be briefly presented.

Experiments with species mixtures are in progress. Two- and three-species mixtures of barley and oats and of barley, oats and wheat are used to investigate effects on disease development and yield stability over environments. Cereal-legume mixtures are investigated for their effects on disease, insect pests, weeds and yield. Preliminary results indicate that mixed cropping greatly reduces disease (up to 80%) and increases yield stability.

SYSTEMIC INDUCED RESISTANCE OF WHEAT AGAINST RUSTS

Manninger, K., Abdou, Els. and Barna, B.
Plant Protection Institute, Hungarian Academy of Sciences, P.O.Box 102, H-1525 Budapest, Hungary

The aim of the work was to investigate the existence of systemic induced resistance in the wheat/rust relationships.

Wheat cultivars Alcedo, Carina, Einkorn, Giza 155, Giza 157, Kadett, Kota and leaf rust races No. 61, No. 77 as well as stem rust races No.1, No.34 and No. 218 were used in the experiments. Various combinations of the compatible and incompatible relationships were applied.

For the induction of resistance the 7-days-old primary leaves were inoculated with the spores and after 4-10 days the second leaves were challenge inoculated.

The infection types and the number of pustules were compared to control plants, which were inoculated only on the second leaves.

The preinoculation of the first leaves with compatible race did not induce resistance in the second leaves, but infection with an incompatible race caused a significant 30-50% reduction of pustule number of compatible stem or leaf rust. A slight reduction of infection type was also observed.

In order to examine the role of necrotization in the induction of resistance barley mildew (causing slight chlorotization on wheat leaves) and mechanical injury were also used as inducer. Barley mildew induced a 25-40%, while mechanical injury only about a 25% reduction of pustule number on the second leaves.

It seems that necrotization is not the only but important factor of the induction of systemic resistance.

INDUCTION OF RESISTANCE TO CROWN RUST IN OAT (poster)

Sebesta, J., Epstein, A.H. and Formanova, M.
Research Institute for Crop Production, Prague, Czech Republic and Iowa State University, Ames, Iowa, USA

Induction of resistance to Puccinia coronata Cda. var. avenae Fraser et Led. was noted in tests on seedlings of three genetic lines of oats inoculated sequentially with one of three inducer - challenger combinations of the pathogen. There was significant reduction in both the number of pustules per leaf as well as in the weight of urediospores harvested in all three host genotypes tested. There were highly significant differences between individual spore harvests correlated with age of the pustules. Development of telia by the challenger was found to occur considerably later and was less intense, when the challenger was inoculated alone as contrasted with treatments in which the challenger followed pre-inoculation with the inducer. There seemed to be no correlation between the numbers of resistant and susceptible lesions within the range of inoculum density used in these experiments.

HOW IS THE SENSITIVITY OF A BULK SAMPLE OF THE WHEAT MILDEW PATHOGEN, COMPARED TO THE COMPOSITION OF SINGLE COLONY ISOLATES?

F. Godet
Laboratoire de résistance, Service Régional de la Protection des Végétaux (S.R.P.V.) 93, rue de Curembourg, 45403 Fleury les Aubrais, France

We studied the composition of bulk samples and their composing Simply Colony Isolates (SCI) towards the sensitivity of triadimenol and fenpropimorph. Results are shown from two samples, one sample came from the Marney valley in 1994, the other was from Calvados in 1995. The both were analysed in the beginning of spring (middle of March) from control The results are as follows:

| YEAR | Sample | Triadimenol | | Fenpropimorph | |
|---|---|---|---|---|---|
| Location | | Mean | | Mean | |
| | | ED50 (mg/l) | Range | ED50 (mg/l) | Range |
| 1994 Marne | Bulk | 28.8 | | 110 | |
| | 18 SCI | 22.1 | 4.4 to 51.8 | 50.4 | 1.4 to 120 |
| | | | | | |
| 1995 Calvados | Bulk | 24.5 | | 21 | |
| | 30 SCI | 20.1 | 0.9 to 55.8 | 26.3 | 8.9 to 45.9 |

In Marne, about three fungicide treatments were applied the year before the analyses, one with a triazole and two with a morpholine fungicide, which seams to explain why the mean is so high. It shows as well the big variability present.

In Calvados, in comparison, only two fungicide treatments were applied, one with a triazole and two with a morpholine, and both, mean and variability are lower.

Interestingly, comparing each isolate towards triadimenol and fenpropimorph, there was a clear evolution of multiple resistance towards these two active components. The data will be discussed in relation to strategies trying to reduce the evolution of multiple fungicide resistance.

# SELECTION OF GENOTYPES INFLUENCED BY FUNGICIDES DURING A POWDERY MILDEW EPIDEMIC

J. Pons
Institut für Pflanzenbau und Pflanzenzuechtung II, Biometrie und Populationsgenetik, Justus-Liebig-Universitaet Giessen, Ludwigstr. 27, D-35390 Giessen, Germany

The population dynamics of barley powdery mildew (*Erysiphe graminis* f. sp. *hordei*) were investigated in field plots under selection pressure caused by the fungicides triadimenol and ethirimol and in untreated plots. Samples of mildew isolates were collected at approximately 10 day intervals during the mildew epidemic in the growing season. For each isolate, the sensitivity to the two fungicides was determined on leaf segments of primary leaves of the barley variety Golden Promise. The seeds of Golden Promise had previously received a seed-dressing application of both fungicides, respectively, at various concentrations. The sensitivity of individual isolates was determined by relating the number of colonies on each treated leaf segment to the number of colonies on untreated control leaf segments. By means of Probit analysis the dose response data were fitted and the effective doses ($ED_{50}$) for each isolate were estimated. In addition, the virulence of each isolate was identified by means of a differential set of the following host resistance factors: *Mlh; Mlg; Mla6; Ml(La); Mla12; Mlk,Mla7; Mla1; Mla9; Mla13; ml-o.*

In the untreated plot as well as in the plot treated with triadimenol, the sensitivity of the mildew population to both fungicides changed only slightly during the epidemic, while in ethirimol-treated plots the sensitivity to ethirimol decreased.

Concerning the mildew virulence factors of the isolates, it was observed that in the triadimenol and untreated plots the frequencies remained almost unchanged during the epidemic. In the plots treated with ethirimol the mildew virulence factors *Vk,a7* and *Va1* increased their proportions significantly. Also the selection favoured the pathotype containing the virulences *Vh; Vg; Va6; Vk,a7* and the pathotype with the virulences *Vh; Vg; Va6; V(La); Vk,a7; Va1; Va9*. The association between sensitivity to ethirimol and certain virulences and pathotypes, respectively, can be explained by hitchhiking selection i.e. indirect selection.

EFFECT OF SPLIT APPLICATIONS OF FENPROPIMORPH CONTAINING FUNGICIDES ON DISEASE CONTROL AND SENSITIVITY OF *ERYSIPHE GRAMINIS* F.SP. *TRITICI*

A.J.G. Engels[1], B.C. Mantel[2] and M.A. De Waard[1]
1: Department of Phytopathology, Wageningen Agricultural University, Binnenhaven 9, 6709 PD Wageningen, The Netherlands. 2: Ciba Agro B.V., Stepvelden 10, 4700 BA Roosendaal, The Netherlands

A field trial was conducted in the south of The Netherlands during three years (1992-1994). Wheat powdery mildew isolates from the experimental field had a reduced sensitivity to fenpropimorph. The effects of Corbel and Tilt Top split applications on disease control and on sensitivity of *Erysiphe graminis* f.sp. *tritici* to fenpropimorph were tested. In all years, wheat powdery mildew was controlled well in all treated plots. In general, the use of split applications (5 * 0.4 l $ha^{-1}$) resulted in a better protection against wheat powdery mildew than the use of normal applications (2 * 1.0 l $ha^{-1}$). In all three years, the sensitivity to fenpropimorph of the mildew population in untreated plots and plots treated with normal applications of Corbel and Tilt Top did not change significantly (Table 1). The degree of reduced sensitivity ($Q_{50}$ value) of isolates from plots treated with split applications Corbel shifted significantly towards higher values. This was consistent in all three years. A significant shift towards higher $Q_{50}$ values was also found in the mildew population in plots treated with split applications Tilt Top in 1993 and 1994. These results indicate that split applications can increase the rate at which *E. graminis* f.sp. *tritici* can become insensitive to fenpropimorph, and consequently, this application strategy is not recommended.

Table 1. $Q_{50}$ values of fenpropimorph of isolates of *Erysiphe graminis* f.sp. *tritici* before (May) and after (July) treatments were applied in 1992-1994.

| Year | Treatment[1] | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| May 92 | 4.6 a | 4.4 a | 4.4 a | 5.0 a | 5.2 a | n.d.[2] |
| July 92 | 3.5 a | 6.0 b | 5.8 a | 4.5 a | 4.5 a | |
| T-value | 1.4 | 2.2 | 1.7 | 0.9 | 1.2 | |
| May 93 | 6.8 a | 6.1 a | 7.1 a | 7.0 a | 7.2 a | 6.6 a |
| July 93 | 6.2 a | 11.0 b | 8.0 a | 7.8 a | 10.0 b | 5.3 a |
| T-value | 1.0 | 4.1 | 1.0 | 0.9 | 2.9 | 1.9 |
| May 94 | 7.1 a | 6.4 a | 6.3 a | 7.3 a | 6.6 a | 6.3 a |
| July 94 | 6.3 a | 8.6 b | 7.4 a | 8.0 a | 8.5 b | 6.1 a |
| T-value | 0.9 | 2.5 | 1.1 | 0.7 | 2.5 | 0.2 |

[1] I and VI = Untreated, II = Corbel 5 x 0.4 l $ha^{-1}$, III = Corbel 2 x 1.0 l $ha^{-1}$, IV = Tilt Top 2 x 1.0 l $ha^{-1}$ and V = Tilt Top 5 x 0.4 l $ha^{-1}$.
[2] n.d.: not determined

MILDEW SPORE PRODUCTION IN DIFFERENT WINTER WHEAT CULTIVARS AFTER DIFFERENT TREATMENTS

Marga Jahn
Federal Biological Research Centre for Agriculture and Forestry, Institute for Integrated Plant Protection, Stahnsdorfer Damm 81, D-14532 Kleinmachnow, Germany

Investigations were made in a three year field trial with three winter wheat cultivars with different resistance ratings for *Erysiphe graminis*. The aim of this part of the trial was to identify the mildew spore production in dependence on fungicide treatments at full and reduced doses. From different methods of sampling spores, trap plants were selected. Plants of the cultivar 'Kanzler' in the first leaf stage were placed into the plots two times per week for 24 hours over a period from May to July. 'Kanzler' is the most susceptible cultivar without any resistance gen. The amount of spore production was determined indirectly by assessment of the disease development on the trap plants.

Significant differences were determined in the spore production each year over the whole period of measuring between the three cultivars 'Borenos' (3, according to the Descriptive List of Cultivars, 1993), 'Astron' (5), and 'Toronto' (6).

Treatments with the fungicides Corbel and Folicur at full (n) and reduced rates (n/2, n/4, n/10) were carried out only after exceeding the threshold level of 1 to 2 % mildew incidence on the upper three leaves.

In 1993, the treatments resulted in a strong reduction of the spore production. A distinct difference of effectiveness between the cultivars was detected; the influence was least on the cultivar 'Toronto'. There were no significant differences between fungicides and doses, however, n/10 tended to be less effective.

In 1994, the influence of the treatments on the spore production in general was very small.

Simultaneously, the results of these trials with the trap plants have been used to evaluate the functions for the calculation of spore production and infection rate in the SIMERY simulation model. The validated functions for sporulation and infection are useful for standardization of the influence of the weather.

# A SIMULATION MODEL OF THE FUNGICIDE EFFICACY AGAINST POWDERY MILDEW AT REDUCED DOSES (poster)

Karel Klem
Agricultural Research Institute, Ltd., 767 01 Kromeriz, Czech Republic

We often note reduced efficacy of fungicide treatments and/or its entire failure in practice. These cases are mostly attributed to the pathogen adaptation to fungicidal effective agents and rapid selection in the population caused by continual selection pressure. However, the treatment efficacy is also influenced (besides the decrease in sensitivity to fungicides) by a number of factors among which the date of application is one of the most important. There is a lack of more precise data and thus, the question of fungicide resistance which is examined only at the protective fungicide application (24 hrs prior to inoculation) is still overestimated.

In order to assess the effect of application time on the fungicide efficacy a laboratory experiment was carried out. Effects of one application prior to powdery mildew inoculation on wheat and of four applications after the inoculation during an incubation period were studied. Values of the efficacy were used for a mathematical function describing a course of non-linear dependence of the fungicide efficacy on application time. Optimizing the model used by Gutsche et al. (1994) for Phytophthora-model the following function was derived:

y = a .(EXP(-(b. (x+c))^d)

where y - fungicide efficacy on powdery mildew infection of leaf area (%)
x - application time in hours after inoculation
a, b, c, d - regression coefficients characteristic for a fungicide and dose.

In all the tested fungicides an adverse relationship between the efficacy and application time was found. However, a course of the function is different in various fungicides. Corbel (750 g fenpropimorph.$l^{-1}$) and Folicur Plus (250 g tebuconazole.$l^{-1}$ + 125 g triadimenol.$l^{-1}$) rank among the fungicides which keep a high level of the efficacy nearly through the whole incubation period, and the effect decreases at the end of the incubation. On the contrary, the rapid decrease in the efficacy already during the application in a short time after inoculation is observed in Bayleton 25 WP (250 g triadimefon.$l^{-1}$). A simulation model suggests that even at the same level of resistance to two effective agents and comparable protective efficacy the resulting effect is not sure to be the same under field conditions. That is valid especially in the case of later curative treatments. By contrast, no significant differences in the course of a model curve were observed at 1/4 and 1/2 reduced doses. It was only moved toward a lower level. However, the effect of the application time is always more significant than that of tested doses of products.

# List of Participants

**Czech Republic:**

P. Bartos
Laboratory of Disease Resistance Genetics
Research Institute of Crop Production
Drnovska 507
CZ-161 06 Praha-Ruzyne

A. Dreiseitl
Cereal Research Institute
Havlíckova 2787
P.O. Box 55
CZ-767 41 Kromeriz

K. Klem
Cereal Research Institute
Havlíckova 2787
P.O. Box 55
CZ-767 41 Kromeriz

J. Sebasta
Research Institute of Crop Production
Plant Production Division
Drnovska 507
CZ-161 06 Praha 6-Ruzyne

L. Vechet
Department of Applied Genetics
Research Institute of Crop Protection
Drnovská 507
CZ-161 06 Praha 6-Ruzyne

**Denmark:**

O. Andersen
Pajbjergfonden, Plant breeders
Gersforffslundvej 1
Hou
DK-8300 Odder

B. Boesen
Statens Planteavlsforsøg
Teglværksvej 10
DK-4230 Skælskør

C. Damgaard
Plant Genetics Section
Environmental Sci. Technology Dept
Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde

H. Giese
Plant Genetics Section
Environmental Sci. Technology Dept
Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde

M. Hovmøller
Danish Research Service for Plant
and Soil Science
Research Center for Plant Protection
Lottenborgvej 2
DK-2800 Lyngby

H.P. Jensen
Plant Genetics Section
Environmental Sci. Technology Dept
Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde

J.H. Jørgensen
Plant Genetics Section
Environmental Sci. Technology Dept
Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde

M.F. Lyngkjær
Plant Genetics Section
Environmental Sci. Technology
Department
Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde

L. Munk
Department of Plant Biology
The Royal Veterinary and Agricultural University
Thorvaldsensvej 40
DK-1871 Frederiksberg C

B.J. Nielsen
Danish Institute of Plant and Soil Science
Department of Plant Pathology and Pest Management
Lottenborgvej 2
DK-2800 Lyngby

B. Secher
Danish Institute of Plant and Soil Science
Department of Plant Pathology and Pest Management
Lottenborgvej 2
DK-2800 Lyngby

H. Østergård
Plant Genetics Section
Environmental Sci. Technology Dept
Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde

**Finland:**

M. Jalli
Agricultural Research Centre
Institute of Plant Protection
SF-31600 Jokioinen

**France:**

F. Godet
DRAF Service Régional de la Protection des Végétaux
B.P. 201
F-45403 Fleury les Aubrais

I. Sache
INRA Pathologie Générale
INA Paris-Grignon
Route de Thiverval
F-78850 Thiverval-Grignon

C. De Vallavieille-Pope
INRA Pathologie Générale
INA Paris-Grignon
Route de Thiverval
F-78850 Thiverval-Grignon

**Germany:**

F.G. Felsenstein
Institut für Pflanzenbau und Pflanzenzüchtung
Technische Universität München
Weihenstephan
D-85350 Freising

M. Jahn
Biologische Bundesanstalt für Land- und Forstwirtschaft
Institut für Inegrierten Pflanzenschutz
Stahndorfer Damm 81
D-14532 Kleinmashnow

J. Pons
Biometry and Population Genetics
Giessen University
Ludwigstraße 27
D-35390 Giessen

E. Schliephake
Bundesanstalt für Züchtungsforschung
Institut für Epidemiologie und Resistenz
Theodor-Roemer Weg 44
D-06449 Aschersleben

U. Walther
Bundesanstalt für Züchtungsforschung
Institut für Epidemiologie und Resistenz
Theodor-Roemer Weg 44
D-06449 Aschersleben

**Hungary:**

K. Manninger
Plant Protection Institute
Hungarian Academy of Sciences
P.O. Box 102
H-1525 Budapest

**Italy:**
F. Casulli
Dipartimento Protezione delle Plante dalle Malattie
Vialamindona 165/A
I-70126 Bari

C. Ciccarone
Instituto di patologia vegetale de l'universita' de Bologna
Via Filippore 8
I-40126 Bologna

**Latvia:**
I.D. Rashal
Plant Genetics Laboratory
Institute of Biology
3 Miera St.
LV-2169 Salaspils

**The Netherlands:**
A.J.G. Engels
Department of Phytopathology
Wageningen Agricultural University
P.O. Box 8025
NL-6700 EE Wageningen

M.J. Jeger
Department of Phytopathology
Wageningen Agricultural University
P.O. Box 8025
NL-6700 EE Wageningen

**Poland:**
E. Gacek
Plant Breeding Station IHAR
Braci Basy 32 Str.
PL-46233 Bakow

**Sweden:**
L. Wiik
Swedish University of Agricultural Sciences
Box 44
S-230 53 Alnarp

**Switzerland:**
J.L. Atzema
Institut für Pflanzenwissenschaften
ETH- Zürich
Eschikon 33
CH-8315 Lindau

U.E. Brändle
Institut für Pflanzenwissenschaften
ETH-Zentrum
Phytomedizin/Pathologie
Universitätstraße 2
CH-8092 Zürich

W. Datzao
Institut für Pflanzenwissenschaften
ETH-Zentrum/LFW
Phytopathologie
Universitätstraße 2
CH-8092 Zürich

M.R. Finck
Institut für Pflanzenwissenschaften
ETH-Zentrum
Phytomedizin/Pathologie
Universitätstraße 2
CH-8092 Zürich

E. Limpert
Institut für Pflanzenwissenschaften
ETH-Zentrum/LFW
Phytopathologie
Universitätstraße 2
CH-8092 Zürich

**United Kingdom:**
R.A. Bayles
National Institute of Agricultural Botany
Huntingdon Road
Cambridge CB3 0LE

J. Brown
John Innes Centre
Colney Lane
Norwich NR4 7UH

A.C. Newton
Mycology and Bacteriology Department
Scottish Crop Research Institute
Ingergowrie, Dundee DD2 5DA
Scotland

B. O'Hara
Cambridge Laboratory
John Innes Centre
Colney Lane
Norwich NR4 7UH

**USA:**
K.J. Leonard
USDA/ARS Cereal Rust Laboratory
University of Minnesota
St. Paul MN 55108

Summary
of
COST 817 Workshop
on
Epidemiological parameters

18-20 October 1995, Roskilde, Denmark

Edited by Hanne Østergård

This workshop was organised by the COST 817 Action on "Population studies of airborne pathogens on cereals as a means of improving strategies for disease control". The organizing committee consisted of Tonnie Engels, Wageningen, Coordinator of Working Group 5 on Epidemiological Parameters, and Hanne Østergård, Risø, Local organiser. Fourty-five scientists from 12 European countries and USA participated. Abstracts are compiled in a "Workshop Proceedings" which is available from Hanne Østergård, Environmental Science and Technology Department, Building 301, Risø National Laboratory, Postbox 49, DK-4000 Roskilde.

The workshop comprised six sessions each closing up with a concluding discussion on the subject covered. For each session, the chairperson made a summary that is given below:

## Epidemiological parameters and estimation of fitness components (Kurt Leonard, USA)

In the first session of the workshop, the participants discussed the general topic of epidemiological parameters and described research projects on specific diseases in which the key components of pathogen reproduction were investigated.

- Kurt Leonard, USA, described the relationship between population density of the wheat stem rust fungus and the efficiency with which the fungus can infect wheat and produce new spores in those infections. Infection efficiency and spore production per infection were reduced by crowding when disease severity becomes high.
- Christian Damgaard, DK, described the relationship between population density of the barley powdery mildew fungus and its infection efficiency and sporulation capacity. Again, infection efficiency and spore production per infection were reduced by crowding when disease severity becomes high. However, also the opposite was observed with respect to spore production on one cultivar.
- Ivan Sache, F, described research on changing patterns of spore production in wheat leaf rust infections as disease severity increases. He showed that crowding of infections reduces spore production more in older infections than in newly formed infections.

- Lisa Munk, DK, reported research showing that infection efficiency and spore production by barley powdery mildew generally are greater when barley is fertilized more heavily with nitrogen. However, some barley varieties did not show this effect; they provide an important trait to select in new varieties to allow the benefits of fertilization without the disadvantage of increased disease susceptibility.

The general discussion in this session focused on the need to identify the traits that contribute most to pathogen fitness and to find ways of measuring them that will lead to consistent research results. Only when such traits and methods are identified it is possible to make reliable comparisons between experimental treatments to reduce pathogen fitness and manage disease.

## Influence of temperature on the composition of pathogen populations (Eckhard Limpert, CH)

The session consisted of three contributions pointing to research describing different effects of environment and temperature affecting the host, the pathogen and the host-pathogen interaction. The host-pathogen systems treated were barley powdery mildew and yellow and leaf rust on wheat.

- Eckhard Limpert, CH, outlined a hypothesis of ecotypes of the barley powdery mildew pathogen as well as data supporting it. The hypothesis is based on metapopulations, geographic barriers and differential selection due to ecological parameters in the respective areas, above all temperature.
- Lubomir Vechet, CZ, reported that the attack with one genotype of the yellow rust pathogen caused different ranking of disease expression on eleven host genotypes from 1992-1994. The difference in susceptibility was discussed in relation to the effect of temperature and its differential interaction with host resistance.
- Fedele Casulli, I, described the effects of weather conditions on leaf rust epidemiology in Italy. The decreasing importance of the pathogen over the past fifteen years was attributed to a decrease of rainfall and temperature. The increasing future risk of unexpected epidemics on new wheat varieties was emphasised.

The introduction to the general discussion focused on further evidence demonstrating the effect of ecotypic adaptation of pathogen genotypes in several host-pathogen systems not considered by COST Action 817. It was felt that adequate knowledge about cereal pathogens spread by wind is still lacking.

## Mlo-resistance/virulence (Adrian Newton, UK)

Three papers and a poster were presented in this session:

- Temporal breakdown of Mlo-resistance in spring barley by the sudden relief of soil water stress (Adrian Newton, UK)
- Comparison of Mlo-virulent and avirulent isolates (Michael Lyngkjaer, DK)
- Evolution of Mlo-virulence (Hanne Østergård, DK)
- The cost of Mlo-resistance (Jannie Atzema, CH)

For discussion some of the main questions concerning the long term effectiveness of Mlo-resistance were presented:

- Should we talk about Mlo-virulence or aggressiveness?
- Is 'full' virulence possible towards Mlo-resistance?
- What is the maximum potential 'aggressiveness'?

These questions reflect the genetic basis of the host-pathogen interaction and therefore address the theoretical probability of resistance breakdown.

The practical likelihood of Mlo-breakdown was addressed by asking:

- Is there a critical population size for selecting Mlo-virulence/aggressiveness?
- What will the effect of gene *mlo* in winter barley be on selection for Mlo-virulence/ aggressiveness?

In general it was thought that the threat of imminent breakdown was not great, largely because of the apparent pleiotropic partial resistance expression. However, there was clearly a lack of knowledge on which to accurately assess this, and in particular the likely effects of Mlo-resistance on virulence selection when it becomes widespread in winter barley. It is probable that no winter barley with Mlo-resistance will be released for a few years yet. The danger of very few sources of the *mlo* gene used in successful cultivars was highlighted.

Discussion of the cost in terms of yield of Mlo-resistance gave several strategies for further investigation. No-one was brave enough to speculate as to what the *mlo* gene itself is/codes for/ functions as, although it was agreed that it is unlikely to be a recognition gene.

## General epidemiology - models of dispersal (Mike Jeger, NL)

This was a wide-ranging session with five contributions and a discussion on the uses of spore dispersal models.

- Mike Jeger, NL, presented a paper describing how gene-for-gene systems can be modelled from an epidemiological perspective, based on absolute rather than relative fitness. From the analysis it proved possible to interpret factors such as fitness costs associated with pathogen virulence or host resistance directly in terms of epidemiological parameters, or indeed to offer different interpretations.

- Bob O'Hara, UK, described how recent developments in spatial modelling enable not only a better understanding of how an epidemic develops in time and space, but also the implications for the development of genetic patchiness and diversity in for example powdery mildew epidemics. Applications were also evident for experimental designs and in developing variety mixtures.

- Claudio Ciccarone, I, continued with the spatial theme showing how statistical techniques such as spectral analysis can be used to integrate climatology, rust epidemiology and wheat production information in the space-time domain. Such analysis gave new insights into strategies for wheat production in regions of Italy.

- Lars Wiik, S, and Bo Secher, DK (poster), decribed problems associated with disease assessment (how often, over what scale?) and development of disease risk indices based on weather, respectively. Both presentations were concerned with practical problems associated with farmer recommendations and the development of decision support systems.

Mike Jeger then led an open discussion on the uses of models of dipersal. The key questions discussed were:
- is pathogen dispersal or disease spread the more important?
- are the theoretical and practical approaches in-step?
- just how important is dispersal in the epidemic cycle?
- how do we assess dispersal, estimate parameters, etc?
- what do we do with information on dispersal?

There was a general feeling that dispersal was important, but that a major theoretical understanding of mechanisms was not necessary to understand and manage epidemics. There was a considerable scepticism expressed over whether dispersal parameters could really be used predictively, and in particular whether genetic, especially molecular, markers could ever be used for this purpose. A minority but strongly argued view was that information on genetic variants of interest, and a broad assessment of dispersive ability, was invaluable in both epidemiological and population genetical studies.

## Cultivar mixtures (Claude Vallavieille-Pope, F)

During the last 25 years, it has become evident that cultivar mixtures can effectively reduce the spread of airborne fungal diseases relative to the mean of their components. However practical use of mixtures is still limited. Furthermore, the actual variety mixtures planted may not be the best arrangement of cultivars. Theoretical investigations intended to explain the mechanisms affecting variety mixtures and predicting the disease level over the season and resistance effectiveness over the years could be divided into 3 types: firstly the genetic studies concerning the evolution of different races and strategies to prevent super-races from becoming predominant in the pathogen population, secondly, spatio-temporal simulation models to evaluate disease level progression function of different epidemiological parameters, and thirdly the combination of genetic and epidemiological approaches. More studies seem necessary integrating agronomical aspects, several diseases and several seasons.

- Two oral presentations (Maria Finckh, CH, and Claude Vallavieille-Pope, F) showed field data on reduction in epidemics in variety mixtures. The one study pointed out that the agronomic characteristics of the varieties mixed can highly affect the mixture effect. The other study assessed the part of mixture effect due to induced resistance.
- Two posters (Klara Manninger, H, and Josef Sebesta, CZ) presented assessment of induced resistance in controlled conditions at the monocyclic level.
- Furthermore, the experimental work actually conducted in Poland on plant competition and yield stability in variety mixture was presented (Edward Gacek, P).

The discussion focused on the practical aspects on the choice of varieties to be mixed. It was explained how the competition effect of a vigorous variety mixed with a less vigorous one could contribute to enhance the mixture effect. The optimal number of components to be mixed was discussed; according to the experience in the former East-Germany, four cultivars in a mixture seemed to be a good compromise between resistance diversity and a reasonable number of varieties to have to select. However, it is not so much the number of varieties as their level of resistance and the number of different, effective resistance genes that are of importance. Two parameters: relative and absolute disease level in variety mixtures had to be considered. The 15-yr experience of growing spring varieties of barley in mixtures in Denmark over 12-15% of the grown acreage was presented as a successful model.

## Evolution of fungicide resistance (Bent J. Nielsen, DK)

This session comprised four papers and one poster:

- Francoise Godet, F, compared the *triadimenol* and *fenpropimorph* sensitivity of bulk samples of wheat powdery mildew with the sensitivity of single colony isolates from the bulk samples. Comparing the single isolates, a clear evolution of multiple resistance towards the two fungicides was found.

- Jörn Pons, D, described the selection of genotypes caused by fungicides during a barley powdery mildew epidemic. In field plots treated with *triadimenol* the sensitivity was unchanged, while in plots treated with *ethirimol* the sensitivity decreased. An association between *ethirimol* sensitivity and certain virulence genes and pathotypes was found. This were explained by hitchhiking.

- Toni Engels, NL, described the effect of split application of *fenpropimorph* on disease control and sensitivity of wheat powdery mildew in field trials over three year. Treatments with normal applications of *fenpropimorph* and *fenpropimorph+propiconazol* did not change the *fenpropimorph* sensitivity, but increasing the numbers of spraying with reduced dosages indicate that split application may increase the rate at which wheat powdery mildew becomes less sensitive to *fenpropimorph*.

- Maisa Jahn, D, reported on spore production in different winter wheat cultivars after fungicide treatments at full and reduced dosages. In one year (1993) the treatments resulted in a strong reduction in spore production with differences between cultivars.

- Kaul Klem, CZ, described a simulation model of fungicide efficacy against powdery mildew at reduced dose (poster presentation). Timing of the applications is very important for the treatment efficacy, and with all the tested fungicides an adverse relationship was found. Some fungicides had a rather high level of efficacy through the whole incubation period, while other fungicides had a more rapid decrease in efficacy shortly after inoculation.

In the last part of the session there were a general discussion on evolution of fungicide resistance. It seems that there has been a selection for resistance against certain fungicides. But for other fungicide types (e.g. the morpholines) the selection has not been so strong although the fungicides have been used widely for many years. Moreover it seems that there is a difference between wheat and barley powdery mildew. The mechanism behind this was discussed and it was emphasized that the biology and the genetics for each pathogen should be considered. Some work has already been done on the genetics of fungicide resistance, but more data are needed. The relationship between important epidemiological parameters and fungicide resistance plays a key role in the dynamics of fungicide resistance and more information is needed before good predictions and modelling of resistance development can be done. The discussion in the session also focused on resistance factors, concluding that the relation between resistance factors and efficacy in the field of the fungicides is not clear. More data are needed which can give a correlation between the control level in the field and the corresponding resistance level in the pathogen population. Different strategies for reducing the risk of resistance development was discussed. Splitting the full dose in many sprays with low dosages can increase the rate at which powdery mildew become insensitive. The number of sprays (exposures) is important, and it was discussed if the resistance risk would be different if the number of sprays with low dosages was changed. Focus in this discussion was on the need for new strategies, models and a better theoretical basis.

European Commission

COST 817

# Integrated Control of Cereal Mildews and Rusts: Towards Co-ordination of Research across Europe

Eckhard Limpert
Maria R. Finckh
Martin S. Wolfe
editors

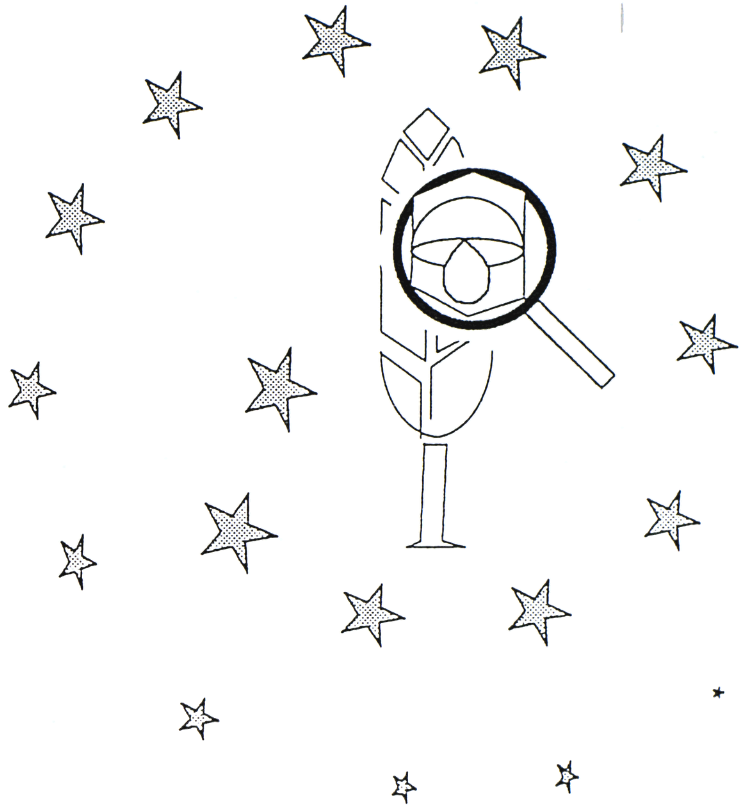
The contributions to the book are ordered according to the following table of contents (a copy of the table is provided on the discette enclosed):

# CONTENTS

Session 4 *POPULATION AND MOLECULAR GENETICS*



Session 5 *FUNGICIDE RESISTANCE*



Integrated Control of Cereal Mildews and Rusts:
Towards Co-ordination of Research across Europe

Cost 817

Zürich / Kappel am Albis
Nov 5 - 10 1994

## FOREWORD

It is an objective of COST to support European agriculture in its attempt to produce healthy and high quality cereal crops with low inputs and in an environmentally safe way. In COST Action 817, improved strategies for the integrated use of host resistance genes and fungicides to control pathogens which are spread by wind throughout Europe are developed. The emphasis is put on major pathogens, such as the powdery mildews and rusts of barley and wheat.

To achieve these goals, a detailed knowledge of pathogen populations across Europe is required. Questions that need to be addressed are, among others: the mode of dispersal of the fungal spores; the kind of selection forces influencing the pathogen populations; the way in which these selection forces could be changed through the strategic use of resistance genes and fungicides; the frequency of mutations and sexual recombination in the pathogen and how these mechanisms influence the appearance of new pathotypes; and how molecular markers can be used to improve our understanding of the genetics of host plant resistance and of pathogen virulence, aggressiveness and fungicide sensitivity.

The Action specifically addresses the following topics:

- Coordination of national surveys on virulence and fungicide resistance as well as analyses of pathogen population data;

- Comparison and, where necessary, standardization of methods, e.g. assessment of virulence, aggressiveness, fungicide sensitivity and definition of DNA markers, so that results from different laboratories can be integrated;

- Coordination of definitions and national monitoring of host resistance genes;

- Improvement of strategies for the management of host resistance genes supplemented by fungicides, and coordination of national recommendations;

- Establishment of regular expert meetings and an information system to ensure a rapid and effective exchange of information to scientists, breeders and farmers.

This workshop was the first of the Action. It has been very successful in establishing the network and exchanging methods and ideas and giving the background for further collaboration.

Chairperson:
Hanne Østergård
Risø National Laboratory
Denmark

Scientific Secretary:
Jean-Pierre Masson
DG XII
Brussels

## PREFACE

Based on the recognition of the outstanding importance of gene flow of the cereal mildew pathogens across Europe, two successful workshops on Integrated Control of Cereal Mildews were held in Germany (1986) and Denmark (1990). With the help of COST Action 817 it became possible to extend the scope in two ways: to include further pathogens spread by wind such as the cereal rusts, and to widen the audience towards a more successful integration of the research in west and east. The present volume is the result of the first workshop of this Action.

The workshop was held from Nov. 5-10 1994 in Kappel a.Albis, Switzerland, and brought together more than sixty colleagues from sixteen European countries. It has provided an invaluable opportuinity for all of us to learn about each other's work and the presented data give an extensive overview over the situation with cereal mildew and rusts all over Europe. There were five separate sessions during the workshop on Virulence to Host Resistance, Host Resistance, Mixtures, Population and Molecular Genetics, and Fungicide Resistance. The discussions at each session were very lively and interesting and have stimulated much interaction among workers from different countries.

To make the information that was exchanged at the workshop more widely accessible, we have put together all the extended abstracts and papers that the participants submitted to us.

The participants of the workshop are extremely grateful to COST, Swiss National Fund and Swiss National Institute of Technology, ETH, for providing the necessary funds, to Jean-Pierre Masson and Hanne Østergård for support with the organisation, to all the workshop participants for their contributions and, finally, to the further hands and heads involved of the ETH Mildew Group.

Zürich, November 1995 Maria R. Finckh, Eckhard Limpert, Martin S. Wolfe

WORKSHOP ON INTEGRATED CONTROL OF CEREAL MILDEWS AND RUSTS
COST ACTION 817
5 - 10 Novenber 1994, Kappel a.A., Zürich

## Recommendations

Sustainability, based on ecologically sound approaches, is widely accepted as a main goal for European agriculture. Arable crops and cereals in particular are of major importance in this context. Therefore, reduction of pesticide use in cereals is a primary objective. This means that improvement of disease resistance and of strategies to manage disease resistance and pesticides play a key role in sustainable agro-ecosystems.

So far, most of the cultivars of wheat and barley that have been produced are susceptible to one or more important diseases and are thus of limited value in sustainable agriculture.

The cost of creating new cereal cultivars for sustainable agriculture is higher than that for current cultivars because each additional resistance is increasingly costly. However, we need to invest now in appropriate resistance research, at all levels from breeding research to management in agro-ecosystems, to protect crops as external inputs are reduced.

Therefore, the Workshop recommends to concentrate on the following tasks:

1. We need to gain a better understanding about the major pathogens, their variability, geographical distribution at the European level and ecological adaptation, preferably using improved technology.

2. Equally, we need to know more about the disease resistance of host plants, and particularly about the various factors that may contribute to durability of disease resistance.

3. We need to understand better the co-evolution of hosts and pathogens in agriculture since this is also a key factor in the expression and durability of disease resistance.

In summary, essential investments for sustainable agriculture in Europe are to support plant breeding and pathology in the development of a variety structure on a Europe-wide basis, which provides durable resistance at low cost. This is a long-term investment, since even the most advanced breeding programmes may still need 10 years or more from initial crossing to registration of a new cultivar; this requires a long-term stable research base.

# Short Term Scientific Missions

## Short Term Scientific Missions 1995

A study contract was signed with Risø National Laboratory, DK, in June 1994. Six missions have taken place in 1995:

| Name | From | To | Days |
|---|---|---|---|
| Jannie Atzema | Zürich, CH | Risø, DK - Østergård | 7 |
| Eckhard Limpert | Zürich, CH | Praha, CZ - Bartos | 5 |
| Ivan Sache | Grignon, F | Rothamsted, UK - Plumb | 3 |
| Jochen Prochnow | Ashersleben, D | Aberystwyth,UK - Clifford<br>Norwich, UK - Brown | 10 |
| Jadwiga Nadziak | Bakow, PL | Zürich, CH - Finckh | 30 |
| Maria Csosz | Szeged, H | Praha, CZ - Bartos | 14 |

On the following pages are the reports from these 6 missions.

# Report of a visit to, Environmental Science and Technology Departement, Risø National Laboratory, Roskilde, Denmark. April, 3rd-8th, 1995.

Jannie Atzema, Swiss Federal Institute of Technology, Zürich, Switzerland.

The main reason for this visit was an exchange of ideas and techniques about mlo-resistance and mlo-virulence. The theme of my PhD- thesis is mlo-resistance and virulence against barley powdery mildew.

One of the aims of the COST-project is to have more international co-operation and exchange of knowledge. Because the group in Risø has much know-how on mlo-virulence and mlo-resistance, it was very useful for me to talk to them. I will give here some of the most important issues discussed.

M. Lynkjaer explained how he prepared segments of leaves for microscopic observation. He explained how he scored the results. He also demonstrated his technique for inoculating plants. (These techniques are different from ours.) We discussed his ideas about the way the mlo-resistance works.

C. Damgaard uses a cyclone sampler for collecting spores from mildew colonies and counts them with a Coulter Counter. I use a Coulter Counter to count spores, but I do not have a non-destructive way of collecting spores. This technique seems very useful for me. I borrowed a sampler to try out in our lab.
He showed some results, which he had obtained using this technique. These results showed that density of colonies had an influence on the number of spores per colony and that the time of colony production was changing with the density. I am interested in spore volumes. It is quite logical that the volumes of the spores are influenced by the same factors, so these results are useful for me.

With J.H. Jørgensen I discussed my results from an experiment on the energy cost of the mlo-gene in barley. Jørgensen had some very useful comments from his experiences and knowledge.

With Mrs. H. Østergård I discussed my results on different subjects. She had some very useful comments.

One thing which came out of discussions with many people was the definition of mlo-virulence or-aggressiveness. The way the mlo-resistance works is still not clear. It is not a normal race specific resistance. It is also not a fully quantitative reaction. It seems to have quantitative and qualitative aspects. This means that it is difficult to speak about virulence. but also aggressiveness is not a good word. A discussion made clear that one has to be careful with the use of both words.

I was able develop my ideas, learned more about some useful techniques, and I am very much stimulated by this visit.

Jannie Atzema,
Zürich, 17-6-'95

J. Atzema Han Østergård

COST 817, WG1

Short term scientific mission of E. Limpert, Zurich to P. Bartoš, Prague

## Report

The Short Term Scientific Mission to the Institute of Crop Production, Prague, took place as planned from April 10-14 1995.
Referring to the list of points outlined in the work plan, we would like to give the following outline of the work done:

1 Trying to compare general features of population biology we agreed that several comparisons made in the literature, e.g. based on the number of resistance genes available can be misleading. Although we became aware of, in part, serious limitations of comparisons, we continue to feel that an attempt can be advantageous.

2 Diversity seems to be a good example to demonstrate difficulties and limitations of comparisons, but there may also be ways to cope with such problems.

3 and 4 There are several examples, particularly from *Puccinia recondita* and *Erysiphe graminis hordei*, which suggest similar basic patterns of evolution to exist. For example genotypes 77 and 77 *SaBa* may be of monotopic origin, as appears to be the case for the *Va9*- and the *Va13* subpopulations. These pathodemes have in common that they all seem to originate in the east.

5 Patterns of complexity were extensively looked at in 21 countries across Europe and in several further areas/continents. The results obtained are so promising that further evaluations are prepared.

In general, we felt to have made considerable progress in focussing on a wealth of data from closely related research areas that have never been compared adequately so far. Indeed, the picture obtained appears to be of both theoretical and practical importance. Although considerable further efforts are needed, joint publications are in progress. We also consider to give a contribution on the outcome of this Mission at the next meeting of WG1 in December at Cambridge.

Prague, April 14 1995 — Pavel Bartoš — Eckhard Limpert

## COST Action 8.17

## Report on a short-term scientific mission to IACR-Rothamsted. 2-4/10/95.

Plant Pathology Department at Rothamsted has a long and rich experience about aerobiology, namely wind and rain dispersal of bacteria, fungal spores and pollen grains. Early works in the 50's and later by P.H. Gregory are still of relevance. Research in that area is now pursued by Dr. B.D.L. Fitt and Dr. H.A. McCartney. Both worked early on stem diseases in cereals and then turned towards diseases of linseed and oilseed rape. They have a current collaboration with Dr. L. Huber, from the Department of Agricultural Meteorology here in Grignon in the area of modelling splash dispersal of spores and other particles. I also began a collaboration with Dr. Huber specifically addressed on the dispersal of rust spores in cereals. This mission was a good opportunity to better co-ordinate research between the three teams involved.

Among the epidemiological parameters characterising wind-borne diseases, dispersal parameters are the most tedious to measure because of the multi-local and multi-scale pattern of dispersal. We already have data on spore and disease dispersal gradients of cereal rusts, but we need more insight about the biophysical mechanisms leading to the build-up of these gradients. My mission was therefore totally in accordance with the aims of the COST subgroup 'Epidemiological parameters', because our goal is to study both holistic and mechanistic aspects of spore and disease gradients. The data we would obtain are likely to be incorporated in more realistic models of disease spread in time and space. Such models are needed for various purposes, e.g. disease prediction, evaluation of diversification strategies, or survey of pathogen virulence shifts with time.

The first part of the mission was devoted to the assessment of the results I have obtained with a M.Sc. student using a miniaturised wind tunnel and a centrifuge. Both Dr. Fitt and Dr. McCartney are familiar with various kinds of wind tunnels used to study spore removal. Our results were considered as relevant to the epidemiology of the corresponding diseases (yellow and brown rusts of wheat). The devices used in Rothamsted are closer to the field situation, since a 12-m long wind tunnel, connected to a 11-m high rain tower is in use there. To study rust spores removal in more realistic conditions than ours, my colleagues invited members of my research group, namely a future Ph.D. student to come to Rothamsted to use their large-size devices. Although people in Rothamsted are not part of COST project, this mission will lead to close collaboration which will be of great profit for the COST project. Incidentally, I also had a stimulating discussion with Dr. S.J. Welham about modelling dispersal gradients and their relationship to disease progress within a single field and from field to field.

| Dr. I. Sache (visitor) | Dr. B.D.L. Fitt (host) |
|---|---|
| Sache | B.D.L. Fitt |
| 16/10/95 | 16/10/95 |

Jochen Prochnow
Bundesanstalt für Züchtungsforschung an Kulturpflanzen
Intstitut für Epidemiologie und Resistenz
Theodor- Roemer- Weg 4
Deutschland
Tel.: + 03473/8790
Fax : + 03473/2709



Dr. H. Østergård
Riso National Laboratory
Enviromental Science and Technology Department
P.O. Box 49
DK-4000 Roskilde, Denmark
Phone +45 46 77 41 00

**Report on the results of a short-term scientiffic mission**

Introduction:
Barley leaf rust (*Puccinia hordei Otth*) is present in Germany every year. The loss of yield is dependent on the time of infection and fluctuates between 15 to 40 percent.
The knowledge of the presence of virulence genes in leaf rust pathogen populations, of the development of populations in dependence on biotic and abiotic influences and also of possible combinations of the different virulence genes in the pathogen genotypes is a very important basis both for breeding of resistant cultivars and the judgement of the durability of resistance in actual cultivars. On the other hand these facts give important information for an effective plant protection.
In Aschersleben exists a pathogen collection with more than 300 isolates of *Puccinia hordei*. For an effective test of material on resistance to *Puccinia hordei* it is not sufficient to know the virulence genes, it is also necessary to determine the relationships between the isolates. This knowledge provides an effective selection of characteristic isolates. Therefore it is essential to determine the relationships of this isolates as a prerequisite for the evaluation of genetic resources and investigation of cultivars.

To realize this work it was necessary to compare the methods. In cooperation with Dr. Brain Clifford, Dr. Elwyn Jones (methods of data sampling) and Dr. James Brown (biometrical methods) the following algorithm was discussed :

Methods :

1. estimate the virulence pattern of the isolates:
The Aschersleben pathogen collection of *Puccinia hordei* based on samples of attacked leaves collected with annually support from breeders and offices of plant protection and in cooperation with Dr. Felsenstein of a mobile spore trap.
The determination of this collection was realised on the differential set by WALTHER (tab.2) using the key of measurement by LEVINE and CHEREWICK (tab.1).
The determination of virulence genes was carried out on the leaf segment test (length of leaves 2,5-3 cm; benzimidazole agar 40 ppm - benzimidazole) with single pustules lines.
A different virulence pattern showed 96 isolates. These isolates were used to develop a numerical taxonomy to describe their relations.

tab 1 : key of measurement to estimate the virulence level
by LEVINE and CHEREWICK, 1952

| | | |
|---|---|---|
| i | = | no reaction, no infection |
| On,c,nc= | | highly resistant, no pustules, necrosis, chlorosis, chlorosis and necrosis |
| 1 | = | very small pustules in necrotic spots |
| 2- | = | small pustules with low spore production in necrotic and chlorotic leaf area |
| 2+ | = | variably mesothetic, conglomeration of uredia of diverse sizes and types tending to integrate, both necrotic lesions and chlorosis usually present |
| 3 | = | moderatly susceptible, uredia of medium size usually slight chlorosis but no necrosis at infection centres |
| 4 | = | extremely susceptible, uredia predominantly large, necrotic lesions absent, chlorosis may be present |

tab. 2 Differential set for barley leaf rust ( *Puccinia hordei Otth* ) and triple code nomenclature (race UN 8-1)

| variety | resistance genes | reaction | factors | sum | |
|---|---|---|---|---|---|
| 1 SUDAN | Pa 1 | a | $2^0$ | 1 x 1 = 1 | |
| 2 PERUVIAN | Pa 2 | r | $2^1$ | 2 x 0 = 0 | |
| 3 RIKA x F1 | Pa 3+2r | r | $2^2$ | 4 x 0 = 0 | 1 |
| 4 GOLD | Pa 4 | a | | 1 x 1 = 1 | |
| 5 CEBADA CAPA | Pa 7 | r | | 2 x 0 = 0 | |
| 6 QUINN | Pa2+Pa5 | r | | 4 x 0 = 0 | 1 |
| 7 BOLVIA | Pa2+Pa6 | r | | 1 x 0 = 0 | |
| 8 EGYPT | Pa8 | a | | 2 x 1 = 2 | |
| 9 HOR 500-1 | (1d+1r)k | a | | 4 x 1 = 4 | 6 |
| 10 HOR 1132 sel. | 2rk | r | | 1 x 0 = 0 | |
| 11 HOR 2596 | Pa9 | r | | 2 x 0 = 0 | |
| 12 HOR 679-3 | Pa3 | r | | 4 x 0 = 0 | 0 |
| 13 ESTATE | Pa3+1r | r | | 1 x 0 = 0 | |
| 14 ODERBRUCKER | Pa1 | a | | 2 x 1 = 2 | |
| 15 REKA | Pa2+? | r | | 4 x 0 = 0 | 2 |
| 16 HOR 4280 | 1d+1r | r | | 1 x 0 = 0 | |
| 17 TRUMPF | (2d+1r)k | r | | 2 x 0 = 0 | |
| 18 LADA | (2r)k | r | | 4 x 0 = 0 | 0 |

The triple code for the race **UN 8-1** is **PH 116020.**
differential set by WALTHER and triple code calculation by FRAUENSTEIN et al

2. mathematical determination of the relations between the isolates :
Because the values ascertained in an ordinal scale, it is impossible to use these data for cluster analysis in a conventional way. Therefore the following algorithm was used to characterize the relations between the isolates :

1. transform the scale of measurement in a numerical code

| notes | numerical code | |
|---|---|---|
| 0 | 0 | (highly resistant) |
| 1 | 1 | (resistant) |
| 2- | 1 | (resistant) |
| 2 | 2 | (moderately resistant - moderat susceptible) |
| 2+ | 3 | (moderately susceptible) |
| 3 | 4 | (susceptible) |
| 4 | 5 | (highly susceptible) |

2. determinate the polychoric correlation coeffizient by POSER (1974)
To estimate the correlation coefficient for these grouped data with an ordinal character the procedure by POSER was used. The objects are the 96 isolates and the characters are the virulence pattern on the 18 test varieties. Because the test variety 'Cebada Capa' (Pa7) is fully resistant to all isolates it shows no variance, these cultivar and the reaction were deleted.

$$r_{pol} = \frac{\sum_i \sum_j (f_{ij} * d_i * d_j)}{\sqrt{\Sigma (f_{i.} * d_i)^2 * å(f_{.j} * d_j)^2}}$$

k - number of categories of x    i=1...k
m - number of categories of y    j=1...m
$-1 <= rpol < +1$

3. transport the correlation matrix in the factor analysis and estimate the factor loadings
The software 'STATISTIKA' was applied in order to estimate the factor loadings.
17 factors were extracted (number of factors = number of characters) with the method 'Principal components' by using the factor rotation 'VARIMAX, RAW'. The factor scorses could not estimated in this procedure, because the origin for the factor analysis was a correlation matrix.

4. estimate the factor scores
To calculate the factor scorses, each object in the origin data matrix was multiplied with each factor loading in the factor loading matrix. These results are metric parameters, suitable for clusteranalysis.

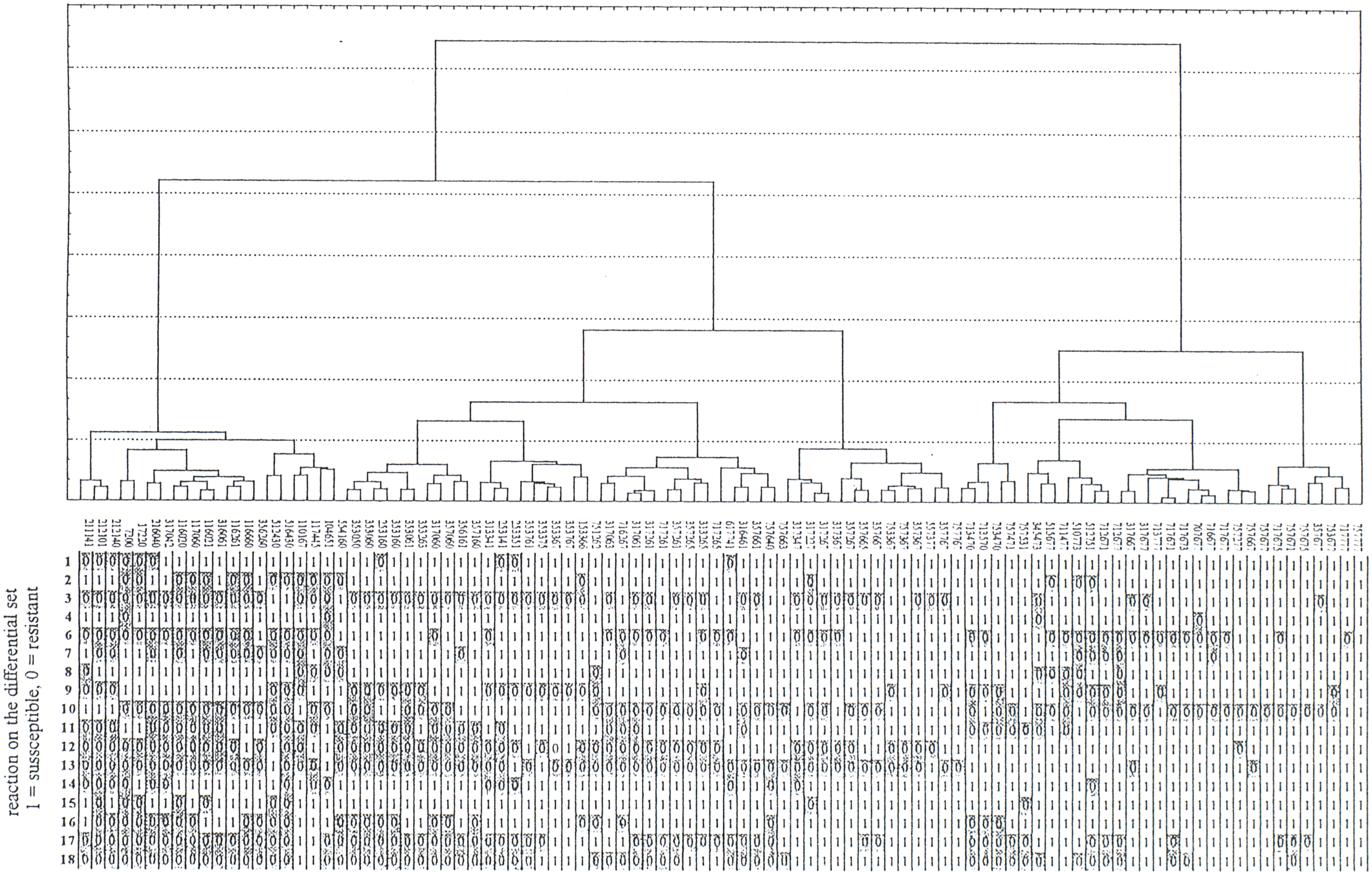
5. clusteranalysis
To classify the isolates the module 'Cluster Analysis' was applied contained in the software 'STATISTIKA' . The clustering method 'Joining Tree Clustering' with the amalgamation rule 'Ward's method' and the distance measure 'Euclidian Distances' was used.

6. results of clusteranalysis:
The result of the clusteranalysis is a dendrogram (graph1). This dendrogram shows the relations betwen the isolates. Members of each cluster are similar in their virulence pattern. The Differences within the groups are small and without the groups high. The cluster algorithm 'Ward's Method' produce approximate equally large groups with low variance within the clusters.

## Results :

To evaluate assortments of barley on resistance to *Puccinia hordei* it's not necessary to use all isolates. By means of the numerical taxonomy it is not difficult to select isolates for determining the basic of resistance on different samples. One isolate of each group is representative as a member of his cluster.

# Dendrogramm for 96 isolates of Puccinia hordei



In the discussion with Dr. Brian Clifford and Dr. Elwyn Jones we compared the methods of the data sampling. A general differential set used in all european countries would be very helpfull to compare the results of the observation of the virulence population. It could be also usefull to divide the differential set into a international and a national part to consider the country-specific conditions in the pathogen development.
Futhermore we compare the infection methods, the key of measurement, the storage of spores and the evaluation tests in the greenhouse and in the field.
Together with Dr. James Brown we searched for an effectiv way to estimate a numerical taxonomy. The amalgamation rule 'Ward's method' is not favourable because this algorithm form small and instable clusters. The algorithm 'WPGMA' discribe the relations between the isolates in a better way. This method should be used when the cluster sizes are suspected to be greatly uneven. To select isolates for evaluation tests it is also necessary to know the precise virulence pattern. Both, the results of the clusteranalysis and the virulence pattern allow an economical selection of test isolates.

Jochen Prochnow

Dr. Brian Clifford

Dr. James Brown

# Report for the stay of Dr. Jadwiga Nadziak at the ETH Zürich from 8. Nov. 1995 to 8. Dec. 1995

According to the detailed work plan I learned the analysis and evaluation of the data with computer using QUATTRO PRO for Windows with the help of Dr. Maria R. Finckh. I used data from mixture experiments of winter barley and wheat from Poland:

1) a mixture experiment of winter barley with the temporal dynamics of competition (2-way, 3 way mixture and pure stands of three cultivars) in 1993, 1994 and 1995.

2) a mixture experiment of five winter barley cultivars 1993 and 1994.

3). a mixture experiment of five winter wheat cultivars.

During my mission I learned to:

- calculate the reduction of diseases based on the non-linear (logistic) assessment key (data from exp. 1).
- evaluate mixing ability (data from experiments 2 and 3)
- evaluate pure stands with the mixtures in different relationship (relative performance of mixtures) (data from experiment 1). Of particular interest are the comparisons of mixtures and their components over time throughout a season (using: number of plants in a autumn, number of plants in spring, number of tillers, number grains per ear or plot, 1000 grain weight, and total yield).

In the experiment on temporal dynamics of competition (expt. 1) the cultivars of winter barley have different morphological head types (awnless, 2-row, 6-row). Field experience indicates that 3-way mixtures with different morphological head types have given beneficial effect concerning the yield and disease reduction. The powdery mildew was reduced between 48-53% in the three-way mixture. In two-way mixtures disease was reduced in all but one case between 2 and 55%. In one mixture disease severity increased by 22% (i.e. 4% more diseased leaf area than expected).

We are currently conducting many experiments with different cultivars. Some of the experiments have been evaluated for disease and yield effects. On the basis of the results the mixtures with the best yield, with stability over environments and disease reduction for Poland are being identified. However, this is very time consuming and expensive. We need some information, how the cultivars are behaving in mixtures in general. It is therefore very important to obtain a generally applicable statistical analysis method. During my stay, we worked out exactly model calculations for trials in general, using the mixture experiments of winter barley.
We have also begun a discussion on the ways in which statistics could be applied to combining ability analysis that we have so far only presented at the COST Workshop in Switzerland in Nov. 94 without being able to evaluate the significances.
So far, all my work has been hampered by the lack of computing facilities. After my stay and study with Dr Maria R. Finckh, I will be able to work out the mixture experiments of barley with the newly acquired computer at the research station in Bakow. I will also be able to teach the research assistants in the basics of spread sheet use. However, it will still be necessary to collaborate in the future to improve on the capacities for conducting statistical analyses in Bakow.

Signed: Jadwiga Nadziak     Maria Finckh (ETH, Zürich) 8. Dez. 95

J. Nadziak

To:

Dr. H.Øestergård
Environmental Science
and Technology Department
P.O. Box 49
DK - 4000 Roskilde, Denmark

From: Jadwiga Nadziak
ETH Zurich
Switzerland

Zürich, 8. Dez. 1995

Dear Dr H.Ostergard

In answer to your letter from 17.11.95 I have the pleasure of informing you that I finished my short-term scientific mission in ETH-Zurich.
In enclosed, I am sending the report, the receipts for expenditure on travel and accomodation.

Yours sincerely

J. Nadziak

Banking details will be provided by Dr. E. Gacek

| | | |
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Report from the study trip

Mária Csősz

Date: 27.11. - 8.12. 1995.

Place: Research Institute of Crop Production

Prague - Ruzyně

Supervisor: Dr. Pavel Bartoš

The main aim of the study trip was to study methods of the leaf and stem rust work in the greenhouse.

During the study trip I learnt the method of infection, the differential sets, the scoring scale and the spore collection. I practised all these methods in the greenhouse and could evaluate results at the end of my stay.

The stem rust infection, the scoring scale and the spore collection are the same as in the leaf rust. The temperature and differential set are different (leaf rust 15-20°C, stem rust 20-25°C).

The leaf rust infection, the scoring and the spore collection I did together with Dr. Bartoš. I also learnt the leaf segment methods from Dr. Hanušová who uses it for powdery mildew and yellow rust.

I started the gene identification work in the field in Szeged. We discussed my problems and how to continue. We agreed that I would send seed samples from the two Sr5, three Sr36 and Sr22 near isogenic lines and GK Kincso for test in the greenhouse. Dr. Bartoš gave me seed samples of Sr31 line and Lr and Sr differential test lines.

In addition I met and spoke with more researchers about Fusarium, Septoria, pesticides, gene bank, breeding: Dr. R. Hanušová, Dr. E. Stuchlíková, Dr. L. Věchet, Dr. M. Hájková-Fromanová, Dr. K. Veverka, Dr. Z. Stehno and Dr. V. Síp.

Conclusion:

My stay at the Research Institute of Crop Production, Prague - Ruzyně was very useful for me because I learnt simple methods which can be applied without expensive technical equipment with good practical results. I also get acquainted with wimple procedures for genetic studies of resistance. I also received necessary seed and was promised that some greenhouse tests will be carried out for me at Prague.

Mária Csosz
Mária Csosz
Cereal Research Institute
Szeged, Hungary

Pavel Bartoš
Dr. Pavel Bartoš
Research Institute of Crop
Production, Prague - Ruzyně

European Commission

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