Pasture and Forage Crop Pathology
Related Society Publications

Forage Cell Wall Structure and Digestibility

Forage Quality, Evaluation, and Utilization

Persistence of Forage Legumes

Post-Harvest Physiology and Preservation of Forages

For information on these titles, please contact the ASA, CSSA, SSSA Headquarters Office; Attn: Marketing; 677 South Segoe Road; Madison, WI 53711-1086. Phone: (608) 273-8080. Fax: (608) 273-2021.
Pasture and Forage Crop Pathology

Proceedings of a trilateral workshop held at the Mississippi State University, Mississippi, 10–13 April 1995, attended by invited delegates from federal and state government organisations, universities, and seed industry representatives from Australia, New Zealand, and the United States of America.

Editorial Committee

Chair: Sukumar Chakraborty
Members: Kenneth T. Leath
        Robert A. Skipp
        Gary A. Pederson
        Robert A. Bray
        Garrick C.M. Latch
        Forrest W. Nutter, Jr.

American Society of Agronomy, Inc.
Crop Science Society of America, Inc.
Soil Science Society of America, Inc.

Madison, Wisconsin, USA

1996
CONTENTS

Preface ............................................................... ix
List of Participants .............................................. xi
List of Contributors Not in Attendance ......................... xv
Acknowledgment .................................................... xvii

Overview of the Crops and Diseases

Overview of Pasture and Forage Crop Diseases in Australia
J.A.G. Irwin, G.M. Murray, and R.D. Davis ........................ 3

Overview of New Zealand Agriculture and Pasture Pathology
G.C.M. Latch .................................................... 23

Pasture-Forage Crops and Diseases in the United States
K.T. Leath, R.E. Welty, R.G. Pratt, and R.M. Sonoda ............ 33

Discussion ......................................................... 59

Assessment of Losses Due to Diseases

Problems and Progress in Assessing Direct and Indirect Yield Losses Caused by Pathogens in Pasture Species
M.J. Barbetti, R.A.C. Jones, and I.T. Riley ....................... 63

Recent Developments in Methods for Assessing Disease Losses in Pasture–Forage Crops
F.W. Nutter, Jr., and R.E. Gaunt ................................ 93

Economic Considerations for the Assessment of Losses Due to Pasture Diseases
N.D. MacLeod and G.A. Norton .................................. 119

Discussion ......................................................... 160

Knowledge Base in Fungal and Bacterial Diseases

Fungal and Bacterial Diseases of North American Forage Crops
J.G. Hancock ..................................................... 165
Fungal, Bacterial, and Nematode Diseases of Australian Pastures
G.M. Murray and R.D. Davis .................................. 187

Fungal and Bacterial Diseases of Pasture Plants in New Zealand
R.A. Skipp and J.G. Hampton .................................. 213

Discussion ............................................................... 237

Knowledge Base in Nematode Diseases

Nematode Pathogens of New Zealand Pastures
C.F. Mercer and R.N. Watson .................................. 241

Nematode Pathogens of American Pasture–Forage Crops
G.D. Griffin, E.C. Bernard, G.A. Pederson, G.L. Windham,
K.H. Quesenberry, and R.A. Dunn .............................. 257

Discussion ............................................................... 285

Knowledge Base in Viral Diseases

Viruses of New Zealand Pasture Grasses and Legumes
P.L. Guy and R.L.S. Forster ................................... 289

Virus Diseases of Australian Pastures
R.A.C. Jones ...................................................... 303

Virus Diseases of American Pasture and Forage Crops
M.R. McLaughlin, R.C. Larsen, L.E. Trevathan, C.E. Eastman,
and A.D. Hewings ............................................. 323

Discussion ............................................................... 362

Seed Industry Perspective

Pasture Diseases: An Australian Seed Industry Perspective
K.C. Goulter ......................................................... 365

The USA Seed Industry Perspective of the Importance of Disease Resistance
in Pasture–Forage Crops
J.E. Brummer and J.B. Moutray ................................ 387

New Zealand Seed Industry Perspective
J.D. McKenzie and W.S. Green .................................. 395
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease Complexes in Pastures</td>
<td></td>
</tr>
<tr>
<td>Disease Complexes in Australian Pastures</td>
<td>403</td>
</tr>
<tr>
<td>S.P. Flett and R.G. Clarke</td>
<td></td>
</tr>
<tr>
<td>Disease Complexes in New Zealand Pastures</td>
<td>429</td>
</tr>
<tr>
<td>R.A. Skipp and R.N. Watson</td>
<td></td>
</tr>
<tr>
<td>Disease Complexes</td>
<td>453</td>
</tr>
<tr>
<td>C.R. Grau</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>472</td>
</tr>
<tr>
<td>Strategies for Disease Management</td>
<td></td>
</tr>
<tr>
<td>Host Resistance and Tolerance and Its Deployment</td>
<td>475</td>
</tr>
<tr>
<td>M.D. Casler and G.A. Pederson</td>
<td></td>
</tr>
<tr>
<td>Prospects of Biological Control of Diseases in Pasture Crops</td>
<td>509</td>
</tr>
<tr>
<td>Molecular Approaches to the Management of Pasture Diseases</td>
<td>533</td>
</tr>
<tr>
<td>T.J.V. Higgins, J.W. Randles, and J.M. Manners</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>562</td>
</tr>
<tr>
<td>Case Studies of Diseases</td>
<td></td>
</tr>
<tr>
<td>Wilt Diseases of Alfalfa</td>
<td>567</td>
</tr>
<tr>
<td>D.R. Viands and B.W. Pennypacker</td>
<td></td>
</tr>
<tr>
<td>The Successful Control of Clover Scorch Disease <em>(Kabatiella caulivora)</em></td>
<td>589</td>
</tr>
<tr>
<td>in Australian Subterranean Clover Pastures</td>
<td></td>
</tr>
<tr>
<td>M.J. Barbetti</td>
<td></td>
</tr>
<tr>
<td>Management Through Improved Understanding: A Case History of <em>Stylosanthes</em> Anthracnose in Australia</td>
<td>603</td>
</tr>
<tr>
<td>S. Chakraborty, D.F. Cameron, and J.A. Lupton</td>
<td></td>
</tr>
<tr>
<td><em>Sclerotinia sclerotiorum</em>: Prospects as a Mycoherbicide in Pastures</td>
<td>621</td>
</tr>
<tr>
<td>I.C. Harvey</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>643</td>
</tr>
</tbody>
</table>
PREFACE

With hay silage and pasture supplying 62% of a dairy cow’s energy and about 91% of that of other livestock, pasture and forage crops contribute to about 36 billion dollars (U.S.) in animal products in the USA. The value of products from Australian pastures totals some $12 billion (Australian) annually. New Zealand derives over 50% of its export income from grassland-based products. Diseases are a constraint to productivity, persistence and quality of pastures worldwide with some 400 fungal, bacterial, viral, mycoplasma and nematode diseases affecting forage grass and legumes. Diseases are fast becoming an increasingly important constraint to increased production as the production levels in many crops and cultivars approach their genetic potential. While realistic estimates of loss to animal production from pasture diseases are largely unavailable, a 10% loss in production is generally accepted. This amounts to billions of dollars in lost production from pasture and forage crop diseases.

If problems in pasture plant health could be overcome, then vast areas of grazing and forage cropland in the three countries could be better utilised for animal production from more sustainable pastures. Persistent legume-based pastures would help conserve soil, water and land resources and enhance soil fertility. There is only a handful of geographically isolated experts who deal with pasture diseases. Historically, their representation at the international grasslands congresses have been generally poor. This has meant that the interaction and exchange of ideas, which is vital to problem solving has not occurred readily and the developments made in cognate areas of science have been slow in filtering through to research on pasture diseases.

A workshop in 1989 on the persistence of pasture legumes attended by a group of eminent agronomists, ecologists, plant physiologists, breeders and pathologists from Australia, New Zealand and the USA identified diseases and pests as a top priority research objective. This workshop brings together for the first time researchers from universities, state, federal and industry organisations from the three participating countries so that they can interact and appraise current and potential pasture/forage crop disease problems and make their collective ideas available in a published proceedings. It provided a forum to promote a higher level of communication among professionals from the three countries interested in reducing disease losses to pasture/forage crops to focus the strengths of each nation’s expertise on common solutions to specific problem areas, for the benefit of all countries. A team of 8 Australian, 7 New Zealand and 10 American delegates prepared review and overview papers on nominated topics. These papers were presented and discussed at the workshop.

The aims of the workshop were (i) to document the importance of diseases in pastures from a realistic assessment of the extent and nature of losses caused by diseases in each country and to consider the methodology needed to assess accurately such losses using economic analysis; (ii) to critically review the current state of knowledge in pasture and forage pathology in each country and to outline the progress made in the management of pasture/forage crop diseases; (iii) to exchange information on concepts, methods, approaches and recent advances in disease management to collate and establish a current knowledge base; and (iv) to enable key researchers from the three countries working on pasture/forage diseases
to promote collaboration, identify priority areas for future research and make recommendations. In addition to the scientific and economic aspects of pasture and forage crop pathology, the workshop addressed issues of low profile of pasture and forage crop diseases in production systems, priority areas for future research, ways and means of improving communication between people interested in pasture and forage crop pathology, the current status of pasture pathology in the three counties and future outlook. A questionnaire (Appendix A) was sent to all participants before the workshop to assess the relative importance of some of the important issues. Results of this survey are given in Appendix B.

The workshop dealt with an overview of the crops and diseases in each country; knowledge base in pasture and forage crop pathology; assessment of loss from pasture and forage crop diseases; disease complexes in pastures; industry perception of the importance of pasture and forage crop diseases; traditional and novel approaches to the management of pasture and forage crop diseases; case histories of successfully managed pasture and forage crop diseases and the future of pasture and forage crop pathology.

This publication gives the first comprehensive and fully referenced coverage of pasture and forage crop pathology written by specialists from the three countries. It should be useful to agronomists, pathologists, breeders and others interested in the pathology of pasture plants, far beyond the geographical boundaries of the three countries.

Financial and other assistance in the organisation of the workshop and publication of the proceedings are gratefully acknowledged. Sincere appreciation is extended to all authors and participants for their contribution and free exchange of ideas and views during discussions.

Sukumar Chakraborty
CSIRO Division of tropical Crops and Pastures
St. Lucia, Queensland, Australia
LIST OF PARTICIPANTS

Martin J. Barbetti  
CRC for Legumes in Mediterranean Agriculture, Western Australian Department of Agriculture, Baron-Hay Court, South Perth, WA 6151 Australia  
martinb@agpol.agric.wa.gov.au

Michael D. Casler  
Department of Agronomy  
University of Wisconsin  
1575 Linden Drive  
Madison, WI 53706-1597  
casler@calshp.cals.wisc.edu

Sukumar Chakraborty  
CRC for Tropical Plant Pathology, CSIRO Division of Tropical Crops and Pastures, 306 Carmody Road  
St. Lucia, Queensland 4067 Australia.  
S.Chakraborty@botany.uq.oz.au

Sze P. Flett  
Institute of Sustainable Irrigated Agriculture, Private Bag, Ferguson Road, Tatura, Victoria 3616 Australia  
fletts@salty.agvic.gov.au

Roy E. Gaunt  
Lincoln University  
Plant Science Department  
P.O. Box 84, Canterbury  
New Zealand  
gaunt@lincoln.ac.nz

Ken C. Goulter  
Pacific Seeds Pty Ltd, 268 Anzac Avenue, Toowoomba, Qld. 4350 Australia.  
K.Goulter@botany.uq.oz.au

Craig R. Grau  
Department of Plant Pathology  
1630 Linden Drive  
University of Wisconsin  
Madison, WI 53706-1598  
cg6@plantpath.wisc.edu

Gerald D. Griffin  
USDA, ARS  
Forage and Range Research Lab.  
Utah State University  
Logan, UT 84322-6300  
griffin@cc.usu.edu

Paul L. Guy  
University of Otago  
Botany Department  
PO Box 56 Dunedin  
New Zealand  
Paul@phyton.otago.ac.nz

Joseph G. Hancock  
108 Hilgard Hall, MC 3110  
University of California  
Berkeley, CA 94720  
hancock@violet.berkeley.edu

Ian C. Harvey  
AgResearch  
Canterbury Agriculture & Science Centre, P.O. Box 60, Lincoln  
New Zealand  
Harveyi@agresearch.cri.nz

T.J.V. Higgins  
CSIRO Division of Plant Industry  
GPO Box 1600, Canberra  
ACT 2601, Australia.  
TJH@pican.pi.csiro.au
Richard N. Watson  
AgResearch  
Ruakura Agricultural Centre  
Hamilton  
New Zealand  
WatsonR@agresearch.cri.nz

GUESTS AT THE WORKSHOP

Robert. G. Pratt  
Forage Research Unit  
P.O. Box 5367  
Mississippi State, MS 39762-5367

Dennis E. Rowe  
USDA-ARS  
Forage Research Unit  
P.O. Box 5367  
Mississippi State, MS 39762-5367

Gary L. Windham  
Corn Host Plant Resistance Unit  
P.O. Box 9555  
Mississippi State, MS 39762  
gwindham@ra.msstate.edu
LIST OF PARTICIPANTS NOT IN ATTENDANCE

Ernest C. Bernard
Dept. of Entomology and Plant Pathology, University of Tennessee
Knoxville, TN 37901-1071

Jessica E. Brummer
ABI Alfalfa, 2316 259th Street
Ames, IA 50014

Don F. Cameron
CSIRO Division of Tropical Crops and Pastures, 306 Carmody Road, St. Lucia, Queensland 4067
Australia
Don.Cameron@tcp.csiro.au

R. G. Clarke
Victorian Institute for Dryland Agriculture, Private Bag 260
Natimuk Road, Horsham, Vic. 3400
Australia.

Robert D. Davis
Plant Protection Unit
Queensland Department of Primary Industries, Indooroopilly, Qld. 4068
Australia.

R. A. Dunn
Dept. Entomology and Nematology
University of Florida
Gainesville, FL

Catherine Eastman
Illinois Natural History Survey
607 Peabody Drive
Champaign, IL 61820
ceastman@uiuc.edu

Richard L. S. Forster
The Horticulture and Food Research Institute of New Zealand Ltd
PO Box 92 169 Auckland
New Zealand

W. S. Green
Wrightson Seeds Ltd.
Kimihia Research Centre
P.O. Box 939, Christchurch
New Zealand

J.G. Hampton
Seed Technology Centre
Department of Plant Science
Massey University, Palmerston North
New Zealand

Frank S. Hay
AgResearch, Grasslands Research Centre, Palmerston North
New Zealand

Adrianna D. Hewings
Office of the Director
USDA, ARS, Midwest Area Office
1815 N. University St.
Peoria, IL 61604
hewingsa@ncaur1.ncaur.gov

John A.G. Irwin
Cooperative Research Centre for Tropical Plant Pathology, The University of Queensland,
Queensland 4072
Australia.

Janet A Lupton
Cooperative Research Centre for Tropical Plant Pathology, The University of Queensland,
Queensland 4072
Australia.

John M. Manners
Cooperative Research Centre for Tropical Plant Pathology, The University of Queensland,
Queensland 4072
Australia.
ACKNOWLEDGEMENT

Financial and/or help with the organisation of the trilateral workshop was provided by the following institutions. This help is gratefully acknowledged.

- Australian Department of Industry Science and Technology
- Grains Research and Development Corporation, Australia
- Meat Research and Development Corporation, Australia
- Crop Care Holdings, New Zealand
- Grassland Memorial Trust, New Zealand
- New Zealand Pastoral Agriculture Research Institute, Ltd
- Trimble Trust, New Zealand
- Lincoln University, New Zealand
- University of Otago, New Zealand
- CSIRO Division of Tropical Crops and Pastures, Australia
- Mississippi Agricultural and Forestry Experiment Station
- Mississippi Department of Economic and Community Development - Division of Tourism Development
- Mississippi State University
- Mississippi State University Alumni Association
- Starkville Visitors and Convention Council
- USDA-ARS Forage Research Unit, Mississippi State
- American Society of Agronomy, Inc.
- Crop Science Society of America, Inc.
- Soil Science Society of America, Inc.

The workshop organisers extend their appreciation to the team of local organisers led by Michael McLaughlin and Gary Pederson of the USDA-ARS Forage Research Unit, Mississippi State, for a very well organised workshop and their generous hospitality. Presentations on the local overview by David Lang, Plant and Soil Science Department, Mississippi State University, Clarence Watson, Experimental Statistics, Mississippi State University, and Frank 'Butch' Withers, Animal Research Center, Mississippi State University, and the tour of laboratory, greenhouse and field research facilities are gratefully acknowledged.