ACPP APPS DARWIN 2011

New Frontiers in Plant Pathology for Asia and Oceania

26-29 April 2011
Darwin Convention Centre
DARWIN, NT

THE 4th ASIAN CONFERENCE ON PLANT PATHOLOGY CONCURRENT WITH THE 18th BIENNIAL AUSTRALASIAN PLANT PATHOLOGY SOCIETY CONFERENCE

HANDBOOK
ACPP APPS 2011

New Frontiers in Plant Pathology for Asia and Oceania

Inaugural joint 4th Asian Conference on Plant Pathology and the 18th Biennial Australasian Plant Pathology Society Conference

26–29 April 2011
Darwin Convention Centre

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Welcome

On behalf of the local committee, I would like to welcome you to Darwin, especially those who come from areas ravaged by natural disasters and political unrest. We are here to participate in the inaugural joint 4th Asian Conference on Plant Pathology and the 18th Biennial Australasian Plant Pathology Society Conference. The conference provides an excellent opportunity to increase collaboration between neighbouring countries and share the latest scientific knowledge.

In the modern world where society is concerned about biosecurity, climate change and global warming, take heed that these important issues also impact on plant health. Worldwide losses from plant disease impact on human and livestock health by trade erosion, food security and market access.

The conference theme ‘New Frontiers in Plant Pathology for Asia and Oceania’ will be covered within our 15 different topics, highlighting the diverse aspects of plant pathology. We acknowledge our local and international plenary speakers who have come from lands far, far away—that is Indonesia, Thailand, USA, New Zealand, Japan and China. We wait in anticipation to hear about their pathology research from their different countries of origin.

We hope you enjoy the comprehensive scientific program, field day and the numerous workshops on offer.

The Darwin Convention Centre is situated on our gorgeous natural harbour and Darwin city is renowned as a vibrant city with tropical weather all year round, multicultural heritage, beautiful sunsets, fabulous fishing, delightful international cuisine, Indigenous art and natural wonders.

We hope you have the opportunity to stay beyond the conference and enjoy the experience of the laid-back Top End Territory lifestyle.

Lucy Tran-Nguyen
ACPP APPS 2011 Conference Convenor

Conference Organising Committee

- Lucy Tran-Nguyen (Convenor)
- Sean Bithell
- Jane Carter
- Andrew Daly
- Rebecca James
- Greg Johnson
- Rachel Meldrum
- Caroline Mohammed
- Jane Ray
- Gina Shaw
- Mark Sutherland
- Peter Williamson

Scientific Program Committee

- Mark Sutherland (Chair)
- Stanley Bellgard
- Sean Bithell
- Mark Braithwaite
- Victor Galea
- Morag Glen
- Jose Liberato
- Caroline Mohammed
- Philip O’Brien
- Gina Shaw
- Lucy Tran-Nguyen
- Peter Williamson

Sponsorship Committee

- Lucy Tran-Nguyen (Chair)
- Jane Carter
- Greg Johnson
- Caroline Mohammed
- Gina Shaw
- Peter Stephens
- Peter Williamson
- Doug Wilson

Workshop Committee

- Lucy Tran-Nguyen (Chair)
- Barbara Hall
- Rebecca James
- Jane Ray

Social Committee

- Jane Ray (Chair)
- Andrew Daly
- Rachel Meldrum
- Lucy Tran-Nguyen

Acknowledgments

- Workshop organisers
- NT Department of Resources Plant Industries staff
- NT local growers
- Conference Logistics staff

Conference Secretariat

Conference Logistics*
PO Box 6150
Kingston ACT 2604
02 6281 6624 [ph]
02 6285 1336 [fx]
0448 576 105 [mobile]
conference@conlog.com.au
www.appc2011.org

*acting as agent for APPS
Sponsors

The Local Organising Committee gratefully acknowledges the support of our sponsors:

**Conference sponsors**

**Platinum sponsors**

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**Silver sponsor and Welcome Reception sponsor**

**Bronze sponsor**

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Grains Research and Development Corporation

The Grains Research & Development Corporation (GRDC) is one of the world’s leading grains research organisations, responsible for planning, investing and overseeing research and development, delivering improvements in production, sustainability and profitability across the Australian grains industry. GRDC is a statutory corporation, founded in 1990 under the Primary Industries and Energy Research and Development Act 1989 (PIERD Act), it is subject to accountability and reporting obligations set out in the Commonwealth Authorities and Companies Act 1997 (CAC Act). The GRDC’s portfolio department is the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF).

Leviable crops:

- wheat
- coarse grains: barley, oats, sorghum, maize, triticale, millets/panicums, cereal rye, canary seed
- pulses: lupins, field peas, chickpeas, faba beans, vetch, peanuts, mung beans, navy beans, pigeon peas, cowpeas, lentils
- oilseeds: canola, sunflower, soybean, safflower, linseed.

FOR MORE INFORMATION
www.grdc.com.au

Horticulture Australia Limited

Horticulture Australia Limited (HAL) is a not-for-profit, industry-owned company. It works in partnership with Australia’s horticulture industries to invest in research, development and marketing programs that provide benefit to industry and the wider community.

HAL invests almost $90 million annually in programs designed to align with the strategic investment priorities of Australia’s horticulture industries and the Australian Government’s rural research and development priorities.

HAL receives recommendations on investment from Industry Advisory Committees (IACs), which provide industry specific experience and expertise.

IACs are committees of HAL that provide advice to the HAL Board. Membership is recommended to HAL by the peak industry body (PIB) of each industry. The PIB is responsible for ensuring the skills required on an IAC are met by the persons they recommend.

As part of the Australian Government’s commitment to rural research and development, horticulture industries can access matching Commonwealth funding through HAL for research and development activities.

FOR MORE INFORMATION
www.horticulture.com.au

ACIAR

The Australian Centre for International Agricultural Research (ACIAR) is an Australian Government statutory authority that operates as part of Australia’s aid program within the portfolio of Foreign Affairs and Trade. Established in 1982, ACIAR contributes to the aid program objectives of advancing Australia’s national interest through poverty reduction and sustainable development by investing in collaborative research in agriculture.

ACIAR commissions research groups and institutions to carry out agricultural research projects in partnership with counterpart organisations in developing countries. Research funded by ACIAR aims to help developing countries to help themselves, by contributing to solving agricultural problems and building research capacity.

Australia shares similar agricultural systems and environments with many of its developing-country partners. ACIAR assists and encourages agricultural scientists to use their skills for the benefit of developing countries while at the same time working to solve Australia’s own agricultural problems.

FOR MORE INFORMATION
www.aciar.gov.au

AusAID

The International Seminars Support Scheme (ISSS) is an Australian Government aid activity administered by AusAID.

ISSS funds attendance at international development-oriented seminars in Australia and overseas.

The scheme helps to develop knowledge and technical expertise in developing countries, and builds linkages between the government, academic and community sectors in Australia and our partner developing countries.

FOR MORE INFORMATION
www.ausaid.gov.au
The Crawford Fund

For a Food Secure World

The Crawford Fund is a non-government organisation that promotes and supports agricultural research designed to benefit developing countries. Like Sir John Crawford, we believe it holds the key to alleviating rural poverty in developing countries, and can thus open the door to economic progress, stability, sustainability and is of mutual benefit to developing countries and to Australia—a win–win proposition.

Good news is worth sharing, and the Fund’s public awareness campaign increases understanding of the importance and potential of international agricultural research, its achievements and needs through public events, journalist visits, impact stories, meetings and policy development.

The Fund also has a training program that fills a niche by offering practical, highly focused non-degree instruction to women and men engaged in agricultural research and management in developing countries.

FOR MORE INFORMATION
crawford@crawfordfund.org
www.crawfordfund.org
02 6285 8308

Cooperative Research Centre for National Plant Biosecurity

The Cooperative Research Centre for National Plant Biosecurity (CRCNPB) coordinates plant biosecurity scientific research throughout Australia. Its research programs cover the full biosecurity continuum; pre-border, border and post-border demonstrating commitment to safeguarding Australia’s plant industries.

The CRCNPB also provides education and training in plant biosecurity through various activities. It has an extensive collaborative network of researchers and educators from 24 participating organisations representing industry, universities, state and federal government.

A key strength of the CRCNPB is the involvement of the participants who are, in many cases, end-users of research results. This ensures maximum benefit and impact in the delivery of project outputs, development of new products and services and capture of intellectual property.

The CRCNPB aims to provide leadership in the development, execution and delivery of plant biosecurity research to:

• safeguard Australia’s plant industries
• ensure food security for Australian consumers
• improve market access for agricultural exporters.

FOR MORE INFORMATION
info@crcplantbiosecurity.com.au
Tel: 02 6201 2882

APPs

The Australasian Plant Pathology Society is dedicated to the advancement and dissemination of knowledge of plant pathology and its practice in Australasia. Australasia is interpreted in the broadest sense to include not only Australia, New Zealand and Papua New Guinea, but also the Indian, Pacific and Asian regions. Although the Society’s activities are mainly focused on the Australasian region, many of the activities of our members are of international importance and significance.

Our journal Australasian Plant Pathology publishes new and significant research in all fields of plant pathology while Australasian Plant Disease Notes publishes new records of plant diseases, quarantine notes and short notes on disease. Distribution and readership of our journals is worldwide, but emphasis is placed on strengthening their role as the major publishing outlet in the Australasian region.

FOR MORE INFORMATION
www.australianplan pathology society.org.au

Northern Territory Government, Department of Natural Resources

Plant Industries Group encompasses the professional disciplines of plant physiology, plant pathology, entomology, agricultural chemistry, extension and research farms. Our goal is sustainable development of economic, social and environmental outcomes.

Through research, development, demonstrations, extension and facilitation services we contribute to the growth of plant industries which include: field crops, forestry, horticulture, forage and hay in the Northern Territory.

We collaborate and provide support in research projects with our neighbouring states of Queensland and Western Australia and countries such as Indonesia, East Timor and the Pacific Islands in capacity building and to improve market access and productivity. Plant Industries support a broad range of local industries that includes; mangoes, ornamentals, melons, bananas, vegetables, forestry, cereals, grapes, rambutan, passionfruit, tomatoes and dates.

FOR MORE INFORMATION
www.nt.gov.au
Nufarm

Nufarm Australia Limited and the link with BASF Australia Limited.

Nufarm has become a successful crop protection company based in Australia but now with global activities that place it at number eight in the global ranking of agrochemical companies. The Nufarm head office is based at Laverton North in Victoria.

In 2004 Nufarm entered into an agreement with BASF Australia Limited for Nufarm to market and develop BASF products within Australia. BASF has an excellent record for developing new horticultural products especially the discovery of new fungicides.

FOR MORE INFORMATION
doug.wilson@au.nufarm.com
03 9282 1427

Department of Agriculture, Fisheries and Forestry

SPHDS is the Subcommittee on Plant Health Diagnostic Standards, a subcommittee of Plant Health Committee with the purpose of increasing the capacity and capability of plant diagnostics in Australia. Major projects include:

- facilitating the development of national diagnostic protocols
- training for diagnosticians
- accreditation of plant health laboratories
- development and implementation of a National Plant Diagnostic Strategy.

SPHDS membership consists of representatives from the Commonwealth, State and Territory Departments, CSIRO, CRC for National Plant Biosecurity, Plant Health Australia and an observer from the New Zealand Ministry for Agriculture and Forestry.

Current achievements by SPHDS include:

- four Reference Standards for protocol development
- six National Diagnostic Protocols endorsed by PHC
- 62 draft diagnostic protocols
- NATA Field of Application Document
- National Plant Health Diagnostic Strategy.

FOR MORE INFORMATION
douglas.kerruish@daff.gov.au
Exhibition floorplan—Exhibition Hall 2

### BOOTHs
- **ABIN** Booth 9
- **ACIAR** Booth 4
- **Agdia** Booth 7
- **APPS** Booth 2
- **Bioline (Australia)** Booth 1
- **CRC for National Plant Biosecurity** Booths 5, 6
- **Springer** Booth 3
- **Thermo Fisher Scientific** Booth 8
Exhibitors

The Local Organising Committee gratefully acknowledges the support of our exhibitors:

Booth 4
ACIAR

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FOR MORE INFORMATION
www.aciar.gov.au

Booth 7
Agdia Inc

Agdia, Inc. is a leading manufacturer of high-quality, easy-to-use test kits for detection of more than 200 plant pathogens. For 30 years, Agdia has focused on providing diagnostic solutions to any size growing operation, all over the world, to help sustain the growth of healthy and profitable crops. Agdia offers several testing formats—including ELISA reagents, PathoScreen® complete ELISA kits and ImmunoStrip® on-site kits—that allow users of all skill levels the ability to test for pathogens that are known to cause economic loss in crops. Agdia also now offers AmplifyRP™, the first commercially available ultra-rapid isothermal DNA and RNA amplification system of its kind for detection of plant pathogens. Agdia Testing Services provides confidential testing for customers who have plant material needing to be tested but do not want to perform the test themselves. Agdia possesses all the USDA permits necessary to receive international samples for diagnostic purposes.

FOR MORE INFORMATION
www.agdia.com

Booth 2
APPS

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FOR MORE INFORMATION
www.australianplantpathologysociety.org.au

Booth 9
ABIN

The Australian Biosecurity Intelligence Network (ABIN) aims to dramatically improve the ability of the biosecurity community of researchers, industry and governments to work together to address common problems or emerging biosecurity issues through ‘real time’ access to data, information and know-how, and use of leading edge tools and technologies to generate biosecurity intelligence.

In essence ABIN aims to make it easier to connect, share, use and create biosecurity intelligence for biosecurity research, surveillance and response through a shared online workspace that can be accessed through the ABIN web portal.

Through ABIN, Australia is leading the way in developing an integrated approach to biosecurity, increasing the quality and quantity of biosecurity intelligence that can be used for more informed and robust decision making, policy development and operational response.

FOR MORE INFORMATION
www.abin.org.au
Booth 1
Bioline (Australia) Pty Ltd

Bioline Australia is a primary manufacturer of high-quality molecular biology reagents specialising in PCR, qPCR and cloning. We will have details of all of our new MyTaq PCR reagents and SensiFAST real-time mixes available on our stand. Entry forms for our conference competition are also available.

FOR MORE INFORMATION
www.bioline.com

Booths 5, 6
Cooperative Research Centre for National Plant Biosecurity

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- ensure food security for Australian consumers
- improve market access for agricultural exporters.

FOR MORE INFORMATION
info@crclistplantbiosecurity.com.au
Tel: 02 6201 2882

Booth 3
Springer

Springer is a leading global scientific publisher, delivering quality content through innovative information products and services. Some 2,000 journals and more than 6,500 new book titles are published every year in the science, technical and medical sector, with a backlist of more than 70,000 titles. Springer’s eBook Collection has grown to over 40,000 titles, which are available on springerlink.com.

Browse our books and journals at the booth—and take a look at our ebooks and journals online.

And don’t miss the chance to discuss your book proposal in person with your Publishing Editor Zuzana Bernhart.

FOR MORE INFORMATION
www.springer.com

Booth 8
Thermo Fisher Scientific

Thermo Fisher Scientific Australia has long been established as one of the largest and leading providers of premium scientific and laboratory products.

Our customers include educators, analytical and diagnostic laboratories, local, state and federal government, law enforcement, military, research institutes, the food and beverage industry as well as the environmental and monitoring industries.

Thermo Fisher Scientific is one of the world’s longest distributors of Conviron Plant Growth Chambers.

Over several decades, Conviron has established a global reputation within the plant science community for its leadership in controlled environment systems. Maintaining a comprehensive portfolio of products, including reach-in chambers, walk-in rooms, and full-scale, high-performance research greenhouses.

From small start-up facilities to many of the world’s largest and most prestigious research institutions, Conviron has a strong record of success. Much more than simply a provider of products, Conviron becomes a close partner with its clients—not only during the development phase but for the life of the facility.

FOR MORE INFORMATION
www.thermofisher.com.au
Conference information

Registration desk
The registration desk is located in the foyer of the Darwin Convention Centre. Please direct any questions you may have regarding registration, attendance, accommodation or social functions to the staff at this desk. The registration desk will be open during the following hours:

- Tuesday 26 April: 1400–1900
- Wednesday 27 April: 0730–1730
- Thursday 28 April: 0730–1730
- Friday 29 April: 0730–1730

The registration desk can be contacted during these hours on 0448 576 105.

Catering
Lunches, morning and afternoon teas will be held in Exhibition Hall 2, which is located on the ground floor of the Darwin Convention Centre. Lunches will be served as an informal stand-up buffet. We have arranged for special meals to be prepared for those delegates who have pre-registered their special requirements. These meals will be available from the designated buffet station during meal breaks. Please see a member of the banquet staff if you require assistance.

Mobile phones
As a courtesy to speakers and other delegates, please ensure that all mobile phones are switched off or in silent mode during sessions.

Name badges
Your name badge is your entry to all sessions, exhibition, lunches, morning and afternoon teas and social functions. Please wear it at all times.

Noticeboard
A noticeboard will be maintained adjacent to the registration desk showing program changes, messages and other information. Please check the board regularly for updates.

Participant list
The participant list has been included in the conference satchel. Those delegates who have indicated on their registration form that they do not wish to have their name and organisation appear on the participant list have not been included.

Program changes
The conference organisers cannot be held responsible for any program changes due to external or unforeseen circumstances. Please check the program board located at the registration desk for any late changes to sessions.

Speakers’ preparation room
A speakers’ preparation room is located behind the registration desk of the Darwin Convention Centre and will be open during the following hours:

- Tuesday 26 April: 1700–1900
- Wednesday 27 April: 0800–1730
- Thursday 28 April: 0800–1730
- Friday 29 April: 0800–1730

All speakers must take their presentation to the speakers’ preparation room a minimum of four hours prior to their presentation, or the day before, if presenting at a morning session. Speakers are also requested to assemble in their session room 15 minutes before the commencement of the session to meet with their session chair and to familiarise themselves with the room and the audio visual equipment.

General information

Useful telephone numbers

| TAXIS | 
| City Radio Taxis | 08 8981 3777 |
| Darwin Radio Taxis | 08 8985 0799 |

| HOTELS | 
| Vibe Hotel Darwin | 08 8982 9998 |
| Medina Grand Darwin Waterfront | 08 8982 9998 |

| Travelodge Mirambeena Resort | 08 8946 0111 |
| 64 Cavenagh Street | Darwin NT 0800 |

| Argus Apartments | 08 8925 5000 |
| 6 Cardona Street | Darwin NT 0800 |

| Palms City Resort | 08 8982 9200 |
| 64 Esplanade | Darwin NT 0800 |

| AIRLINES | 
| Qantas | 13 13 13 |
| Virgin Blue | 13 67 89 |
| Jetstar | 13 15 38 |

| EMERGENCY SERVICES | 
| Police, Fire or Ambulance: 000 (or 112 from mobile) |
| Royal Darwin Hospital—non urgent inquiries: 08 8922 8888 |
| Northern Territory Police—general inquiries: 08 8922 3344 |
PRAYER ROOM

A prayer room has been organised for delegates who wish to utilise this space throughout the conference. The prayer room will be situated in Meeting Room 4 on the ground level of the Darwin Convention Centre.

PUBLIC TRANSPORT

The Public Transport Division provides a safe and convenient public bus transport service for locals as well as visitors to Darwin.

The network of services operate between three main interchanges located in Darwin City, Casuarina and Palmerston. A bus timetable can be collected from the Tourism Top End—Darwin Visitor Information Centre at 6 Bennett Street, Darwin City or by visiting www.nt.gov.au/transport/public

Social Program

Welcome reception

Date: Tuesday 26 April 2011
Time: 1730–1900
Venue: Darwin Convention Centre, Exhibition Concourse
Dress: Conference attire/smart casual
Cost: Included in full conference registration
One ticket is included with all full registrations. Additional tickets for day registrants and accompanying persons can be purchased from the conference secretariat.

Poster, wine and cheese night

Date: Wednesday 27 April 2011
Time: 1800–1900
Venue: Darwin Convention Centre, Exhibition Hall 2
Dress: Conference attire/smart casual
Cost: Included in full conference registration
One ticket is included with all full registrations. Additional tickets for day registrants and accompanying persons can be purchased from the conference secretariat.

Conference dinner

Date: Thursday 28 April 2011
Time: 1830 for 1900 until late
Venue: Darwin Convention Centre, Exhibition Hall 1
Dress: Conference attire/smart casual
Cost: Included in full conference registration
One ticket is included with all full registrations. Additional tickets for day registrants and accompanying persons can be purchased from the conference secretariat.

Social dinner

Date: Friday 29 April 2011
Time: 1830–2130
Venue: Crocosaurus Cove, 58 Mitchell Street, Darwin City (corner of Mitchell and Peel Streets)
Dress: Conference attire/smart casual
Cost: Tickets are $66 each and can be purchased from the conference secretariat.
Cooperative Research Centre for National Plant Biosecurity

securing trade and market access
for Australia’s plant industries
through science...

The Cooperative Research Centre for National Plant Biosecurity coordinates plant biosecurity scientific research throughout Australia. Our research programs cover the full biosecurity continuum; pre-border, border and post-border demonstrating our commitment to safeguarding Australia’s plant industries.

We also provide education and training in plant biosecurity through various activities. We have an extensive collaborative network of researchers and educators from 24 participating organisations representing industry, universities, state and federal government.

info@crcplantbiosecurity.com.au  |  Tel: 02 6201 2882

www.crcplantbiosecurity.com.au

Come and visit us at Booth 5 and 6 to see how we’re helping to provide scientific solutions to Australia’s plant biosecurity issues.
The McAlpine lecture

The invitation to present the McAlpine lecture to the biennial conference of the Australasian Plant Pathology Society is extended to an eminent scientist in recognition of their significant contribution to Australasian plant pathology. The lecture is named after Daniel McAlpine, considered to be the father of plant pathology in the Australasian region. His most notable contributions were to study wheat rust following the 1889 epidemic, to classify and describe Australian smuts, and to recognise *Ophiobolus graminis* (now *Gaumannomyces graminis*) as the cause of wheat take-all. He also collaborated with Farrer on resistance to rust in wheat (John Randles 1984, Stanislais Fish 1976).

In 2011, the McAlpine Lecture will be delivered by Professor Lester Burgess from the University of Sydney.

**Previous McAlpine lecturers**

<table>
<thead>
<tr>
<th>Year</th>
<th>Lecturer</th>
<th>Institution</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>Dr Lilian Fraser</td>
<td>Department of Agriculture, NSW</td>
<td><em>Disease of citrus trees in Australia—the first hundred years</em></td>
</tr>
<tr>
<td>1978</td>
<td>Dr David Griffin</td>
<td>Australian National University, ACT</td>
<td><em>Looking ahead</em></td>
</tr>
<tr>
<td>1980</td>
<td>Mr John Walker</td>
<td>Department of Agriculture, NSW</td>
<td><em>Taxonomy, speciments and plant disease</em></td>
</tr>
<tr>
<td>1982</td>
<td>Professor Richard Matthews</td>
<td>The University of Auckland, NZ</td>
<td><em>Relationships between plant pathology and molecular biology</em></td>
</tr>
<tr>
<td>1984</td>
<td>Professor Bob McIntosh</td>
<td>University of Sydney, NSW, and Dr Colin Wellings, Department of Agriculture, NSW</td>
<td><em>Wheat rust resistance: the continuing challenge</em></td>
</tr>
<tr>
<td>1996</td>
<td>Dr Allen Kerr</td>
<td>Waite Agricultural Research Institute, SA</td>
<td><em>Agrobacterium: pathogen, genetic engineer and biological control agent</em></td>
</tr>
<tr>
<td>1989</td>
<td>Dr Albert Rovira</td>
<td>CSIRO Division of Soils, SA</td>
<td><em>Ecology, epidemiology and control of take-all, rhizotomies bare patch and cereal cyst nematode in wheat</em></td>
</tr>
<tr>
<td>1991</td>
<td>Mr John Walker</td>
<td>Department of Agriculture, NSW</td>
<td><em>Plants, diseases and pathologists in Australasia—a personal view</em></td>
</tr>
<tr>
<td>1993</td>
<td>Dr John Randles</td>
<td>University of Adelaide, SA</td>
<td><em>Plant viruses, viroids and virologists of Australasia</em></td>
</tr>
<tr>
<td>1995</td>
<td>Dr Ron Close</td>
<td>Lincoln University, NZ</td>
<td><em>The ever changing challenges of plant pathology</em></td>
</tr>
<tr>
<td>1997</td>
<td>Professor John Irwin</td>
<td>CRC Tropical Plant Pathology, Qld</td>
<td><em>Biology and management of Phytophthora spp. attacking field crops in Australia</em></td>
</tr>
<tr>
<td>1999</td>
<td>Dr Dorothy Shaw</td>
<td>Department of Primary Industries, Qld</td>
<td><em>Bees and fungi with special reference to certain pathogen diseases</em></td>
</tr>
<tr>
<td>2001</td>
<td>Dr Alan Dube</td>
<td>South Australian Research and Development Institute, SA</td>
<td><em>Long-term careers in plant pathology</em></td>
</tr>
<tr>
<td>2003</td>
<td>Dr Mike Wingfield</td>
<td>University of Pretoria, South Africa</td>
<td><em>Increasing threat of disease to exotic plantation forests in the southern hemisphere</em></td>
</tr>
<tr>
<td>2005</td>
<td>Dr Gretta Weste</td>
<td>University of Melbourne, Vic</td>
<td><em>A long and varied fungal foray</em></td>
</tr>
<tr>
<td>2007</td>
<td>Dr Graham Stirling</td>
<td>Biological Crop Protection, Qld</td>
<td><em>The impact of farming systems on soil biology and soil-borne diseases: examples from the Australian sugar and vegetable industries, the case for better integration of sugarcane and vegetable production and implications for future research</em></td>
</tr>
<tr>
<td>2009</td>
<td>Assoc Prof Phil Keane</td>
<td>La Trobe University, Vic</td>
<td><em>Lessons from the tropics—the unfolding mystery of vascular-streak dieback of cocoa, the importance of genetic diversity, horizontal resistance, and the plight of farmers</em></td>
</tr>
<tr>
<td>2011</td>
<td>Honorary Professor Lester Burgess</td>
<td>University of Sydney, NSW</td>
<td><em>A love affair with Fusarium</em></td>
</tr>
</tbody>
</table>

**McAlpine lecturer 2011: Lester Burgess**

Honorary Professor Lester Burgess has had a career-long teaching and research interest in the biology and control of soil-borne fungal plant pathogens. However the focus of his research has been on the genus *Fusarium*. Since his PhD Lester has had a particular interest in the biology and control of the stress-related disease complexes of wheat, sorghum and corn, especially *Fusarium* crown rot of wheat. However his greatest passion has been the taxonomy, ecology and mycogeography of *Fusarium* in natural ecosystems, an area he pioneered in the 1970s. This led to the discovery of remarkable new species, the critical effect of climate on distribution, and a better understanding of the role of indigenous plants as reservoirs of crop pathogens. Over 40 postgraduate research students contributed to these studies. He has also had wide experience with soil-borne pathogens of tropical crops in S.E. Asia through ACIAR and AusAID capacity-building projects, ATSE Crawford Master Classes and related training programs, and The University of Sydney International Program.

Lester is a Foundation Member of APPS and has held various positions including President. As Secretary, 1972 to 1973, he convened the inaugural APPS Conference in 1974 and established the first Newsletter, which subsequently evolved into the journal Australasian Plant Pathology. He has been at the University of Sydney since 1971 and was Dean of Agriculture from 1988 to 2000. Lester ‘retired’ in 2006, but continues researching, supervision of postgraduate students, and international teaching. He is a Fellow of both APPS and of the American Phytopathological Society.

**Allen Kerr Postgraduate Prize**

The Allen Kerr Postgraduate Prize commemorates the significant contribution to research in plant pathology made by Professor Allen Kerr AO, recipient of the inaugural Australia Prize. The award is made at the APPS biennial conference and is open to postgraduate student members of APPS undertaking original research relevant to Australasia. The prize is awarded by the Society for the best piece of original research by a postgraduate student in the field of plant pathology. The prize is normally awarded on the basis of publication in refereed journals.
Les Baxter, ACIAR

Mr Les Baxter is currently Research Program Manager (Horticulture) with the Australian Government overseas development assistance agency ACIAR (The Australian Centre for International Agricultural Research) and Principal Regional Coordinator for PNG and the Pacific. The program focuses on improving the productivity, profitability and sustainability of fruit, vegetable and ornamental crop production in developing countries (Philippines, Pakistan, Bhutan, Cambodia, Indonesia and the Pacific) and Australia.

Prior to this, he held General Manager positions with the Australian Development Contractors, IDP Education Australia and Illawarra Technology Corporation, implementing international education development projects on behalf of donor agencies such as AusAID. Les has filled a range of research, development, extension and management positions in the field of horticulture with the Queensland and Tasmanian Departments of Primary Industries and Fisheries, the Horticulture Research and Development Corporation (now Horticulture Australia Limited) and several commercial horticultural production and processing companies. He has twenty years experience in perennial and annual horticultural crops production working in the disciplines of plant breeding, crop agronomy and seed physiology.

Les holds an honours Degree in Applied Science from the Queensland Agricultural College (University of Queensland, Gatton), a Masters Degree in Agricultural Science from the University of Queensland and a Masters Degree in Business Administration from Southern Cross University.

Matthew Bellgard, Murdoch University

Professor Matthew Bellgard is Chair in Bioinformatics at Murdoch University and the Director of the Western Australian State Government Centre of Excellence, the Centre for Comparative Genomics. His scientific work has resulted in developments in the both the areas of pairwise sequence alignment and artificial intelligence, bacterial bioinformatics, whole genome analysis and annotation, and advances in the development of web-based integrated systems utilising high performance computing.

Professor Bellgard’s international experience includes a placement at the European Molecular Biology Laboratory (Heidelberg, Germany) and a postdoctoral fellowship at the National Institute of Genetics (Mishima, Japan). Professor Bellgard is the Convenor of the Australian Bioinformatics Facility (ABF) which is funded through the National Collaborative Research Infrastructure Strategy. As Convenor of the ABF, Professor Bellgard’s role is to provide advice, leadership, integration and coordination of bioinformatics activities to nationally support the Genomics, Proteomics and Metabolomics biomolecular platforms. Professor Bellgard also directs the IVEC Informatics Facility based at Murdoch University which houses a 512 core supercomputer with a 10 gigabit per second link to the iVEC Petabyte scale storage facility. This facility is soon to be upgraded with a 9,600 core, 500 terabyte HP POD to be commissioned in the fourth quarter of 2010.

Angus Carnegie, Industry & Investment NSW

Dr Angus Carnegie is a Principal Research Scientist with the Forest Health and Productivity Assessment program in the Department of Industry & Investment NSW. His main roles include managing and conducting forest health surveys and overseeing and improving pest and disease management programs. His areas of expertise include forest health (pests and diseases), forest health surveillance, leaf spot fungi of eucalypts, research on improving pest and disease management strategies, and forest biosecurity. He has collaborative links and research projects with numerous Australian and international colleagues. Dr Carnegie’s involvement in the emergency response to the recent incursion of an exotic disease in Australia has strengthened his expertise in biosecurity at the operational, strategic and policy levels. Future research projects will include the impact of myrtle rusts on key industries and the native environment in Australia and on new and emerging pest and disease issues.

Victor Galea, The University of Queensland

Dr Vic Galea commenced his PhD studies in 1983 on Microdochium panattonianum, the causal agent of anthracnose disease in lettuce (Lactuca sativa) with Prof. Terry Price at LaTrobe University. He was later appointed as a postdoctoral research fellow at the Research School of Biological Sciences (ANU) investigating the use of bio-protection agents against root and foliar pathogens of field crops.

In 1988 he commenced duties as a lecturer in Plant Pathology at the Queensland Agricultural College—Gatton (now the University of Queensland).

He is currently Associate Professor in Plant Pathology in the School of Land, Crop and Food Sciences, and was until recently Chair of the school Teaching and Learning Committee. He has three distinct areas of research: the development of disease forecasting systems for horticultural crops; the development of plant pathogens as biological control agents for woody environmental weeds; and research into the development of teaching and learning methodologies.

Vic Galea is an outstanding and dedicated teacher who challenges his students and inspires them to become creative thinkers, problem solvers and reflective practitioners. He is committed to designing and creating a coherent curriculum with stimulating resources, activities and assessment that motivate his students to engage with disciplinary scientific thinking and contemporary research.

Caroline Mohammed, University of Tasmania

Associate Professor Caroline Mohammed completed her PhD in 1987 in France, researching what was then still being referred to as the Armillaria mellea complex. Until 1995 and her employment by the University of Tasmania, Caroline gained considerable experience in various exploits ranging from librarian, technical translator, field technician to Postdoctoral fellow at the University of Oxford. Since her arrival in Tasmania, when she accepted a co-joint position (50% teaching, 50% research) between the University and CSIRO, Caroline has been actively involved in, facilitated and promoted research in forest health while teaching in plant pathology and related subjects. Over the last 5 years, especially in her role as a Project Leader within the CRC Forestry, Caroline gradually adopted a more generic approach to the management of biotic stress for the sustainable management of production forest within the landscape—moving towards multidisciplinary approaches, involving geneticists, remote sensing specialists, physiologists, growth modelling, ecologists and climate change scientists. In mid 2010 Caroline’s co-joint position with CSIRO ceased and she assumed a newly created leadership role within the Tasmanian Institute of Agricultural Research, University of Tasmania as Theme Leader in Climate Change Adaptation. Caroline remains one of the senior forest health experts in Australia and as such is increasingly engaged in consultancy type projects, e.g. the
drafting of pest risk analyses and contingency plans, including that for guava rust, *Puccinia psidii*; also a national audit of forest biosecurity preparedness in the commercial forest plantation sector. Despite an increasing management and consultancy profile Caroline continues to lead numerous large international and multidisciplinary projects, including ARC projects. She particularly enjoys her current international projects with fellow forest pathologists in Indonesia and Vietnam where she gets to carry out some exciting science.

**Francisco Ochoa-Corona, Oklahoma State University**

Dr Francisco Ochoa Corona received his PhD from the University of Florida and is a forensic plant pathologist, specialising in developing and delivering reference diagnostics for exotic, naturalised, and indigenous plant viruses and other phytopathogens of relevance to agricultural biosecurity and microbial forensics. His work is applicable to plant pathogens that can be intercepted at borders, or detected by general surveillance at field settings or within transitional facilities. Dr Ochoa Corona moved to OSU in 2008 from the Investigation and Diagnostic Centre (IDC) at Biosecurity New Zealand (BNZ), Ministry of Agriculture and Forestry (MAF), where he was Principal Adviser Virology. His current research at NIMFFAB includes adaptation and development of novel tools for sampling, detection, discrimination and diagnostics. Also targeted are the identification of molecular landmarks and signatures, and the implication of this genetic data on taxonomic relationships, host-pathogen associations and pathogen detection (including select agents or high consequence microorganisms). Of particular interest are the prediction of biosecurity threats, monitoring the dynamics of relevant plant pathogens, tracking their global dispersal routes and delimiting their bio-geographic distribution.

**Ratana Sdoodee, Prince of Songkla University, Thailand**

Dr Ratana Sdoodee grew up in South Thailand and graduated with BSc. (Agriculture) and MSc (Plant Virology) degrees from Chiang Mai University. She taught for 5 years at Prince of Songkla University before being awarded a PhD at The University of Queensland, Australia, in 1989 under the Thai-Australian Prince of Songkla University Project. Her work on transmission of tobacco streak virus from pollen grains, through Thrip-wounded leaves, was a breakthrough that received international recognition.

Since returning to Thailand and PSU, Ratana was appointed as an associate professor in 1995. She maintains her interest in virus and virus-like disease. Her main research is focused on molecular diagnosis and transmission of citrus tristeza, huanglongbing and sugarcane white leaf diseases.

**Susamto Somowiyarjo, Gadjah Mada University, Indonesia**

Professor Susamto Somowiyarjo is Head of the Plant Virology Laboratory and former Dean of the Faculty of Agriculture at Gadjah Mada University. In recognition of his services to the field he was elected as Secretary General of the Indonesian Phytopathological Society and has been appointed to the Committee of Yogyakarta Food Security and as the Chairman of the Commodity Cooperative Development Center. He is currently the third President of the Asian Association of Societies for Plant Pathology.

Being born and raised on a small farm in Yogyakarta, gave Professor Susamto a great passion for research into plant diseases. He began his career inspired by three renowned professors: Prof Triharso (Gadjah Mada University), Prof N. Sako (Saga University), and Prof K. Tomaru (Tokyo University of Agriculture). Having earned his Bachelors, Masters, and PhD degrees in phytopathology from leading universities in Indonesia and Japan, his goal was to advance research into the serological detection of plant viruses. Recently he has been conducting research into virus diseases of horticultural crops in collaboration with Australian and Japanese colleagues.

**James P Stack, Kansas State University**

Professor Jim Stack is Director of the Great Plains Diagnostic Network (GPDN) and Professor of Plant Pathology at Kansas State University. As the Director of GPDN, he coordinates a nine-state project for the rapid detection and accurate diagnosis of high consequence pathogens and pests. He served as the first Executive Director for the National Plant Diagnostic Network (2004-2006). Prof Stack is the principal investigator of a plant biosecurity project at the National Agriculture Biosecurity Center and has collaborated on several international projects regarding plant biosecurity. Prior to joining K-State, he was on the faculty at the University of Nebraska and at Texas A&M University. He formerly worked for EcoScience Corporation as the Director of Applied Research, leading the discovery, development and commercialisation of microbe-based products to protect fruit from storage decay pathogens. His research interests include pathogen detection and diagnostics, pathogen ecology, and epidemiology.

**XuDong Zhou, Chinese Academy of Forestry**

Professor XuDong (David) Zhou obtained his Bachelor (1995) and Master Degrees (1998) in Microbiology at Yunnan University, China. His Masters project focused on sapstain fungi associated with pine-attacking bark beetles in south-western China. He then moved to Forestry and the Agricultural Biotechnology Institute, Pretoria University, where he worked with Prof. Mike Wingfield, and obtained his Ph. D degree in 2003 on taxonomy, biology and population genetics of conifer-infesting bark beetles. After completing these PhD studies, XuDong was awarded a post-doctoral position with Sappi Ltd until 2006. He then took a joint position as professor and assistant director at the China Eucalypt Research Centre and at University of Pretoria.

His current research interests centre on taxonomy, phylogeny, and population genetics of fungi (including tree pathogens and their pathogenecities). He has been involved with initiating a number of projects funded by international communities, and as Principal Investigator, leads five projects funded by Chinese organisations working on eucalypt diseases. He has published over 20 papers in internationally recognised journals and currently serves as a council member of the Chinese Forest Pathology Society, a board member of the Chinese Mycological Society (also the director for international affairs) and is on the editorial boards for Forest Pathology and Fungal Diversity.
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EXOTIC PESTS
HIGH PRIORITY EXOTIC PESTS OF THE GRAINS INDUSTRY

The following are some key high priority exotic pest threats for the Australian grains industry as identified through the development of the Grains Industry Biosecurity Plan. Any of these pests would have serious consequences should they enter and become established in Australia.

EXTREME RISK > Karnal bunt (Tilletia indica)
- Can infect wheat, durum and triticale
- Parts of seeds are blackened and crush relatively easily
- Infected grains have a distinct fishy smell
- Symptoms similar to Common bunt
- High impact for market access

HIGH RISK > Khapra beetle (Trogoderma granarium)
- Adults small (2-3 mm long) and do not fly
- Spread in infested grain
- Larvae are hairy and can survive for over a year without food
- Phosphone fumigation gives poor control
- If established, would affect market access

MEDIUM RISK > Phosphone resistant strains of stored grain insects
- Stored grain insects with strong resistance to phosphone have been detected in Australia and overseas
- Exports are threatened due to insects surviving in stored grain
- Incorrect phosphone fumigation and poor grain storage practices increase selection of resistant insect strains
- Live insects remaining after fumigation should be reported and tested for resistance

HIGH RISK > Russian wheat aphid (Diuraphis noxia)
- Primary hosts are wheat and barley
- Light-green, elongated aphid (up to 1.3mm long)
- Could cause yield losses up to 75% in Australia crops
- Damage symptoms include:
  - White, purple or yellowish leaf streaks
  - Rolling of leaves, flag leaf and awns
  - Bleached heads with small grains

HIGH RISK > Hessian fly and Barley stem gall midge (Mayetiola destructor and M. hordei)
- Adults look like small mosquito’s (2-4 mm long)
- Pupae have a “haxeed” appearance
- Attack leaves, stems and heads of cereals
- Most chemical controls are not effective
- Cereal crop losses up to 40% could occur

MEDIUM RISK > Sunn pest (Eurygaster integriceps)
- Brown bug with wide round body (12mm long) with a wide triangular head and oval-shaped body
- Attacks most cereal crops
- Colonies can be seen on cereal heads in spring
- Injects enzymes into the plant as it feeds which can result in grain damage and abortion

MEDIUM RISK > Barley Stripe Rust - Main host is barley
- Infects barley, mainly in cool climates
- Approximately 80% of Australia’s barley varieties would be susceptible
- Any stripe rust on barley should be reported
- Yellow stripes of fungal spores produced between veins of leaves
- Can be spread by wind and rain, or on clothing, machinery and tools

HIGH RISK > Wheat stem rust, pathotype Ug99 (Puccinia graminis f. sp. tritici)
- Pathotype identified in Uganda in 1999 that has overcome several stem rust resistance genes
- Many Australian wheat varieties will be susceptible
- Elliptical blisters produced on stems, which break open to reveal a mass of rust coloured spores
- Stem rust on known resistant varieties should be reported

EXOTIC PLANT PEST HOTLINE
1800 084 881
# Program

**Tuesday 26 April 2011**

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<td>1630–1730</td>
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**Day 1—Wednesday 27 April 2011**

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<td>0830–0900</td>
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<td>Professor Maria Lodovica Gullino, ISPP President, University of Turin</td>
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<tr>
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<td>0900–0930</td>
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<td>0900–0930</td>
<td>Dr Susamto Somowiyarjo, Gadjah Mada University</td>
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<tr>
<td>0900–0930</td>
<td>Plant disease problems on smallholder farms in Asia</td>
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<td>PLENARY 2—APPS Presidential address</td>
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<td>Chair: Rob Magarey</td>
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<td>1030</td>
<td>Evaluation of research and development on phase-out of methyl bromide use in Australian horticulture</td>
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<td>Ian Porter, Department of Primary Industries, VIC</td>
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<td>SESSION 2 Plant-pathogen Interactions A</td>
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<td>Chair: Paul Taylor</td>
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<td>Expression of pathogenesis-related genes confirms induction of systemic acquired resistance by salicylic acid in broccoli</td>
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<td>Arati Agarwal, Department of Primary Industries, VIC</td>
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<td>SESSION 3 Soilborne Diseases A</td>
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<td>1100</td>
<td>Novel approaches to the management of soil-borne diseases in vegetable crops</td>
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<td>Caroline Donald, Department of Primary Industries, VIC</td>
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<td>Beyond compliance: Integrated systems approach for pest risk management in South-East Asia</td>
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<td>Peter Whittle, Queensland University of Technology, QLD</td>
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<td>The role of native plants during a pathogen incursion: survival of the plant pathogen Xylella fastidiosa in Australian native plant species</td>
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<td>1100</td>
<td>Anna Rathe, Department of Industry &amp; Investment NSW</td>
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<td>Formic acid as a seed treatment for Rhizoctonia black scurf on potato</td>
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<td>Nigel Crump, VICSFA, VIC</td>
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<td>Multiple suppressors encoded by tomato leaf curl virus, a multipartite begomovirus associated with betasatellite</td>
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<td>Masato Ikegami, Tokyo University of Agriculture, Japan</td>
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<td>1100</td>
<td>Use of corn stalk as carrier of plant disease biocontrol agents for management of soil-borne diseases of vegetable in greenhouse</td>
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<td>Shidong Li, Chinese Academy of Agricultural Sciences, China</td>
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<td>Association of Pseudomonas fluorescens with take-all suppressive soils in New Zealand</td>
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<td>Sooie Chng, New Zealand Institute for Plant and Food Research, NZ</td>
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<td>Biosecurity model for exotic and non-exotic plant parasitic nematodes</td>
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<td>Sunil Singh, CSIRO Ecosystem Sciences, ACT</td>
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| 1115 | Development, registration and commercialisation of a microbial fungicide for controlling cotton verticillium wilt in China  
**Ping Ma**  
Hebei Academy of Agricultural and Forestry Sciences, China |
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| 1130 | Control of Eutypa dieback in grapevines by remedial surgery  
**Mark Sosnowski**  
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| 1145 | Development of boscalid for Sclerotinia disease control in Australian vegetable crops  
**Doug Wilson**  
Nufarm Australia Limited, VIC |
| 1200 | Molecular characterisation of Colletotrichum gloeosporioides, the incitant of Noni anthracnose and exploiting PGPR and fungal antagonists for its management  
**Manjunath Hubballi**  
TNAU, India |
| 1215 | Review of disease management posters |
| 1230–1330 | LUNCH  
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Student–Mentor Lunch  
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| 1330–1430 | Poster Session 1: Disease Management; Plant–pathogen Interactions; Soil-borne Diseases; Biosecurity; New Technologies; Epidemiology  
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Chair: Philip O’Brien, Murdoch University, WA  
**Matthew Bellgard**, Murdoch University  
Advanced bioinformatics approaches to elucidate plant/microbe interactions from large-scale genome sequencing projects  
Auditorium 2 |
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<td>Room: Auditorium 2 Chair: Jacky Edwards</td>
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<td>Evaluation of non-conventional products for management of cucurbit powdery mildew in protected cropping Kaye Ferguson South Australian Research and Development Institute, SA</td>
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<td><strong>SESSION 6</strong> Epidemiology</td>
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<td>Room: Waterfront Room 1 Chair: Bill McLeod</td>
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<td>Detection and control of leaf blotch and stem end rot of strawberry caused by Gnemoniopsis fructicola Rajendra Gounder Department of Primary Industries, VIC</td>
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<td><strong>SESSION 7</strong> Soilborne Diseases B</td>
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<td>Room: Waterfront Room 2 Chair: Robert Tegg</td>
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<td>Selection of potato somoclones with possible broad spectrum resistance to tuber-invading diseases Calum Wilson Tasmanian Institute of Agricultural Research, TAS</td>
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<td>Evaluation of novel platforms to differentiate pathogens of plant pathogenic bacteria Deborah Hailstones Department of Industry &amp; Investment NSW</td>
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<td>Quantification and differentiation of Meloidogyne javanica, M. incognita and M. arenaria in soil and roots using real-time PCR Herdina South Australian Research and Development Institute, SA</td>
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<td><strong>SESSION 8</strong> New Technologies</td>
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<td>Room: Waterfront Room 3 Chair: Phil O’Brien</td>
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<td>Benchmarking the Brassicaaw® disease predictive models against weekly sprays and fungicide alternatives Elizabeth Michinton Department of Primary Industries, VIC</td>
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<td>Room: Waterfront Room 3 Chair: Phil O’Brien</td>
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<td>Investigating the impact of elevated CO₂ on wheat, cereal yellow dwarf virus and its aphid vector Merrin Spackman Department of Primary Industries, VIC</td>
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<td>1700–1800</td>
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<td>Chair: Brett Summerell, Botanic Gardens Trust, Sydney</td>
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<td></td>
<td>Professor Lester Burgess, University of Sydney</td>
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<tr>
<td></td>
<td>A love affair with Fusarium</td>
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<tr>
<td>1800–1900</td>
<td><strong>POSTER, WINE AND CHEESE SESSION</strong></td>
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<td>1900</td>
<td>APPS Executive Meeting</td>
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<td>Nematology Meeting</td>
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### Day 2—Thursday 28 April 2011

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<tr>
<td>0730–0830</td>
<td>Presidential Breakfast</td>
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<tr>
<td>0800–0900</td>
<td><strong>Plenary 5</strong></td>
<td>Auditorium 2</td>
<td>Chair: Brendan Rodeni, Dept of Primary Industries, Victoria</td>
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<td><strong>Dr Francisco Ochoa-Corona</strong>, Oklahoma State University, USA</td>
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<td></td>
<td></td>
<td></td>
<td><em>Biosecurity, microbial forensics and plant pathology: education challenges, overlapping disciplines and research needs</em></td>
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<tr>
<td>0900–0930</td>
<td><strong>Plenary 6</strong></td>
<td>Auditorium 2</td>
<td>Chair: Lucy Tran-Nguyen, Dept of Resources, NT</td>
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<td><strong>Dr Ratana Sooddee</strong>, Prince of Songkla University, Thailand</td>
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<td></td>
<td><em>Diagnosis and transmission of huanglongbing and citrus tristeza disease</em></td>
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<td>0930–1000</td>
<td><strong>Plenary 7</strong></td>
<td>Auditorium 2</td>
<td>Chair: Morag Glen, University of Tasmania</td>
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<td><strong>Dr Angus Carnegie</strong>, Industry and Investment NSW</td>
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<td><em>Myrtle rust: emergency response of an exotic incursion</em></td>
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<td>1000–1030</td>
<td>Concurrent Oral Sessions</td>
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<td>1030–1230</td>
<td><strong>Session 9</strong></td>
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<td><strong>Alternatives to Chemical Control A</strong></td>
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<td>Room: Auditorium 2</td>
<td>Chair: Tony Reglinski</td>
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<tr>
<td>1030</td>
<td>Evaluation of alternatives to fungicides for white blister rust control on Brassica vegetables</td>
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<td><strong>Joanna Petkowski</strong>, Department of Primary Industries, VIC</td>
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<tr>
<td>1045</td>
<td>Efficacy of fungicide alternatives in managing powdery and downy mildews on cucurbits</td>
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<td><strong>Elio Jovovich</strong>, Department of Employment, Economic Development and Innovation, QLD</td>
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<td>1100</td>
<td>Novel control of lettuce downy mildew (Bremia Lactucae) and anthracnose (Microdochium panattonianum)</td>
<td></td>
<td><strong>Belinda Rawnsley</strong>, South Australian Research and Development Institute, SA</td>
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<td>1115</td>
<td>Control of powdery mildew in viticulture using milk and milk components</td>
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<td><strong>Dale Godfrey</strong>, University of Adelaide, SA</td>
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<td><strong>Philip Davies</strong>, University of Sydney, NSW</td>
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<td>1130</td>
<td>Evaluation of Australian essential oils on the growth of the postharvest pathogen Monilinia fructicola</td>
<td>Elena Lazar-Baker, Department of Industry &amp; Investment NSW</td>
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<td>Quantitative PCR and histopathological investigations of cereal tissues during infection by the crown rot pathogen Fusarium pseudograminearum</td>
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<td>A survey of root and collar rot pathogens of peas (Pisum sativum) in New Zealand</td>
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<td>Ian Harvey, PLANTwise Services Limited, NZ</td>
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<td>The length of an internal poly(A) tract of Hibiscus latent Singapore virus affects its infectivity in Nicotiana bethamiana</td>
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<td>Sheng Niao Niu, National University of Singapore, Singapore</td>
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<td>1145</td>
<td>Role of constitutive and induced defences in the resistance of unripe mangoes to Colletotrichum gloeosporioides</td>
<td>Nimal Adikaram, University of Peradeniya, Sri Lanka</td>
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<td>Meta-analysis of stripe rust epidemiology, severity and yield loss in wheat in Western Australia</td>
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<td>Pests and diseases remain the main complaint of banana farmers in Indonesia</td>
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<td>Catur Hermanto, Indonesian Fruit Research Institute, Indonesia</td>
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<td>Influence of ZMROP1 expression on the infection of maize by sugarcane mosaic virus</td>
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<td>Zaifeng Fan, China Agricultural University, China</td>
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<td>1200</td>
<td>Preliminary studies on the biology, culturing and field release of Puccinia spegazzinii de toni.: a classical biocontrol agent for Mikania micrantha Kunth (mile-a-minute) in Papua New Guinea</td>
<td>Annastasia Kawi, National Agricultural Research Institute, Papua New Guinea</td>
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<td></td>
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<td>Characterisation of stripe rust resistance in selected South African wheat lines</td>
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<td>Johanna Snyman, University of Sydney, NSW</td>
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<td>Interesting new fungal and bacterial associations on horticulture and forestry hosts in New Zealand</td>
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<td>Megan Romberg, Ministry of Agriculture and Forestry—Biosecurity New Zealand, NZ</td>
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<td>1215</td>
<td>Review of alternatives to chemical control posters</td>
<td>Review of cereal pathology posters</td>
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<td>Review of disease surveys posters</td>
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<td>Review of virology posters</td>
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<td>1230–1330</td>
<td><strong>LUNCH</strong></td>
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<td>Editors Lunch</td>
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<td>1330–1430</td>
<td><strong>Poster Session 2:</strong> Virology; Alternatives to Chemical Control; Disease Surveys; Cereal Pathology; Forest Pathology; Tropical Horticulture; Training, Extension and Technology Transfer; Prokaryotic Pathogens; Population Genetics</td>
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<td>1430–1500</td>
<td><strong>PLENARY 8</strong></td>
<td>Chair: Treena Burgess, Murdoch University, WA</td>
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<td>Professor David Zhou, Chinese Academy of Forestry</td>
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<td>Eucalypt diseases and their management in China</td>
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<td>1500–1530</td>
<td><strong>AFTERNOON TEA</strong></td>
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<td><strong>Exhibition Hall 2</strong></td>
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<tr>
<td>Time</td>
<td>SESSION 13</td>
<td>SESSION 14</td>
<td>SESSION 15</td>
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<td>1530–1700</td>
<td>Disease Management C</td>
<td>Plant-pathogen Interactions B</td>
<td>Forest Pathology</td>
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<td>Room: Auditorium 2</td>
<td>Room: Waterfront Room 1</td>
<td>Room: Waterfront Room 2</td>
<td>Room: Waterfront Room 3</td>
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<tr>
<td>Chair: David Guest</td>
<td>Chair: Amanda Able</td>
<td>Chair: Morag Glen</td>
<td>Chair: Catia Delmiglio</td>
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<tr>
<td><strong>1530</strong></td>
<td>Integrated management of Phytophthora root rot of papaya in the wet tropics of far northern Queensland, Australia</td>
<td>Common spear rot of oil palm: identification of pathogenic agents and potential role of water-related stress as predisposition factor</td>
<td>Eradication and containment of Phytophthora cinnamomi from natural ecosystems</td>
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<tr>
<td>Lynton Vawdrey</td>
<td>Suwandi Suwandi</td>
<td>Bill Dunstan</td>
<td>Ichiro Uyeda</td>
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<tr>
<td>Department of Employment, Economic Development and Innovation, QLD</td>
<td>Hokkaido University, Japan</td>
<td>Murdoch University, WA</td>
<td>Hokkaido University, Japan</td>
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<tr>
<td><strong>1545</strong></td>
<td>Integrated pest and disease management on cocoa is profitable in Papua New Guinea</td>
<td>Unravelling the anthracnose disease complex of capsicum spp.—species, formae specialis, pathotypes</td>
<td>The potential risk of Phytophthora dieback in the Greater Blue Mountains</td>
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<td>Josephine Saul Maora</td>
<td>Paul Taylor</td>
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<td>WHA</td>
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<td>Papua New Guinea Cocoa Coconut Institute</td>
<td>University of Melbourne, VIC</td>
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<td>Zoe-Joy Newby</td>
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<tr>
<td><strong>1600</strong></td>
<td>The Queensland sugarcane smut epidemic: research outcomes</td>
<td>Interactions between Phoma koolunga, Didymella pinodes and Phoma medicaginis var. pinodella, casual agents of ascochyta blight on field pea in South Australia</td>
<td>Bacterial diseases of Eucalyptus</td>
</tr>
<tr>
<td>Rob Magarey</td>
<td>Jenny Davidson</td>
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<td>Teresa Coutinho</td>
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<tr>
<td>BSES Limited, QLD</td>
<td>South Australian Research and Development Institute, SA</td>
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<td>University of Pretoria, South Africa</td>
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<tr>
<td><strong>1615</strong></td>
<td>Screening and evaluation of fungicides for the control of sugarcane smut in seedcane</td>
<td>Molecular and morphological characterisation of variation of sugarcane smut (Ustilago scitaminea Sydow) in the Philippines</td>
<td>Ceratocystis species: increasing threats to tree health</td>
</tr>
<tr>
<td>Shamsul Bhuiyan</td>
<td>Rosalyn Luzaran</td>
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<td>Jolanda Roux</td>
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<td>Philsurin, The Philippines</td>
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<td>University of Pretoria, South Africa</td>
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<tr>
<td><strong>1630</strong></td>
<td>Management of the major foliar diseases of mungbeans and peanuts in Australia</td>
<td>Characterisation of Alternaria species causing leaf blotch and fruits spot in apples in Australia</td>
<td>Silvicultural options for field management of Ganoderma root rot in Acacia mangium plantation</td>
</tr>
<tr>
<td>Malcolm Ryley</td>
<td>Merran Neilson</td>
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<td>Abdul Gafur</td>
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<td>Department of Employment, Economic Development and Innovation, QLD</td>
<td>University of Queensland, QLD</td>
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<td>APRIL Forestry R&amp;D, Indonesia</td>
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<td><strong>1645</strong></td>
<td>Impacts of bacterial blast and orchard management on pear productivity</td>
<td>Spring needlecast in Tasmania—fungal communities and environmental factors</td>
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## Day 3—Friday 29 April 2011

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<td>0730–1730</td>
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| 0900–0930 | **PLENARY 9**  
Chair: Mark Sutherland, University of Southern Queensland  
Mr Les Baxter, Australian Centre for International Agricultural Research (ACIAR)  
*Plant pathology research and capacity building in developing countries: issues and opportunities* | Auditorium 2 |
| 0930–1000 | **PLENARY 10**  
Dr Vic Galea, University of Queensland  
*Teaching and learning in plant pathology for a new century—what has changed?* | Auditorium 2 |
| 1000–1030 | **PLENARY 11**  
Chair: Ceri Pearce, Department of Employment, Economic Development and Innovation, Qld  
Professor James Stack, Kansas State University  
*Reconciling plant biosecurity strategy and tactics with trends in emergence and evolution of plant diseases* | Auditorium 2 |
| 1030–1100 | ** Concurrent Oral Sessions**  
| **SESSION 17** | Alternatives to Chemical Control B  
Room: Auditorium 2  
Chair: Caroline Donald  
*Onion stunts: factors associated with severity and management options*  
Simon Anstis, South Australian Research and Development Institute, SA | Auditorium 2 |
| 1100–1130 | **SESSION 18** | Plant–pathogen Interactions C  
Room: Waterfront Room 1  
Chair: Rosalie Daniel  
*Genetic transformation in Colletotrichum truncatum associated with anthracnose disease of chilli*  
Adeline Auyong, University of Melbourne, VIC | Auditorium 2 |
| 1130–1155 | **SESSION 19** | Disease Surveys B  
Room: Waterfront Room 2  
Chair: Christine Horlock  
*Disease surveys of vegetable and flower crops in the Dalat area of Vietnam, and selected IDM strategies*  
Hoa Tuan Trinh, Plant Protection Research Institute, Vietnam | Auditorium 2 |
| 1155–1200 | **SESSION 20** | Tropical Horticulture  
Room: Waterfront Room 3  
Chair: Jose Liberato  
*Occurrence of branch dieback and canker of mangoes in Derby, north Western Australia*  
Hossein Golzar, Department of Agriculture and Food WA | Auditorium 2 |
| 1200–1230 | ** Concurrent Oral Sessions**  
| **SESSION 21** | Biological control of Pythium root rot on hydroponic coriander  
Room: Auditorium 2  
Chair: Caroline Donald  
*Pathogenicity mechanism on Verticillium wilt of Cotinus coggyria*  
Chengming Tian, Beijing Forestry University, China | Auditorium 2 |
| **SESSION 22** | Biogfumigant green manure crops for use in disease management  
Room: Auditorium 2  
Chair: Caroline Donald  
*A change in the symptoms of vascular-streak dieback of cocoa in Southeast Asia and Melanesia*  
Philip Keane, La Trobe University, VIC | Auditorium 2 |
| **SESSION 23** | Evaluation of Ochrobactrum sp. as a potential bioherbicide for angled onion (Allium triquetrum L.) in laboratory conditions  
Room: Auditorium 2  
Chair: Caroline Donald  
*Fusarium thapsinum is the dominant species associated with sorghum stalk rot in Queensland and northern New South Wales*  
Malcolm Ryley, Department of Employment, Economic Development and Innovation, QLD | Auditorium 2 |

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**New Frontiers in Plant Pathology for Asia and Oceania** | **ACPP APPS 2011**
### SESSION 21
**Training, Extension and Technology Transfer**
Room: Auditorium 2
Chair: Vic Galea
- **Planning for the future: introducing plant biosecurity activities into schools to increase Australia’s plant health capacity**
  - Kirsty Bayliss
  - Cooperative Research Centre for National Plant Biosecurity, WA

### SESSION 22
**Prokaryotic Pathogens**
Room: Waterfront Room 1
Chair: Calum Wilson
- **Molecular differences between strains of Pseudomonas syringae pv. actinidiae isolated from Europe and those isolated from Asia**
  - Joel Vanneste
  - Plant and Food Research, NZ

### SESSION 23
**Population Genetics**
Room: Waterfront Room 2
Chair: Juliane Henderson
- **Teratosphaeria destructans in Australia: biosecurity threat or elusive native pathogen?**
  - Vera Andjic
  - Australian Quarantine and Inspection Service, WA
- **The pan-genome of Erwinia amylovora provides insights into host specificity and better diagnostic design**
  - Rachel Powney
  - La Trobe University, VIC

### SESSION 24
**Biosecurity B**
Room: Waterfront Room 3
Chair: Vincent Lanoiselet
- **Biosecurity risk of native fungi**
  - Peter Johnston
  - Landcare Research, NZ

### Enrolments are open!
**Introducing the certificate, diploma and masters in plant biosecurity**
- Kirsty Bayliss
- Cooperative Research Centre for National Plant Biosecurity, WA

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<th>Room</th>
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<td>Room:</td>
<td>Acquisition of a pathogenicity island encoding coronafaci acid in Pectobacterium carotovorum subsp. carotovorum strains causing blackleg on potato</td>
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<td>New Zealand Institute for Plant and Food Research, NZ</td>
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<td>Room:</td>
<td>In planta excision of a pathogenicity island, HAI2, in Pectobacterium atrosepticum is mediated by integrase</td>
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<td>New Zealand Institute for Plant and Food Research, NZ</td>
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<td>Room:</td>
<td>A novel N-acylhomosweine lactonase AIDH from Ochrobactrum sp. quenches the pathogenicity of bacterial pathogens</td>
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<td>China Agricultural University, China</td>
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<td>Room:</td>
<td>Genetic diversity of Guignardia musae on banana based on multi-gene sequence analysis</td>
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<td>University of Southern Queensland, QLD</td>
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<td>Room:</td>
<td>Species composition and genetic diversity of Cylindrocarpon species found commonly infecting New Zealand grapevines</td>
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<td>Lincoln University, NZ</td>
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<tr>
<td>Room:</td>
<td>Genetic and phenotypic diversity of Pseudomonas syringae strains isolated from waterways on three continents</td>
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<td>Room:</td>
<td>Re-establishing area freedom for Globodera rostochiensis in Western Australia—a world first</td>
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### Increasing diagnostic capacity of plant diseases in Timor Leste using remote diagnostics microscopy
- Roni Tpoi
- Ministry of Agriculture and Fisheries, East Timor

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<td>Room:</td>
<td>Population structure of Ascochtya rabiei in Australia, using the newly developed microsatellite loci markers</td>
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<td>University of Melbourne, VIC</td>
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<td>Room:</td>
<td>National strategies to enhance Australia’s plant biosecurity system</td>
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<tr>
<td>Room:</td>
<td>Biosecurity research and development needs for the AQIS Operational Science Program</td>
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<td>Development of biosecure packaging for transport of emergency plant pest samples</td>
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### Best practice management framework for Phytophthora dieback in south-west Western Australia
- Nari Williams
- Murdoch University, WA

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<td>Successful establishment of a cooperative research model—biological control of Parkinsonia (Parkinsonia aculeate)</td>
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### Papua New Guinea, the last country to succumb to late blight on potato
- Rudolf de Boer
- Department of Primary Industries, VIC

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### 1500–1530
**AFTERNOON TEA**

### 1330–1500
**Concurrent Oral Sessions**
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<td>1530–1600</td>
<td>APPS Awards: Fellows and honorary members</td>
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Oral abstracts

Advanced bioinformatics approaches to elucidate plant/microbe interactions from large-scale genome sequencing projects

M. Bellgard¹
¹Murdoch University

Recent exciting advances in next generation biotechnologies with substantially reduced costs is now enabling scientists to conceive and undertake large scale genomics related activities in ways never before possible. Bioinformatics is the essential enabling capability that applies informational communication technologies in the fields of biotechnology and molecular biology. With the enormous amounts of data generated by these next generation biotechnologies, bioinformatics plays critical roles in data management, data analysis, and integration of various data from disparate sources to enable scientists to accelerate scientific discovery and decision making. However, the sheer explosion of data that can now be generated from a single biological experiment is nothing short of breathtaking and potentially a daunting task for scientists to interpret. In addition, bioinformatics solutions need to straddle the needs for cross-omics analysis (such as genomics, transcriptomics, proteomics and metabolomics) with simple to use software systems. While Internet-based software technologies are now mature enough to support these kinds of biological research projects, the exponential increase in biological data generation that can be generated poses many challenges.

In this presentation, I explore these bioinformatics challenges in the context of applications to large scale genome sequencing projects in plant, microbes and their potential interaction. I describe bioinformatics research we have undertaken in this area and propose a bioinformatics framework that enables both high throughput analysis well as a strategy to undertake detailed bioinformatics analysis. The results of such analysis can then be used in a systematic way as the basis for further biological research and experimentation.

A love affair with Fusarium

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Fusarium is one of the most remarkable genera of the fungi. Representatives are found in most bioclimatic regions of the world especially in association with plants and soil in undisturbed, non-cultivated and cultivated ecosystems. Their relationships with plants are complex. Many are aggressive pathogens, others are endophytes or pathogens depending on the host and environment, while others are secondary colonisers or saprophytes. The plant pathogenic species cause a wide range of diseases of continuing socio-economic importance, and some species produce mycotoxins. Diseases include vascular wilts, the insidious root, crown, stalk and head rots, storage rots, and growth deformations such as pokkah boeng of sugarcane and bakanae in rice. As most species are easily isolated many diseases have been wrongly attributed to Fusarium. I started research on Fusarium crown rot of wheat in 1964. However my love affair with Fusarium really started while working in W.C. Snyder’s laboratory at the University of California, Berkeley. Here I came to appreciate both the diversity of Fusarium, through a global collection of cultures, and the vast array of Fusarium diseases. Snyder’s influence led me into eco-taxonomic research on Fusarium in undisturbed or non-cultivated ecosystems, especially grasslands and rangelands, a career-long scientific hobby. This research has spanned the morphological and molecular eras of taxonomy.

On this historic joint conference of ACPP and APPS I propose to use our studies on Fusarium to illustrate the invaluable benefits of international cooperation in teaching, learning and research. I will use two main examples for this purpose: Fusarium graminearum, the cause of Fusarium head blight of winter cereals, and stalk and cob rot of corn; and the Fusarium wilts of watermelon (Vietnam) and vanilla (Indonesia). Some of the considerable gaps in our understanding of Fusarium will be highlighted, as well as the issues relating to incursions and the emergence and evolution of new pathogens.

Biosecurity, microbial forensics and plant pathology: education challenges, overlapping disciplines and research needs

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This article comments on aspects of functional overlapping of biosecurity, biosafety, bioterrorism, microbial forensics, plant pathology and education in a changing world showing the impact of increasing international trading, globalisation and anthropogenic interventions. This commentary also introduce current research approaches such as, rapid collection devices, massive parallel sequencing systems and helicase dependent amplification applied to problems in biosecurity and microbial forensics.

Diagnosis and transmission of huanglongbing and citrus tristeza disease

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Huanglongbing (HLB) and tristeza diseases are the most destructive diseases of citrus production worldwide. Conventional and molecular diagnosis, and vector transmission have been employed to understand disease epidemic. Eighty-four and 54% of samples collected from all major citrus producing areas of Thailand were infected by Citrus Tristeza Closterovirus (CTV) and by HLB pathogen, respectively while 48% of the samples were mixed infection with CTV and HLB as tested by enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR). Citrus and citrus related species are affected by HLB including Citrus aurantifolia, C. hystrix C. maxima, C.
microcarpa C. reticulata, C.sinensis x Poncirus trifoliata (Troyer citrange), Murraya exotica and M. paniculata. Sequence analysis of 16 s rRNA gene indicated that the HLB disease was caused by Candidatus Liberibacter asiaticus, a phloem limited gram negative bacterium. HLB pathogen was also detected in adult psyllid vector (Diaphorina citri) visiting infected citrus trees in the rate of 80-100% but only one occasion that the pathogen was discovered in the adult psyllids collected from M. exotica trees. Later, it was proved that the HLB pathogen was transmitted by single psyllid vector from naturally infected Shogun mandarin (C. reticulata) to either M. exotica or M. paniculata. Results from biological indexing and restriction fragment length polymorphism (RFLP) indicated that a mixture of CTV stem pitting (CTV-SP) strains including P25/Hinf I RFLP group 3 and group 6 was found to be dominant in the field. The complex of CTV RFLP group 1, 2, and 6 coexisting in an infected field tree of West Indian lime resulted in mild symptom expression. CTV-SP is widely spread in Siam and Shogun mandarin, the two major citrus producing cultivars in Thailand. However, the viral infection was less effect on these two cultivars than its occurrence in cultivar Orah, a mandarin hybrid (Temple tanger x C. reticulata). CTV single aphid (Toxoptera citricida) transmission was attempted and 5-60% of transmission rates were recognised. Isolation of CTV through the aphid vector transmission revealed naturally mixed infection of mild and severe strains in citrus trees. Development of simple and reliable immunostrip test specific to severe CTV-SP for early detection will also be discussed.

Myrtle rust: emergency response of an exotic incursion

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A rust was detected in New South Wales in April 2010 at a cut-flower farm on the Central Coast, and identified as Uredo rangelli (and dubbed ‘myrtle rust’). Uredo rangelli is a taxon currently considered as within the Puccinia psidii (guava rust) complex; these two taxa are morphologically similar, and cannot be separated based on phylogenetic analyses of three gene regions. Guava rust is native to South and Central America, has a wide host range within Myrtaceae, and is known to cause significant disease in eucalypt plantations in Brazil. As such, guava rust is a recognised biosecurity threat to Australia. The detection of U. rangelli in NSW was immediately identified as an emergency plant pest (EPP), and an emergency response began, including delimiting surveys, treatment of infected material, quarantining infected Premises (IPs), and tracing the movement of plant material to and from IPs. By October 2010, 36 IPs had been detected, the majority in nurseries or cut-flower farms, but no rust found in native bush. Currently, 10 species have been identified as hosts from surveys. Host testing, initially in situ at IP1 and then in a quarantine facility, began in June, to identify whether U. rangelli may be a threat to forestry and whether it had a wider host range, with 10 additional host species identified by October.

Eucalypt diseases and their management in China

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Eucalypts were first introduced into China in 1890, and the first commercial eucalypt plantation was established in Zhanjiang, GuangDong province in 1954. Because natural ecosystems have been strictly protected from logging since 2000, eucalypt plantations in South China have been extensively expanded to meet the needs of a rapidly growing local economy. Approximately 3 million ha of eucalypt plantations have now been established and half of these represent clones of Eucalyptus urophylla x E. grandis, and E. camaldulensis x E. grandis hybrids. However, the sustainable development of the eucalypt plantations is under increasing threats due to pathogens and pests. The fact that there has been very limited work on eucalypt pathology in China compounds this fact. During the course of past four years, a program known as the CFEPP (http://www.fabinet.up.ac.za/cfepp/index) focusing on eucalypt health problems in China has been developed, and a large number of eucalypt disease surveys have been conducted in areas such as GuangXi, GuangDong, Hainan, Fujian and Yunnan. This work has resulted in the collection of over 1000 fungal strains many of which are well-known eucalypt pathogens. A total of 20 fungal species (nine of them new to science) residing in 11genera such as Calonectria, Chrysoraphore, Quambalaria and Teretosphaera, have been characterised based on comparisons of morphology and DNA sequence data. Both glass-house and field trials have been conducted to test the pathogenicity of the most important of these fungi on commercially used eucalypt clones. Results have shown that there are significant differences in the susceptibility of these clones to fungal isolates/species, indicating that selection of resistant material for commercial planting in the future can be achieved.

Plant pathology research and capacity building in developing countries: issues and opportunities

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To date Australian R&D institutions have provided significant and resilient plant pathology research and capacity development skills that have had a positive impact in developing countries and there is little doubt that there will be a range of future opportunities.

This paper uses an assessment of four separate case studies in the horticultural crops sector to:
• demonstrate the range of plant pathology-related research and capacity building activities and interventions currently being used by ACIAR in developing countries

• identify some of the major issues associated with the implementation of these activities

• highlight progress to date, major successes and identify major lessons learnt.

While opportunities exist for future involvement of Australia's plant pathology capacity and expertise in official development assistance programs (ODA), capturing these opportunities will require a change in the current mindset of Australian R&D agencies. It is important that scientists, technicians and R&D organisations wishing to participate in the ODA program fully appreciate the changing nature of the R&D and international development environments and develop a deep understanding of how these impact on these future opportunities. To capitalise on these opportunities it is suggested that:

• Australian R&D agencies become more proactive in aid/development policy and strategy

• Australian scientists and technicians learn the new and rapidly evolving aid/development language and determine the intersections of plant pathology research and capacity development with development themes

• Australian plant protection practitioners stay abreast of developments not only in their own fields of technical expertise, but also the international aid/development landscape.

Teaching and learning in plant pathology for a new century—what has changed?

V. Galea

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Over the last two decades, there has been what was at first a gradual, then more recently a rapid decline in the number of plant pathologists in Australian universities. This has been reflected in an ever shrinking exposure of undergraduate students to what were once considered core disciplines such as plant pathology and microbiology. The new ‘generalist’ model for undergraduate programs considers disciplines such as plant pathology as ‘specialist topics’ which are often relegated to senior classes or reserved for elective units.

Industry, government and research organisations remain as the main recruiters of young plant pathologists, many of whom have noted, and sometimes complain of the decline in plant pathology capabilities among recent graduates. In this presentation I will address the nature of this problem, and some of the approaches taken by plant pathologists at Australian universities to meet these challenges.

Reconciling plant biosecurity strategy and tactics with trends in emergence and evolution of plant diseases

James P. Stack

1Great Plains Diagnostic Network, Kansas State University

Understanding of the emergence of new pathogens and pests and the underlying facilitators of emergence have increased in recent years and point to the limitations of current plant biosecurity strategies. There are many drivers of emergence including characteristics inherent to the organism (e.g., mutation rate, phenotypic plasticity) and the environmental regulators of the expression of those traits (e.g., temperature, water activity). Due to changes in several drivers, the opportunities for emergence and subsequent establishment of pathogens and pests have increased dramatically. The ISPP Convention objective is to facilitate trade without compromising plant biosecurity and relies heavily on prevention and interception as the primary strategy for plant biosecurity. The objective should be to ensure plant biosecurity without compromising trade. Although subtle, it is not a trivial distinction. The current convention precludes the regulation of unknowns and requires science-based pest risk analyses (PRA). However, at present, unknowns are the biggest threats and the science of invasion biology, upon which PRAs are formulated, is imperfect with a limited track record for predicting invasions and impacts. Prevention and interception are important components of an effective plant biosecurity strategy. However, the massive increase in trade with little increase in adequately trained border inspectors has resulted in very low inspection rates, estimated at 1-2%, often with visual inspection times of less than seven seconds per plant. Quiescent infections in carrier hosts and moderate to long latent periods for many diseases coupled with rapid transoceanic and transcontinental disease transport times that permit harvest on one continent and sale in another in just a few days, provides ample opportunity for pathogens and pests to evade visual inspection-based prevention and interception practices. The staggering increase in trade through distribution systems subject to the policies and practices of the International Sanitary and Phytosanitary Convention, the massive and unregulated movement of live plants, seeds, and agricultural products across borders and through unregulated distributions systems not subject to ISPS policies and practices, the rapid integration into global trade and distribution systems of emerging economies that lack the infrastructure to support safe trade, the uncertainty associated with climate change, the daunting food security challenges of feeding nine billion people adequately, and the increased energy demand and land-use changes associated with a growing population with increasing standards of living, make clear that a more comprehensive approach to plant biosecurity is required.
Evaluation of research and development on phase-out of methyl bromide use in Australian horticulture

I.J. Porter1, S.W. Mattner1, D. Collins2, R.W. Emmett3, J. Edwards1
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Methyl bromide (MB) is an ozone depleting substance listed for international phase-out under the 1987 Montreal Protocol. The impact of a research and development (R&D) program conducted from 1994-2008 on phase-out of the use of MB fumigation for soil disinfestation and other non-quarantine and pre-shipment purposes in Australian horticulture was evaluated. Key outputs from 15 projects in the program included the development and communication of alternative treatments, methods and/or strategies for the control of pests (soil-borne pathogens, pests and weeds) for different horticultural industries and contribution to policy development and implementation. Practices used by these industries before and after the R&D program and their levels of adoption, associated crop losses and costs were identified and their economic, environmental and social impacts were assessed. While adoption of alternative practices to MB soil fumigation after the R&D mostly provided adequate pest control, generally benefits were lower because of lower increments in yield. Other quantified impacts were social benefits (avoided human health costs) arising from Australia’s participation in the international phase-out program and from effects of the Victorian Department of Primary Industries’ involvement on the phase-out in other countries.

Biological suppression of Rhizoctonia disease in wheat—effect of carbon and available nitrogen levels in soil

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Disease suppressiveness of soil is the ability of a soil to reduce disease severity even in the presence of a pathogen, its host plant and favourable climatic conditions. It is an inherent property of all biologically active soils but the level of suppression ability varies with edaphic and environmental variables. Management practices that add higher levels of biologically available C inputs over long periods can support higher levels of suppression. We investigated the effect of C and N turnover during non-crop period on the suppression of Rhizoctonia bare patch disease in wheat in (i) a long-term field experiment at Avon, South Australia and (ii) glasshouse bioassay experiments. Prior to this investigation during 2000-2004, the soil in the field experiment was identified as highly suppressive against soil-borne diseases caused by necrotrophic fungal pathogens.

In the long-term field experiment Rhizoctonia damage increased (an indication of low disease suppression) in response to returning of previous season’s crop material killed by herbicides at anthesis and this effect was cumulative over seasons. However, a single harvested crop resulted in a large decline in Rhizoctonia root damage. These observations were related to C and N turnover after crop harvest which is influenced by the quality of crop residues, e.g. mineral N accumulation in the surface soil occurs early over summer when green plant residue was returned compared to dry stubble after harvest. In the glasshouse experiments changes in C and N availability prior to sowing altered the level of disease suppression.

Our field experiments describe the changes in the level of disease suppression in a crop to the management events occurred in previous season. These management changes could be to address agronomic aspects in a crop or during non-crop period. In our experiment, crop kill at anthesis by herbicide application was done to mitigate the development of herbicide-resistant weeds.

Disease suppressiveness in soils collected during non-crop period was done using a bioassay experiment.

Formic acid as a seed treatment for Rhizoctonia black scurf of potato

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Reducing tuber-borne inoculum of R. solani is an important component in control of black scurf in potato production systems. The efficacy of formic acid as seed dip to reduce tuber borne inoculum of R. solani was tested by measuring the viability of sclerotia removed from treated tubers in vitro. Black scurf infested tubers collected from field grown potatoes were dipped into various concentrations (0, 1, 2, and 4%) of formic acid for 3 time periods (5, 10 and 15 min). After 1 week the number of eyes with sprouts per tuber was determined. After 10 days, the tubers were potted into pathogen-free potting mix and grown in the glasshouse for evidence of any phytotoxic effects of formic acid. All concentrations of formic acid produced sprouts indicating that there was no negative effect on sprouting or on the number of stems produced per plant. Growth of sclerotia collected from the treated tubers on agar was significantly reduced by all formic acid concentrations, with 1, 2 and 4% almost completely preventing mycelial growth from sclerotia. Further research is required to evaluate formic acid as a seed treatment under field conditions.
Development, registration and commercialisation of a microbial fungicide for controlling cotton verticillium wilt in China

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Cotton verticillium wilt (CVW), caused by Verticillium dahliae, is a constraint factor in cotton production around the world. Antagonistic Bacillus subtilis strain NCD-2 against V. dahliae was isolated from the cotton rhizosphere in Hebei province of China. The efficacy bioassays of strain NCD-2 for controlling CVW were performed in greenhouse and field conditions. A preparation of the microbial fungicide, 109 cfu/g B. subtilis WP, was formulated with strain NCD-2. Field trials showed that the preparation could reduce 60%–80% severity of CVW by seed treatment in different regions of China. It was no-pathogenic to 8 crops including cotton, wheat, corn, cotton, potato, eggplant, cucumber and soybean. The survival rate of strain NCD-2 was over 90% after 18 months storage under normal condition. This preparation was registered for controlling CVW in China in 2006. The mass production technology of strain NCD-2 was optimised in 500L., 5000L and 15000L fermentation tanks, respectively. Control spectrum studies revealed that the microbial fungicide significantly controlled some other soil-borne diseases such as eggplant verticillium wilt, cotton fusarium wilt, watermelon fusarium wilt, yam root rot. Preliminary study indicated that the supposed action mechanisms of strain NCD-2 included inhibition (antifungal compounds production), colonisation on the surface of cotton root and transportation in the cotton plant to block the pathogen extension, and growth promotion.

Control of Eutypa dieback in grapevines by remedial surgery

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Eutypa dieback is a disease of grapevine caused by the fungus Eutypa lata, which infects through wounds and gradually colonises wood tissue, causing stunted shoots with cupped, chlorotic and necrotic leaves, dieback of cordon and eventually death of vines. Once infection is established control using fungicides, biocontrol agents and nutrients is ineffective. Twelve long-term trials were established in South Australia to evaluate two methods of remedial surgery to control Eutypa dieback: i) low-cut, which involves removing the trunk 30 cm above ground and training a watershoot to replace the canopy and ii) high-cut, where trunks are cut at the crown and the lowest shoot is trained to form a new canopy, followed by removal of excess trunk. Between 42 and 100% of vines produced watershoots, generally reaching a plateau within 3 years. More shoots developed on high-cut vines than on low-cut vines, with considerable variation among cultivars. Recurrence of stunted shoots ranged from 0 to 11% up to 9 years after surgery on low-cut vines, compared with 9 to 54% on high-cut vines. On high-cut vines, the lowest watershoot suitable for reworking emerged from anywhere between the ground and the crown and recurrence of stunting increased with height above ground. The higher frequency of stunting in high-cut vines was probably due to infected tissue remaining in the trunk. Findings support the need to remove all E. lata-infected tissue from diseased vines to restore long-term productivity to vineyards.

Development of boscalid for Sclerotinia disease control in Australian vegetable crops

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Sclerotinia diseases (are major threats to the sustainable production of many vegetable crops in Australia. The availability of effective fungicides is critical for the management of Sclerotinia diseases. In green beans and lettuce, losses due to Sclerotinia can range from 20% to 100%. In 2004, when procymidone was withdrawn from use on bean and lettuce crops in Australia, boscalid was identified as a suitable replacement fungicide. Boscalid has not been registered for use in any vegetable crops in Australia, and its long term use is subject to establishing its efficacy, crop safety and the development of recommendations for use in various vegetable crop groups. In 2004–2008, eight field trials highlighted the effectiveness of boscalid for Sclerotinia control. The influence of spray timing, sprays adjuvants, crop variety, plant vigour and weather conditions on fungicide control were also examined. Du-Wett, a new blend of organosilicone and organic adjuvant, was found to improve the performance of boscalid through a reduction in control variability associated with application under dry conditions.

Molecular characterisation of Colletotrichum gloeosporioides, the incitant of Noni anthracnose and exploiting PGPR and fungal antagonists for its management

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Noni (Morinda citrifolia) reportedly contain a range of medicinally beneficial phytochemicals. Commercial cultivation of Noni has recently suffered losses due to pests and diseases. In July 2008, a disease outbreak on noni farms at Tamil Nadu, Karnataka and Kerala exhibited shot hole symptoms typical of anthracnose infection. The causal agent was subsequently isolated and identified by ITS sequencing as Colletotrichum gloeosporioides Penz. Management of C. gloeosporioides using different isolates of bacterial and fungal antagonists under inviwo, revealed that Pseudomonas fluorescens (TDK1), Bacillus subtilis (SVPR) and fungal antagonists Trichoderma viride (TV1) inhibited the mycelia growth of C. gloeosporioides effectively. It was due to the production of antifungal
metabolites. The effective bacterial antagonists revealed the presence of antibiotic biosynthetic gene namely, phenazine in TDK1 and Iturin in SVPR4. The antibiotics produced by the bacterial antagonists were further analysed through HPLC and Mass Spec analysis.

Consortia comprising of TDK1, SVPR4 and TV1 was developed using vermicompost and neem cake mixture as carrier material. The shelf life of this formulation was maintained up to 120 days. The formulation was effective in reducing the disease incidence to the tune of 52 per cent when compared to untreated control.
Expression of pathogenesis-related genes confirms induction of systemic acquired resistance by salicylic acid in broccoli

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This study has demonstrated for the first time the successful use of induction of systemic acquired resistance to control clubroot in broccoli confirming its potential to be used as a disease management strategy. An initial proof-of-concept study was conducted in Arabidopsis thaliana. Application of 0.5 mM SA applied to A. thaliana roots as a 1 minute dip halved the number of plants infected by P. brassicae and caused a 76% reduction in the severity of symptoms of root galling. In broccoli application of 0.1 mM SA (neutralised pH 7) as a single 15 minute seedling dip, significantly reduced the severity of symptoms of clubroot under low to moderate disease pressure. At higher disease pressure a triple dip (three 15 minute dips in 0.1 mM SA applied 72, 48 and 24 hours before transplanting) improved the efficacy of treatment. The systemic nature of the response was confirmed in SA treated broccoli root and leaf tissue by the up-regulation of three PR genes (PR-1, PR-2 (β-1,3-glucanase) and PR-3 (chitinase)) known to be associated with plant defence responses. Expression of PR genes as measured by real-time RT-qPCR was maximum 72 hours after SA treatment indicating the optimum time required for SAR to establish fully in the plant.

Priming for systemic acquired resistance in brassicaceae species against Plasmodiophora brassicae

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The phytohormone, salicylic acid (SA) is implicated as a signal in defence against pathogens via systemic acquired resistance (SAR), a mechanism of induced defence. Jasmonic acid (JA) may play a role in disease development in biotrophic interactions; however this interaction is not yet clearly defined. We are investigating SA-induced SAR in broccoli and Arabidopsis and the role of JA in clubroot disease, caused by the biotroph Plasmodiophora brassicae. Variation in the susceptibility of Arabidopsis ecotypes to P. brassicae from completely susceptible (Col-0) to tolerant (Tsu-0) has been observed. Arabidopsis mutants, altered in defence pathway regulation, are being used to understand the roles of SA and JA in plant defence responses. Reverse phase-high-performance liquid chromatography (RP-HPLC) and liquid chromatography/mass spectroscopy (LC/MS) has been optimised to measure SA and JA at nanomolar levels, allowing us to monitor a particular phytohormone after inoculation. RP-HPLC results in broccoli show that the minimum rate of exogenous SA required to significantly increase endogenous levels is 250µM; higher application rates are to be tested. These results together with complimentary (RT-qPCR) studies of changes in gene expression in shoot tissue following inoculation with the pathogen are being used to optimise the potential of SAR to prevent clubroot in broccoli.

Multiple suppressors encoded by tomato leaf curl java virus, a monopartite begomovirus associated with betasatellite

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We previously identified the tomato leaf curl Java virus (ToLCJAV) from Southeast Asia as a new member of the emerging group of monopartite begomoviruses that require a tomato leaf curl beta betasatellite (ToLCJAB) component for symptom induction. When BC1 gene encoded by ToLCJAB and green fluorescent protein (GFP) gene were co-expressed in the GFP-expressing Nicotiana benthamiana line 16c from a PVX vector, βC1 protein was able to suppress posttranscriptional gene silencing (PTGS) induced by GFP and eliminated the short interfering RNA (siRNA) associated with GFP expression, with a correlated increase in GFP mRNA accumulation. When C2 gene of ToLCJAV and the GFP gene were co-expressed in the GFP-expressing N. benthamiana line 16c, C2 protein showed a weak suppressor activity. Leaves of N. benthamiana line 16c expressing GFP were co-infiltrated with an Agrobacterium strain carrying GFP and Agrobacterium expressing BC1 or C2. C2 protein suppressed local but not systemic silencing. V2 elicits a reaction resembling the hypersensitive response (HR) associated with the induction of necrosis and a systemic burst of H2O2 production when expressed from a potato virus X vector in Nicotiana species and tomato and showed PTGS suppressor activity. Thus, the ToLCJAV/ToLCJAB complex has at least three RNA silencing suppressors that, together, suppress both local and systemic silencing, and likely target the antiviral silencing pathway at multiple steps.

Studies of different interactions between Phytophthora infestans and potato

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Phytophthora is the most devastating pathogen of dicot plants. Its ability to infect plants involves sophisticated manipulation of the defence systems in plants. There is a need for many new resistance sources with different modes of action to counteract the fast evolution of this pathogen. With the goal to understand mechanisms of resistance and if combination of putative breeding material is useful against P. infestans, we analysed three clones of potato.
Two clones of potato, Sarpo Mira and SW93-1015, exhibited strong resistance against *P. infestans* in field trials, whole plant assays and detached leaf assays.

Resistant clones developed different sizes of hypersensitive response (HR) related lesions at microscopic and macroscopic level. SW93-1015 can be characterised as a weak cpr mutant without spontaneous HR lesions indicated by the presence of a constitutive active defence with constitutive H2O2 production and Pathogen related (PR) protein secretion and could be predicted to be a relatively durable resistance source. Apoplast analysis revealed putative protein candidates that are involved in defence. In a breeding program it can be useful to include fairly simple molecular analysis to detect different types of resistance.

**Genetic relationships among *Murraya* species and their susceptibility to huanglongbing**

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Orange jasmine is the favoured host of the Asiatic citrus psyllid, *Diaphorina citri* Kuwayama [Hemiptera: Sternorrhyncha: Psyllidae], one of two known vectors of ‘Candidatus Liberibacter spp.’ [a-Proteobacteria] that cause huanglongbing (HLB), the most serious disease of citrus. Reports indicate that the widely grown ornamental form of orange jasmine may be a transient host of liberibacters. Orange jasmine is considered by some authors to be *Murraya exotica* L. (Rutaceae: Aurantioidae: Aurantieae), by others and more widely, as either *M. paniculata* (L.) Jack or *M. paniculata* var. *exotica*. The susceptibility to HLB of wild forms, including two that occur naturally in Australia is not known, and may have ramifications for managing incursions of *D. citri* and the pathogens in Australasia, where, with the exception of New Guinea, the psyllid and the pathogens do not occur. We have used six regions of the maternally-inherited chloroplast genome and part of the internal transcribed spacer region of the nuclear-encoded ribosomal RNA operon as well as morphological leaf and leaflet characters to determine phylogenetic relationships of accessions from Asia, the Americas and Australia to resolve the taxonomic status of the forms. The phylogenetic relationships we have derived place most accessions in two distinct clades, Paniculata and Exotica, with subclades within the Paniculata clade containing, in most analyses: (1) *M. paniculata* accessions from Indonesia; (2) the large and small leaf forms of *M. paniculata* subsp. *ovatifoliatana* from Australia, *M. paniculata* subsp. *omphalocarpa* from Taiwan and *M. paniculata* subsp. *zollingeri* from Indonesia; and (3) *Murraya* accessions from Cuc Phuong in northern Viet Nam, Yingde in northern Guangdong in China, and from Pakistan. To date, only accessions in the Exotica clade are known to host liberibacters.

**Evaluating the role of defence pathways of *Arabidopsis thaliana* in resistance to *Phytophthora cinnamomi***

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In this study we evaluated the role of plant defence pathways in resistance to *Phytophthora cinnamomi* by testing the susceptibility of mutants of *Arabidopsis thaliana* impaired in various defence pathways to *P. cinnamomi* infection. Susceptibility to infection was assessed by measuring the number of callose papillae, production of hydrogen peroxide, and measurements of pathogen biomass using quantitative PCR. Mutants impaired in the salicylic acid, jasmionic acid, ethylene, and phytoalexin camalexin pathways did not show increased susceptibility to *P. cinnamomi* compared to their wild type background Col-0. However, the *abo*2 mutant deficient in abscisic acid (ABA) signalling displayed a very much higher level of susceptibility than the wild type parent, Col-0. The results show that resistance of *A. thaliana* to *P. cinnamomi* is mediated by the ABA signalling pathway.

**Using proteomics to identify phytotoxins unique to the spot or net form of *Pyrenophora teres***

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The two forms of barley net blotch disease, spot form and net form, are caused by *Pyrenophora teres f. maculata* (*Ptm*) and *P. teres f. teres* (*Ptt*) respectively. While *Ptm* and *Ptt* are genetically similar, the symptoms they cause are different. *Ptm* causes circular or elliptical brown lesions whereas *Ptt* causes distinctive dark-brown, longitudinal lesions. We have previously shown that both forms of the fungus produce proteinaceous phytotoxins which cause necrosis in a host specific manner (Farpeleh et al 2007 Phytopath 97: 907-915; Sarpeleh et al 2008 PMPP 72: 73-79). Two-dimensional gel electrophoresis was used to compare the proteome of the phytotoxin extractions from cultures of *Ptt* and *Ptm*. A total of six differentially expressed proteins were identified. One protein unique to *Ptt* (NF1) and one protein unique to *Ptm* (SF1) have been characterised further. Patterns of gene expression in vitro and in planta suggest that the proteins are expressed by actively growing hyphae and during the development of symptoms. Both SF1 and NF1 have been heterologously expressed and the recombinant protein used to bioassay susceptible and resistant barley cultivars. Evidence of the important role these proteins play in symptom development, virulence and the interaction between barley and the two forms of *P. teres* will be presented.
Novel approaches to the management of soil-borne diseases in vegetable crops

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Changing trends in pesticide registration and regulation have left vegetable growers with limited options to control a number of important soil-borne pathogens, and have led us to develop novel alternative approaches. Four approaches with potential for future application to manage soil-borne diseases in vegetable crops have been identified. These approaches target the pathogen or seek to strengthen the host against disease. Plant and fungal (endophyte) derived volatiles have been identified that inhibit the growth and survival of mycelium of a range of soil-borne pathogens, including Pythium, Fusarium, Rhizoctonia and Sclerotinia spp. Reductions in soil-borne inoculum of selected pathogens following treatment application have been quantified using molecular and classical methods. In addition, the induction of systemic acquired resistance in brassicas and grafting onto resistant rootstocks in snake bean have significantly reduced the susceptibility of these crops to diseases caused by soil-borne pathogens. Progress towards commercial application of each approach is discussed including the optimisation of rates, methods and timing of application of selected treatments.

Use of corn stalk as carrier of plant disease biocontrol agents for management of vegetable soil-borne diseases in greenhouse

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Soil-borne diseases resulting from the accumulation of Meloidogyne incognita, Fusarium solani,Ralstonia solanacearum and F. oxysporum are important factors limiting production of tomato, cucumber and eggplant in greenhouse during winter in China. We used corn stalk as the main carrier of the biocontrol microorganisms, selected out in the past few years, to change the microflora of the infested soil. When corn stalk at 4000 kg/mu (mu = ~0.165 acres) was amended with the microbial preparations at 1 kg/mu and then buried under planting lines, it was observed in field tests in Shanxi and Liaoning that the microbial preparation containing Bacillus subtilis and Paecilomyces lilacinus at 10⁶cfu and 10³cfu/g, respectively, could enhance soil temperature at 2cm depth by 3-8centigrade, and increase CO₂ concentration by 4-10 times. The microbial agents mixed into corn stalk could increase the height and diameter of tomato by 10cm and 1cm, respectively, after 20 days of transplanting. Yield was also increased by 112.4% for tomato and 35.5% for eggplant due to the enhancement of fruit number per plant and weight per fruit. In addition, rate of malformed tomato fruit was reduced by 55%. This technique may provide a way for the successful management of the infested soil in greenhouse vegetable fields, although there are still many questions to be clarified.

Association of Pseudomonas fluorescens with take-all suppressive soils in New Zealand

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Take-all, caused by Gaeumannomyces graminis var. tritici (Gt), is a damaging root disease of wheat. Successive monoculture of wheat induces take-all decline (TAD), which has been reported to be associated with increased soil populations of Pseudomonas fluorescens. A controlled environment experiment, simulating seven growth seasons, showed that P. fluorescens populations increased with successive planting of wheat in soils naturally infested with Gt. In wheat soils exhibiting different take-all suppression properties in pot experiments, P. fluorescens and other micro-organisms, identified using denaturing gradient gel electrophoresis, were shown to be present only in the suppressive soils. Another trial in commercial wheat fields assessed effects of different hosts grown before successive wheat sowings. Increased P. fluorescens populations occurred in Gt-inoculated plots after the third wheat sowing where the plots had been previously sown with ryecorn and wheat. These results together suggest the likely association of the bacterium with take-all suppressive soils. The importance of the other micro-organisms associated with take-all suppression in this study has yet to be confirmed.

Biocontrol of clubroot disease of cruciferous crops by Bacillus subtilis XF-1 in Yunnan Province, China

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Clubroot, caused by Plasmodiophora brassicae, is a severe disease of cruciferous crop worldwide. It is very difficult to control the disease because the pathogen can survive in the field for longer than 10 years even without cruciferous crops present. Chemicals show unstable control and may cause pollution of soil and underground water; also few resistance genes are available. Yunnan Province suffered from the disease with 20 million US dollars loss annually from this disease across crops including Chinese cabbage, cauliflower, kale and oilseed rape. Furthermore, the disease becomes severer year by year. To control the disease, we isolated Bacillus subtilis XF-1 from soil infected with the pathogen in 2005. The bioagent could control clubroot with 75-90% effect when applied at 3.2 x 10⁶CFU/ml by dipping twice, at seeding time and 7-10 days after germination or at
Once after transplanting healthy plants. XF-1 can degrade *P. brassicae* resting spore very well in 30 minutes through its extracellular chitinase and hinder the resting spore to germinate by surfactin, fengycin, and bacillomycin D. The bacterium prefers sucrose than glucose and forms very specific colonies when it is cultured in medium. Its genome has been sequenced and whole sequence will be released in 2011. Other molecular analyses have been or are being proceeded. The formulated products are being used in China at present.

### The management of Fusarium wilt of snake beans by grafting

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Snake beans (*Vigna unguiculata* s.sp. *sesquipedalis*) are severely affected by Fusarium wilt (*Fusarium oxysporum* f.sp. *tracheiphilum*) (Fot) in Darwin. *F. ox* f.sp. *tracheiphilum* is also responsible for severe losses to cowpeas overseas especially in California, USA. Fot is a soil-borne disease with no effective chemical control. Some farmers try to avoid the disease by moving from infected to new land but inevitably the disease is transferred by machinery or human traffic. 76 snake bean selections were sourced from overseas and within Australia and screened for resistance to Fot. Although no commercially acceptable snake bean was found with resistance to the disease, several cowpeas were found to have good resistance to Fot in Darwin. One cowpea variety called Iron, (PI 293520, AustRCF 306393) was chosen as a rootstock for grafting because combined with strong resistance to Fot, it is also resistant to root knot nematodes and has a vigorous root system. In the absence of a commercially acceptable resistant variety, grafting snake beans onto Iron cowpea rootstock was developed as a disease management option where the disease pressure was moderate to severe.

### Root disease suppression by *Trichoderma* Tr905 shifts the genetic structure of target pathogen populations, but not soil microbial community composition

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Disease suppressive efficacies of *Trichoderma* inoculant Tr905 against *Rhizoctonia solani* and *Pythium irregulare* root rots in barley (Butte, SA) and wheat (Young, NSW) were determined by quantifying soil-borne inoculum levels and root isolation frequencies. Incidences of *R. solani* and *P. irregulare* on barley roots at Butte were 25% and 40%, respectively with Tr905 significantly reducing root isolation of both pathogens comparable to or better than the chemical seed treatment. At Young incidence of *P. irregulare* (70%) was significantly greater than *R. solani* (6%) and only the chemical treatment significantly decreased *Pythium* incidence. AFLP analyses resolved significant inter- and intra- population differentiation among geographical and Tr905-treated populations of *R. solani* and *P. irregulare*. Tr905-treatment selected more diverse pathogen populations implying that greater rhizosphere competition among pathogen genotypes contributes to disease suppression. T-RFLP analyses resolved significant geographical and temporal differentiation of both fungal (5.8s rRNA ITS) and bacterial (16s rRNA) communities. Despite Tr905 significantly reducing *R. solani* and *P. irregulare* incidence (Butte, SA), there were no significant inoculant-induced differences in rhizosphere microbial community structure at either location.

### Seasonal dynamics of *Rhizoctonia solani* AG8 inoculum is influenced by crop rotation and environmental factors


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*Rhizoctonia solani* Kühn AG-8 causes seedling diseases in a wide range of cereal and legume crop plants. Recent estimates in Australia indicate that it causes significant losses in cereals, $59 million pa, mainly in low to medium rainfall regions across southern Australia. *R. solani* fungus is known to grow on decomposing soil organic matter and produces hyphal networks in the surface soil. We monitored changes in inoculum levels in surface soil during summer and in-crop as influenced by crop rotation and environmental factors in field experiments in South Australia and New South Wales. Results show that in the absence of host plants, summer rainfall events >50mm in a week reduced *Rhizoctonia* DNA levels, whereas it increased during prolonged dry periods. Inoculum changes in summer are also related to the amount of decomposing organic residues (i.e. particulate organic matter) in soil. Non-cereal crop rotations substantially reduced the pathogen inoculum compared to wheat and cereal rye. Inoculum levels were lowest after canola and mustard. An improved understanding of the factors influencing pathogen inoculum will assist to develop improved management options for *Rhizoctonia* disease control.
Beyond compliance: integrated systems approach for pest risk management in South-East Asia

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This paper describes a project to apply and test a new method for developing and managing pest risk management systems in trade. Conventionally, importing countries make trade contingent on a single measure such as a chemical post-harvest treatment. When such a measure is not available or desirable, a ‘systems approach’ (SA) may be feasible; defined as ‘a pest risk management system for trade based on the integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests’ (ISPM No. 5). Unfortunately, establishing an SA can be fraught by the difficulty of constructing a complex system and demonstrating its efficacy. Bayesian Networks (BNs) can facilitate this work, through modelling the system and permitting the use of estimates where ‘full’ data do not exist, to evaluate the system probabilistically. A BN can be used to evaluate the SA’s efficacy and robustness, and to identify the relative contributions, strengths and weaknesses of its components. Control Points (CPs) can be used to focus and simplify the construction of Bayesian Networks for SAs. The project involves applying a new CP-BN template to a set of example proposed trade SAs in Malaysia, The Philippines, Thailand, Indonesia and Vietnam. The project will progress establishment of these trade cases, build country and regional capacity, and inform international agricultural trade policy.

The role of native plants during a pathogen incursion: survival of the plant pathogen Xylella fastidiosa in Australian native plant species

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Vectored by insects, predominantly Homalodisca vitripennis Germar (Hemiptera: Cicadellidae), Xylella fastidiosa Wells is a xylem-limited plant pathogenic bacterium that causes diseases in numerous host species including food and feed crops, ornamentals and weeds. X. fastidiosa, not yet detected in Australia, is native to the Americas and is considered to be highly invasive. Australian climatic conditions are favourable for establishment and the wine and table grape industry is particularly concerned about the arrival of X. fastidiosa because of the economic impact on this important Australian commodity. Past X. fastidiosa invasions have demonstrated the need for rapid detection and containment of an incursion which requires knowledge of pathogen host plant species and their subsequent monitoring. In Riverside, California, Australian native plants were inoculated with the pathogen and assayed for the pathogen after ten months using culturing and PCR to determine host status, persistence of the pathogen over winter, population growth and systemic spread. The results, to be presented, indicate the host status of several Australian native plant species and whether they may act as reservoirs from which further spread of the pathogen can take place should it reach Australia. The implications of these findings will be discussed and placed in an Australian invasion context.

Biosecurity model for exotic and non-exotic plant parasitic nematodes

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With the increasing globalisation of trade there is increased risk of invasive species gaining entry to new localities. The majority of nematode species currently on the quarantine list are known to cause damage elsewhere are not present in Australia or have restricted distribution in Australia. There are also varied levels of threat posed by exotic and non-exotic nematode species or pathotypes. Internationally there is increasing biosecurity concern for selected nematode species which have pathotypes or races with a number of countries placing restrictions based on the nematode pathotypes or races. In this study, a review of the Australian plant parasitic nematode fauna was undertaken to determine exotic and non-exotic nematode species of biosecurity concern. Over 200 nematode species of quarantine significance were determined with 9.5% of nematode species currently present in Australia, compared to 18.5% present in USA, 10% in China, 8.5% in UK and 8% in New Zealand. In this presentation we discuss a biosecurity model for the estimation of risks from exotic and non-exotic nematode species or pathotypes. The model includes an initial assessment of nematode distribution (presence and absence) data using Self Organising Maps followed by a more detailed assessment of selected species based on interception data, trade data, pathways, biosecurity system, ecological and climate suitability, biological traits and detection and diagnostic capability. We also discuss current and emerging biosecurity threats to the Australian agriculture using examples of nematode species.
Microscopic and PCR detection of sugarcane smut spores captured by spore trapping

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Sugarcane smut, caused by *Ustilago scitaminea*, is a major disease of sugarcane. In 2006 the disease was found for the first time in Eastern Australia. Fifteen Burkd ‘spore and pollen samplers’ were purchased soon after the initial smut detection and a trapping program began in late 2006. The purpose of trapping was two-fold: to provide an early warning system, and to carry out epidemiological assessments.

Initial diagnosis of spore tapes was by light microscopy. This technique is time consuming and difficult, but has the advantage of being quantitative. Next, a standard PCR test for *U. scitaminea* was developed for use in the early warning program where only a plus or minus result was required. For two years, spore traps were run in smut-free areas, and in most cases spores were detected well before or close to when symptoms were observed in the field. A quantitative PCR test was developed for epidemiological work. Trapping was used to measure the distance of aerial spread from a known source and used for long term monitoring of spore numbers. By comparing the three techniques for sensitivity, speed, cost and reliability, it was found that the ‘best’ technique depended on the purpose of the trapping.

A proof of concept biosecurity microarray for identification of fungi and bacteria

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New molecular techniques are becoming available that offer potential as valuable tools for improving the ease and efficiency of screening imported plant material for unwanted organisms at the border. For example, microarray technology can be used to screen samples of up to 20,000 different microorganisms at the same time, and results can be obtained in 48 hours. Diagnostic microarrays for viruses and bacteria are available, but we investigated the feasibility of designing a microarray to detect both fungi and bacteria on the same chip. Specific oligonucleotides based on the rDNA intertranscribed spacer region (ITS) region for both bacteria and fungi have been designed and tested. Universal bacterial ITS primers were designed and tested for labelling with fluorescent dye before insertion of the targets into the hybridisation chambers. Specific oligonucleotides for the biosecurity risk fungi *Guignardia citricarpa* (citrus black spot), *Spaceloma perseae* (avocado scab), and for the biosecurity risk bacteria *Xylella fastidiosa* (Pierce’s disease of grapes), *Xanthomonas axonopodis pv. citri* (canker) and *Pseudomonas syringae pv. actinidiae* (kiwifruit canker) have been designed and tested. It is possible to incorporate both bacterial and fungal probes on the same microarray chip using this methodology, but two labelling reactions are required, one for fungi and one for bacteria.

Impact of climate change on food security and biosecurity in small Pacific nations

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The small island nations of the South Pacific face some immovable constraints to developing agricultural market driven economies, including their smallness (lack of economies of scale), geography (fragmentation and distance from major markets), and vulnerability to natural disasters. Concerns about food security in the region have been raised with increasing dependence on non-indigenous imported foods and vulnerability to increasing world food prices. In this study we are looking at the impacts of climate change on food security in the Pacific region through direct impacts on food production and the ability of countries to import food supplies. Climate-related disasters are predicted to increase and will place increased pressure on Pacific countries to maintain adequate agricultural systems for food production. These climatic events combined with possible changes in the movement of food products within the region will expose Pacific countries to new biosecurity threats. A survey and questionnaire directed at agricultural leaders and scientists of the participating countries, to identify the impacts of climate change on their agricultural systems, will be discussed. The aim is to develop networks and opportunities to assist regional scientists manage climate change impacts. This may involve development of research projects, education and training and the use of remote diagnostics.

Plant biosecurity—key risk analysis aspects and plant pathology

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Risk analysis plays a significant part in Australia’s biosecurity protection. It assists the Australian Government in considering the level of quarantine risks that may be associated with the importation or proposed importation of animals, plants or other goods into Australia. If the risks are found to exceed the level that is acceptable to Australia, risk management measures are proposed. If the quarantine risks cannot be reduced to an acceptable level, trade will not be allowed.

In conducting plant risk analysis, Plant Biosecurity identifies the pests and diseases of quarantine concern that may be carried by the plant product. The identified pest or disease is then assessed for the likelihood to enter, establish or spread and the probable extent of the harm that may result. Broadly, risk analyses is a study to predict future occurrences of disease by using a non-experimental
approach that involves determining the potential abilities of pests and diseases to establish, damage and impact. This information underpins quarantine policy to mitigate the risk associated with imported commodities to protect the Australian people, environment and industry.

Here we discuss the key components of risk analysis employed by Plant Biosecurity to measure and mitigate plant pest and diseases risks and some of the constraints on risk analysis.
Evaluation of non-conventional products for management of cucurbit powdery mildew in protected cropping

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Powdery mildew (Podosphaera xanthii) is a serious disease of cucumbers worldwide causing defoliation and premature senescence; primarily management is with fungicides. Management is becoming increasingly difficult due to fungicide resistance and because few products are registered for use in protected cropping. Two trials in cucumbers in commercial greenhouses evaluated non-conventional products for management of powdery mildew. Severity of powdery mildew on the leaves was rated before the first spray, each subsequent spray and up to four weeks after the last spray. In the first trial sprays of Path XT (a disinfectant), SilmatrixXTM (a silicon product), XPRESS®+SETT EnhancedXTM (a nutritional product) or Ecocarb®+Syntrol® Horti Oil (a potassium bicarbonate product) were applied three times at fortnightly intervals. Path XT was the most effective product with minimal powdery mildew developing after three sprays compared to 20% mean infection in the unsprayed control. The program with XPRESS®+SETT EnhancedXTM was not significantly different from the unsprayed control. In the second trial treatments with alternative products were compared to spray programs that included Amistar®. Again Path XT was the most effective product, and programs of SilmatrixXTM or Ecocarb®+Syntrol® Horti Oil alone had significantly less powdery mildew than the unsprayed control. Treatments that included early sprays of Amistar® alone or that alternated with alternative products were not significantly different from the control.

Cucumber Corynespora leaf spot disease can be controlled by fosetyl-Al but not by a resistance inducer acibenzolar-S-methyl

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Corynespora leaf spot caused by Corynespora cassicola is a major disease of cucumber. Control of this disease is difficult as pathogen isolates resistant to benomyl and strobilurin fungicides are widely distributed in their populations. Boscald-resistant isolates also caused a failure of disease control. Efficacy of disease resistance inducers was tested using potted cucumber plants in a greenhouse. Acibenzolar-S-methyl, well-known to be effective against cucumber powdery and downy mildew diseases, did not exhibit any control efficacies against Corynespora leaf spot. In contrast, fosetyl-Al was highly effective against this disease when sprayed protectively. Interestingly, however, neither fosetyl-Al nor phosphorus acid inhibited conidial germination or mycelial growth strongly in vitro so far tested.

Evaluation of research and development on grapevine mildew management in Australia

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The impact of a research and development (R&D) program in 1988-2008 on integrated powdery and downy mildew management in Australian vineyards was evaluated. Key outputs from 15 projects in the program included the formulation of disease monitoring procedures and improved disease control strategies. Typical spray regimes used by grape growers before and after the program, the level of adoption of revised strategies, associated crop losses and costs in seasons with low, average and high disease severity and in different climatic zones were identified. After the R&D, wider adoption of preventative regimes which included early season sprays that aligned with stages of vine growth substantially improved powdery mildew control but often increased control costs, a reflection of the industry’s low crop tolerance of powdery mildew. Adoption of control regimes for downy and powdery mildew using eradicant and/or preventative sprays based on weather and/or vineyard assessments of disease potential or incidence improved disease control and reduced control costs. The R&D program involved a total industry and R&D agency investment of $4.8 million (present value terms). Benefits for Australia from the investment included an estimated economic pay-off of $74.5 million (net present value), a return of $16.50 for each dollar invested, and the potential environmental benefits associated with reduced chemical use.

Integrated management of powdery and downy mildews in zucchini

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Powdery mildew (Podosphaera xanthii) and downy mildew (Pseudoperonospora cubensis) limit the productivity of cucumber crops in the Dry Tropics of north Queensland. During the March-to-November cropping season, sequential and overlapping plantings, proximity between crops at different growth stages, abandonment of infected crops, and the overuse of systemic fungicides has favoured the proliferation of fungicide-resistant pathogen strains. The aim of this study was to improve disease control by planting cultivars with resistance in combination with fungicide alternatives and minimal use of systemic fungicide sprays. Four spray programs and a non-spray control were evaluated in eight-week-long zucchini crops of two moderately resistant cultivars, Paydirt and Nitro, and two susceptible cultivars, Houdini and Calida. Weekly-spray programs included Agri-fos 600® (AF), Bion® (BN), and Tricop® (TP), as fungicide alternatives and the conventional fungicides Acrobat MZ® (AMZ), Amistar® (AR), Mancozeb® (MZ), Nimrod® (ND), and Bravo® (BV), Micronised sulphur (Microthiol Dispers®, MD) was included in every spray program. The evaluation programs were: a) BN-BN-BN-TP-
MD-TP-MD-TP; b) AF-AF-AF-TP-MD-TP-MD-TP; c) AF-AF-AMZ-TP-MD-TP-MD-TP; d) AMZ-AR-MZ-ND-BV-BD-MD-BV-BD; and e) no sprays. When cultivars with moderate resistance were integrated in programs a, b, and c, disease intensity levels were lower or equal to that in plants sprayed only with conventional fungicides (d). These results demonstrate that fungicide alternatives and genetic resistance can be integrated into management programs that reduce dependence on systemic fungicides.

Benchmarking the Brassica<sub>spot</sub> disease predictive models against weekly sprays and fungicide alternatives

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White blister, caused by Albugo candida, has been a constant problem on broccoli since its emergence in 2001. The efficacy and economics of three versions of the Brassica<sub>spot</sub> disease predictive model, weekly sprays, a biocontrol agent (Streptomyces lyticus) and a detergent were evaluated for control of white blister on heads of broccoli variety ‘Grevillea’ in a trial planted in winter 2008 in Victoria. At harvest, heads with the ‘Weekly’ treatment (15 copper-based fungicide sprays) had the lowest disease incidence (3%). Economic analyses ranked the ‘Weekly’ program as the most economical treatment, followed by Brassica<sub>spot</sub>™ (2 fungicide sprays), S. lyticus (9 sprays), the two modified versions of Brassica<sub>spot</sub>™ (1 or 3 fungicide sprays), Control (0 sprays) and the detergent (6 sprays). In a subsequent trial, the white blister tolerant variety ‘Viper’ was subjected to the Brassica<sub>spot</sub>™, Weekly or Control spray regimes. Heads of all treatments, which were asymptomatic at harvest, developed white blister after post harvest cold storage. The infection-based Brassica<sub>spot</sub>™ model needs to be enhanced with an in-field test kit to detect sporulation and a post harvest disease evaluation module.

Benchmarking the BREMCAST™ disease predictive model for control of downy mildew in lettuce

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Downy mildew caused by Bremia latucae is a major disease of lettuce crops in southern Australia. The efficacy and economics of timing spray applications based on the DOWNCAST™ and BREMCAST™ disease predictive models were evaluated against Grower spray regimes and unsprayed Control plants in trials on Cos lettuce variety ‘Amadusa’ and Iceberg lettuce variety ‘Marksman’ during spring 2009 and 2010, respectively, in two Victorian cropping regions. Grower regimes were a combination of systemic and preventative fungicide sprays. In the Cos trial both model based and Grower regimes were equally effective and significantly reduced disease incidence by up to 77%, when compared with the unsprayed Control. Both BREMCAST™ and DOWNCAST™ assigned 5 sprays and the Grower regime, 6 sprays. In the Iceberg trial BREMCAST™ modelling and the Grower treatments each received 3 sprays and DOWNCAST™ modelling 5 sprays, but only BREMCAST™ significantly reduced disease incidence on whole plants and heads by 16% and 68%, respectively, and a disease index on wrap leaves by 59%, compared with the Control. BREMCAST™ was the most economical treatment to control downy mildew on lettuce.
Detection and control of leaf blotch and stem end rot of strawberry caused by *Gnomoniopsis fructicola*

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*Gnomoniopsis fructicola* (syn. *Gnomonia comari*) is an endophyte that under conducive conditions can cause foliar (leaf blotch) and fruit (stem end rot) diseases of strawberry and yield losses of 17% in the Australian fruit industry. Disease certification and runner (strawberry transplants) multiplication schemes in Australia aim to minimise the risk of transmitting pathogen(s), such as *G. fructicola*, from strawberry nurseries to the fruit industry. This paper compares the incidence of *G. fructicola* in different runner generations of the multiplication scheme following severe stem end rot epidemics in the fruit industry in the 1990s and 2000s. In the 1990s, *G. fructicola* was detected at intermediate levels (60%) in all stages of the multiplication scheme. Field trials investigating 13 fungicides showed that prochloraz was most effective in reducing the severity of leaf blotch in runner crops (90%). By the 2000s, the incidence of *G. fructicola* has fallen to low levels (0–10%) in the multiplication scheme, particularly in generations where strict hygiene and prochloraz regimes are followed. Current research is focusing on treatments to supplement the use of prochloraz in the runner industry, and identifying environmental factors that trigger the transition of *G. fructicola* from an endophyte to a pathogen.

**Disease cycle of Alternaria in apples**

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Alternaria leaf blotch and fruit spot of apple are caused by *Alternaria* spp. and annually cause losses to the apple industry in Queensland and New South Wales. Control measures are inadequate, mainly due to a poor understanding of the etiology of the diseases. There is little information on the epidemiology and the identity of the pathogen(s) is still unknown in Australia. The aims of this study are to determine the identity, diversity and distribution of the pathogen(s) and determine essential features of the disease cycle such as sources of inoculum, overwintering, seasonal dynamics, timing of infection and infection process of *Alternaria* spp. in the Australian apple orchards. In order to investigate seasonal dynamics and timing of infection of *Alternaria* inoculum in the orchard, leaf residue, leaves from the canopy, buds and twigs were routinely collected from three trees in three orchards of a susceptible variety in Queensland. *Alternaria* spp. conidia were observed mainly in leaf residue and occasionally on twigs. These results indicate that these plant parts are putative sources of inoculum in orchards. Amount of conidia observed vary with seasons and significantly decreased in the winter rest periods. Increase in conidia concentrations may be related to periods of warm temperatures and high humidity. Studies on the timing of infection and infection process are under way.

**Impact of water and temperature stress on Eutypa dieback in grapevines**

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Eutypa dieback is caused by the fungus *Eutypa lata* which invades wood tissue causing dieback, stunted shoots, and the gradual death of grapevines. Seasonal variation of foliar symptoms is thought to be due to environmental conditions. The effect of temperature and water stress on symptom expression in inoculated vines was evaluated. Potted grapevines were grown in controlled environment rooms at 14, 22 and 30°C for 7 months. Within each room, soil was maintained at low, medium and high water content. Foliar symptoms tended to be most severe on inoculated vines subjected to the upper and lower extremes of both soil water content and temperature. The most severe symptoms developed on vines grown at 30°C with high soil water content. Conversely, growth of *E. lata* from the inoculation site, assessed by isolation, appeared to be less for vines kept in extreme conditions, suggesting fungal growth may be impeded under stressful conditions. The effect of deficit irrigation on wound infection by *E. lata* was investigated in field experiments in the Barossa Valley and Riverland wine regions of South Australia. Control vines were irrigated according to annual allocation whereas deficit-irrigated vines received 0–60% of the volume applied to controls. The frequency of recovery of *E. lata* from wounds increased from 74 to 95% in vines under severe water deficit in the Riverland, yet it remained unchanged in the Barossa Valley. As the Riverland is drier and warmer than the Barossa Valley, these results suggest that vines under severe stress are more susceptible to infection by *E. lata*.

**Global distribution of Fusarium head blight of wheat in relation to climate**

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Head blight of wheat caused by *Fusarium graminearum* has emerged as a major problem in many grain growing regions. Occurrence of epidemics is linked to weather, especially warm, humid conditions at anthesis. This study aims to link the distribution of head blight to climatic conditions considered conducive to the disease. Georeferenced records of authentic *F. graminearum* were obtained from Europe, North and South America, Asia and Australasia. DIVA-GIS was used to map the locations and to perform climatic analyses. The BIOCLIM and DOMAIN prediction systems within DIVA gave climate envelopes with close fits to known distributions using a combination of the
parameters annual mean temperature, maximum temperature of the warmest month, mean temperature of the wettest quarter, mean temperature of the warmest quarter, and precipitation of the warmest quarter. These parameters would be expected to be correlated with weather conditions in late spring and early summer when wheat is most susceptible to infection. Predicted distributions included parts of southern and eastern Africa where head blight is known to occur but which had not been included in the data set because of uncertainty about the lineage identity of isolates from these areas. Future work will use the GIS to test published models for head blight occurrence based on temperature, rainfall and relative humidity in the months when anthesis usually occurs in different grain growing regions.

Investigating the impact of elevated CO₂ on wheat, cereal yellow dwarf virus and its aphid vector

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The Intergovernmental Panel on Climate Change released their fourth assessment report in 2007 which concluded global warming is occurring and both CO₂ and temperature are expected to increase. In order to study the effects of elevated CO₂ on wheat production, the Department of Primary Industries Victoria, the University of Melbourne and the Department of Climate Change have established a Free-Air CO₂ Enrichment (FACE) research facility at Horsham, Australia. This facility is being used to study the effects of projected CO₂ concentrations (550ppm) under field conditions on wheat, the Cereal yellow dwarf virus (CYDV) RPV isolate, as well as the population dynamics of its aphid vector Rhopalosiphum padi (Homoptera, Aphididae). Results from studies on wheat plants conducted at the FACE facility show changes in C:N ratio, increase in plant height, biomass, number of tillers, and surface area in response to elevated CO₂ with root biomass and root length unaffected. However, variable field conditions have proved difficult for studying the impact of elevated CO₂ on CYDV and its vector, therefore in addition to the FACE facilities, controlled environment growth chambers are being used to study the physiology and feeding behaviour of R. padi and its ability to acquire and transmit CYDV under various climatic conditions and CO₂ concentrations. Preliminary experiment data from the FACE facility and growth chambers will be described and results presented. Potential ecological and epidemiological consequences will be discussed.
Selection of potato somaclones with possible broad spectrum resistance to tuber-invading diseases

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Soil-borne disease causes significant losses to potato production in Australia and around the world. We used cell selection techniques with a pathogen-derived toxin as a positive selection agent to obtain potato somaclones with enhanced resistance to common scab disease. In subsequent evaluation we discovered several of these clones showed resistance to a second significant tuber-invading disease, powdery scab. Multiple field and glasshouse testing of elite clones revealed that several have significant (P<0.05) multiple resistance to powdery scab compared to the standard commercial parent control line. Histological studies of tubers, showed increased suberisation of the periderm within lenticels during early tuber development following exposure to the pathogen in the resistant somaclones, compared to parent controls. Young lenticels are the primary entry point for infection for both common and powdery scab pathogens. As lenticels mature they become more resistant to infection. Lenticel maturation is associated with suberisation, thus we postulate that our disease resistant somaclones through showing enhanced suberisation posses enhanced resistance to a broad range of lenticel invading pathogens of potato.

Managing soil organic matter and Fusarium wilt—are the two processes compatible?

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Fusarium wilt is a serious disease of many crops throughout the world caused by the fungal pathogen Fusarium oxysporum. Increasing or maintaining soil organic matter is a strategy important for sustainable agriculture as it improves soil structure, fertiliser use, water efficiency, and the management of plant pathogenic nematodes. However, the addition of soil organic material provides an additional source of carbon for pathogenic Fusarium oxysporum, which can result in increased disease levels. We have been evaluating the effect that different composts have on Fusarium wilt of banana in glasshouse pot experiments, as well as the effect that these composts have on soil properties. Different sources of organic matter were used including unmatured compost, raw bagasse and fresh cut millet grass. Initial experiments have indicated that the addition of these compost increases the severity of Fusarium wilt of banana. Following the addition of composts there were significant plant-growth promotion effects, and a significant improvement of the soil biological properties. Further experiments are under way to determine if additional nutrient supplements such as silicon and calcium, in combination with compost, can ameliorate the enhanced disease severity as the benefits to sustainable banana production from the improved soil organic carbon are worth pursuing.

Understanding the role of seed-borne inoculum in the development of Verticillium wilt of potatoes in Australia

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Verticillium wilt (VW) is a major disease of potato and has been implicated in potato early decline disease throughout the world. Several species of Verticillium including V. dahliae and V. albo-atrum have been shown to cause the disease however, V. dahliae has been the major pathogen detected in infected plants in Australia. Verticillium spp. persists for years in soil as microsclerotia and can be carried in the vascular tissue of potato tubers used for seed. In Australia, the extent and significance of seed tubers infected with Verticillium spp. is not known. The incidence of Verticillium spp. infecting seed tubers collected from a range of potato growing areas of Australia was extremely variable (0-55%). Stem-end vascular discoloration did not correlate with presence of the pathogen indicating that symptoms alone were a poor indicator of infected tubers. Verticillium dahliae was the dominate species isolated from tubers. The virulence of these isolates is being studied in glasshouse trials. Importantly, research will focus on understanding the significance of seed-borne inoculum of V. dahliae on Australian potato production. An adequate knowledge about the biology and distribution of the pathogen will ultimately lead to better management of the disease.

Molecular characterisation of a Phytophthora ‘hybrid swarm’ in native ecosystems and waterways in Western Australia

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During surveys of dying vegetation in natural ecosystems and associated waterways in Western Australia many new taxa have been identified and subsequently described. Additionally from within Phytophthora ITS Clade 6, a huge array of natural hybrids all containing numerous single base pair polymorphisms have been isolated. In phylogenetic analyses, the hybrids cluster most closely with the newly described sterile species P. thermophilia prov. nom. and P. litoralis prov. nom. For representative hybrid isolates, the region spanning the internal transcribed spacer region of the ribosomal DNA (ITS), the heat shock protein 90 and the mitochondrial coxl gene were amplified, cloned and
sequenced. The hybrids are not the result of a simple hybridisation event between two parent species, rather there is evidence of a hybrids swarm with hybridisation not only between parent species, but also between hybrids. Results from the molecular analysis of these hybrids will be presented.

**Spongospora subterranea root infection reduces potato plant growth and tuber yields**

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*Spongospora subterranea* causes powdery scab of potato tubers, an important quality-limiting disease in fresh, processing and seed potato production. Potato cultivars vary in reaction to tuber powdery scab, from very resistant to very susceptible. The pathogen also infects potato stolons and roots, producing zoosporangia, and later, galls containing sporosori, which are the perennation life cycle stage. Results from a series of glasshouse and field experiments have demonstrated that root infection disrupts root function (water and nutrient uptake), reducing plant growth and tuber yields. Further glasshouse experiments with cultivars expressing reactions to tuber powdery scab of very resistant (three cultivars), moderately resistant (three cultivars) or very susceptible (two cultivars) have shown that inoculation with *S. subterranea* disrupted root function and reduced plant growth similarly in all eight cultivars tested. This indicates that the pathogen is likely to reduce tuber yields even in cultivars which do not develop tuber powdery scab. Furthermore, root infection is likely to result in build-up of sporosorus inoculum in soils where cultivars resistant to tuber infection are grown. Root infection by *S. subterranea* is thus likely to be more important than previously recognised for production of high-yielding potato crops.

**The effect of plant disease in a natural system on soil biology**

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Soil bacteria and fungi degrade organic material releasing minerals into the soil. The process contributes to soil stability, plant growth and ecosystem function. Little is known about the effect of pathogens on soil biology. Dieback in Australian natural ecosystems associated with the soil-borne Oomycete *Phytophthora cinnamomi* presents a major threat to vegetation communities because of the death of susceptible plants. Alternatively, death of susceptible plants deprives *P. cinnamomi* of living hosts and increases competition from other soil microbes, potentially facilitating ecosystem maintenance or recovery. To investigate the effect of a soil-borne disease on soil microbial activity, transects were established across the dieback disease margin in a natural vegetation community in Barrington Tops National Park, NSW. Soil biological activity (fluorescein diacetate assay) and fungal biomass (ergosterol) were highest close to the infested side of the disease margin, corresponding with the massive organic matter inputs to the soil resulting from the death of susceptible plants. Microbial diversity (t-RFLP) is currently being assessed. Understanding the effect of disturbances, such as disease, on plant communities, will improve our understanding of ecosystem structure, function and sustainability.
Quantification and differentiation of *Meloidogyne javanica*, *M. incognita* and *M. arenaria* in soil and roots using real-time PCR

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There is a need for rapid and accurate methods to identify and quantify individual Meloidogyne species in soil and roots that will assist researchers and growers in managing soils. This study describes the development of TaqMan® MGB assays to quantify *Meloidogyne javanica*, *M. incognita* and *M. arenaria*. The tests were designed using sequences of PCR products amplified using sequence-characterised amplified region primers. The specificity of the provisional tests has been tested against a DNA collection of Meloidogyne species. The results indicate that *M. javanica* and *M. incognita* tests are specific. These tests have been evaluated for their ability to specifically quantify each species using 15 soil samples from across cereal cropping regions in Australia. Each soil was divided into paired samples of 100 g and 6600 eggs were added to one of the paired samples. The extracted DNA was tested using the two species specific assays and an ITS-based assay which detects all three species. The results indicate that *M. javanica* assay is specific but is about seven PCR cycles less sensitive than the general Meloidogyne assay and has a detection limit of 1-4 eggs/g of soil. Validation experiments are under way for *M. arenaria* and *M. incognita*.

Evaluation of novel platforms to differentiate pathovars of plant pathogenic bacteria

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Many of the biggest threats to the biosecurity of Australia’s plant industries are bacterial, but difficulties in identification to pathovar level could seriously delay incursion management and affect market access. Pathovars are defined by host specificity so bioassays remain the definitive means of identification, but require physical containment and can be slow and subjective. Some pathovar-specific serological and molecular tests are available but better diagnostic methods are often required.

We have evaluated the use of proteomics and metabolomics, platforms that identify functional molecules potentially associated with plant-pathogen interactions, to identify biomarkers that differentiate pathovars in *Xanthomonas* species.

The proteomics component has focused on profiling membrane-associated proteins extracted from selected bacterial isolates. Profiles show isolates of the same pathovar cluster together and proteins are differentially expressed between distinct pathovars. Differentially expressed proteins have been analysed by digestions and mass spectrometry and the genes that encode them identified by reference to genomic sequences. Based on this information, molecular tests to differentiate the pathovars are being designed and validated.

The metabolomics component has analysed metabolite expression in selected bacterial pathovars. Results show separation between the different pathovars and differentially expressed metabolites are evident.

New approaches for diagnosing bacterial pathovars

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The diagnosis of exotic phytopathogenic bacteria associated with incursions into Australia and the USA in the past decade has been compromised by an inability to reliably differentiate between bacterial pathovars and closely related species. Industry biosecurity plans have identified 56 plant pathogenic bacteria as a threat to the Australian agricultural and horticultural industries and 11 of these exotic plant pests are considered high risk to Australia.

The development of robust diagnostic markers for the detection and differentiation of plant pathogenic bacterial species and pathovars using a genomics approach offers the capability to develop rapid pathogen-specific molecular tools that enhance detection while minimising errors. These tools are designed to be specific and sensitive to minimise false positives that unnecessarily interrupt trade and false negatives that allow pathogens to go undetected. Diagnostic markers can be designed to detect genes from the core genome that will detect all strains and pathovars of a specific bacterial species, or to detect genes from the flexible genome of a bacterial species that can differentiate between strains at the sub-species level.

Fast, robust and low cost molecular-based diagnostic tools for detecting exotic plant pests are the foundation for secure border protection, a more rapid response to incursions and larger scale active surveillance programs. Current research activities in bacterial genomics will be presented together with a discussion on plant bacterial pathogens that will be targeted for diagnostic development using this approach.
Artificial microRNA based technology for resistance to viruses

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Thrips-transmitted tospoviruses affect a wide range of commercial crops with global annual losses exceeding US $1 billion. Besides direct loss to yield and quality, other significant expenses include cost of chemicals to control thrips vectors. Virus control strategies are complicated by the complex epidemiological association of virus, host plants and thrips vectors and breakdown of resistance in crop varieties. Tomato spotted wilt virus (TSWV), the type member of the Tospovirus genus has a wide host range of more than 900 plant species.

We are developing artificial microRNAs (amiRNAs) for introducing host delivered resistance to TSWV. We have engineered artificial microRNAs constructs targeting TSWV mRNA sequences encoding the nucleocapsid protein (N) and the silencing suppressor (NSs) genes in the backbone of Arabidopsis thaliana mir159a. Expression of virus-specific amiRNA and the ability of the amiRNA constructs to confer resistance to TSWV has been confirmed using transient expression of amiRNAs in Nicotiana benthamiana. We are currently investigating the efficiency of these constructs to impart virus resistance in a stable transgenic system with Arabidopsis and tomato. The amiRNA-based resistance offers an effective approach to prevent breakdown of resistance in the field by targeting conserved regions or multiple viruses.

Identification of the scar markers for detection of biocontrol Bacillus sp. BH1 and B006 in soil

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Two Bacillus strains, BH1 and B006, are highly suppressive against Fusarium spp., the causal agent of plant root diseases. Discrimination of these strains from native soil bacteria was critical to study their population dynamics and behaviours in soil. Polymorphism in genomic DNA of the strains BH1 and B006 as well as 25 references including Bacillus spp., Sphingosine spp. and Pseudomonas spp. were analysed with 16 random primers by RAPD. Sequence-specific fragments with 658-bp and 730-bp could be obtained from strains BH1 and B006 by PCR with single specific primers C01 and B19, respectively, which were absent in other strains. In order to increase the amplification specificity and stability, 12 and 6 SCAR marker primer pairs were designed on the base of the nucleotide sequence information of RAPDs closely linked to the strains BH1 and B006, respectively, and their specificity were confirmed by amplification of specific DNA bands of the strains BH1 and B006. Two primer sets SCAR-BH1 and SCAR-
Evaluation of alternatives to fungicides for white blister rust control on Brassica vegetables

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White blister rust of Brassicaceae, caused by Albugo candida, affects many economically important crops including Brassica oleracea and B. rapa vegetables around the world. The disease is controlled by using resistant varieties and conventional fungicides such as TriBase-Blue® and Amistar®. Alternative regimes were evaluated for white blister rust control on broccoli crops in two field trials and on broccoli, Chinese cabbage and pak choi seedlings in two glasshouse trials in Victoria, Australia. The alternative treatments included surfactants, Du-Wett® and sodium lauryl sulphate (SLS); polymers, Nu-Film® and VaporGard®; the plant resistance activator Bion® WG and biocontrol agents, Bacillus subtilis and Streptomyces lydicus. None of the alternatives was as effective as the conventional fungicides, either on their own or in combination. On the B. rapa seedlings, only Bion® WG was effective although phytotoxic. On broccoli seedlings, VaporGard® and Bion® WG and B. subtilis significantly reduced white blister by 33%, 54% and 70%, respectively, when compared with the unsprayed control. In one field trial, SLS and S. lydicus significantly reduced white blister rust on broccoli heads. None of the alternatives tested was effective on foliage in the field trials. Effective alternatives provide valuable options for control of white blister rust on seedlings and broccoli heads.

Efficacy of fungicide alternatives in managing powdery and downy mildews on cucurbits

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Management of foliar diseases of cucurbits depends largely on the use of fungicide sprays. This could be costly and unsustainable when resistance from the target pathogens develops from excessive use. Reducing the number of seasonal systemic sprays to a minimum should delay the development of resistance from the different fungal strains and thereby prolong the effective life of the fungicides. This can be done with fungicide alternatives. The efficacies of 14 fungicide alternatives, sprayed weekly on a field-grown zucchini and cucumber cultivar were evaluated for the control of powdery mildew (Podosphaera xanthii), downy mildew (Pseudoperonospora cubensis) and anthracnose (Colletotrichum orbiculare) in four field trials in northern Queensland. Control plots were either not sprayed, sprayed with water, or sprayed with conventional fungicides with systemic and contact actions. Tested products included: micronised sulfur (Microthiol Dispers®); copper octanoate (Tricop®); potassium bicarbonate (Ecocarb®); phosphorus acid (Agri-Fos 600®); hydrogen dioxide (Peracol®); soluble silicon (Enhance KCS® and Stand SKH®); neem oil (Triology®); canola oil (Synterol Horti oil®); tea tree oil (Timorex Gold®); acibenzolar-s-methyl (Bion®); chitosan (Aminogro®); milk, and propylene glycol alginate (Cal Agri 5ONF®). Downy and powdery mildews were the main diseases on both crops and anthracnose was also present on cucumbers. Tricop, Microthiol, Bion and Agri-Fos 600 provided acceptable downy mildew control; however Microthiol and Bion caused phytotoxicity in cucumbers. Tricop, Microthiol, Stand SHK, milk, Timorex, Synertrol Horti Oil, Agri-Fos 600, Ecocarb and Aminogro provided acceptable control of powdery mildew. Although some of these alternative products used alone in a weekly spray program were not as effective as conventional fungicides for suppressing the target foliar diseases, they provided a degree of control that should make them good components in an integrated disease management program that includes a reduced number of systemic fungicide applications.

Novel control of lettuce downy mildew (Bremia lactucae) and Anthracnose (Microdochium panattonianum)

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Downy mildew (Bremia lactucae) and Anthracnose (Microdochium panattonianum) are two major diseases of lettuce worldwide. Although downy mildew control is achieved by the use of resistant lettuce varieties, frequent application of fungicides is widely used to control both diseases in field and hydroponic production systems. Greenhouse and field trials were undertaken to assess the use of alternative products to control anthracnose and downy mildew to reduce reliance on chemical fungicides. A selection of 38 products including six combinations were assessed for efficacy of disease control in the greenhouse including existing registered products, new products, natural growth enhancing products, biological formulations and isolates of Trichoderma and Streptomyces species. Standard controls included fungicides commonly used to control disease on lettuce and water. Seedlings were inoculated with B. lactucae or M. panattonianum isolated from infected lettuce and grown at 14°C under a 12 hr light/dark cycle. Products were applied either 3 days pre-inoculation or 3 days post-inoculation at the recommended rates. Disease control was variable, but in general products applied pre-inoculation were most effective. The most effective products incorporating active ingredients, amino acid, phosphorous acid, potassium bicarbonate, calcium, Streptomyces and Trichoderma were chosen for field trials. A randomised block design was established in a commercial lettuce crop. Nine treatments were applied at intervals of 7-14 days depending on weather conditions and plants were assessed prior to harvest for incidence and severity of disease. With ongoing trial work, products are showing promise as alternatives to the use of fungicides for control of downy mildew and anthracnose.
Control of powdery mildew in viticulture using milk and milk components

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Grapevine powdery mildew, caused by Erysiphe necator (syn. Uncinula necator), is the most economically important fungal disease of grapevine in Australia. Disease control is predominantly based on the use of sulfur and synthetic fungicides. However, toxicity of sulfur to agricultural workers and beneficial vineyard organisms, and the development of fungicide-resistance, are considerable incentives for investigating alternatives. Previous research has demonstrated the potential of bovine milk to reduce powdery mildew severity in a commercial vineyard; the current research aims to identify the components of milk responsible for antifungal activity, and to determine their mode of action. Experiments were undertaken to assess milk and milk components for efficacy in controlling powdery mildew on detached leaves in vitro. In particular, two milk fatty acids and a dairy waste stream exhibited curative activity in vitro. Materials shown to reduce disease severity were further evaluated in greenhouse and small plot vineyard trials to assess efficacy in a commercial environment. Ultimately, the objective of this work is to contribute to development of environmentally sustainable strategies for the management of powdery mildew.

Evaluation of Australian essential oils on the growth of the postharvest pathogen Monilia fructicola

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Brown rot caused by Monilia fructicola is a major postharvest disease of stone fruit, leading to significant losses during marketing. Control of the pathogen is normally achieved through the use of conventional registered fungicides. Despite the relatively low toxicity of these chemicals a range of ‘greener’ alternatives are sought for controlling this disease.

Some essential oils exhibit antifungal properties against postharvest pathogens, which provides the opportunity to develop new safe postharvest treatments for fresh horticultural produce. The aim of this research was to evaluate the antifungal activity of Australian essential oils extracted from lemon myrtle (Backhousia citriodora), anise myrtle (Anetholea anisata) and tea tree (Melaleuca alternifolia) and two standards, citral and trans-anethole against the postharvest pathogen Monilia fructicola. In vitro trials have shown that Monilia fructicola exhibited a different level of sensitivity to each essential oil/standard, but was highly susceptible to lemon myrtle oil and the citral standard at very low concentrations. The lemon myrtle and citral treatments were evaluated further in in-vivo trials for their antifungal activity via fumigation using inoculated nectarines. These trials confirmed that the oil and the standard exhibited antifungal activity, with the level of activity dependent upon the concentration. Lemon myrtle essential oil and citral show significant promise as biocontrol options for the control of brown rot of stonefruit.

Role of constitutive and induced defences in the resistance of unripe mangoes to Colletotrichum gloeosporioides

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Anthracnose in ripe mangoes originates from the quiescent Colletotrichum gloeosporioides infections in the immature fruit. Unripe fruit contains three classes of constitutive antifungal substances, gallotannins in the peel, chinatines in the latex and resorcinols in both. Gallotannins, 5-(12-cis-heptadecenyl) resorcinol and 5-pentadecyl resorcinol are present at fungitoxic levels in the unripe fruit and decline during ripening together with the latex. Mango peel tissues responded to C. gloeosporioides by activating ROS (O2· and H2O2) in the challenged cells, within 9 to 24 h. Conidia had germinated and produced melanised appressoria within 9-12 h. Cells challenged by C. gloeosporioides turned brown within 12h and displayed autofluorescence. There was no phytoalexin accumulation, however, enhanced chitinase, PAL and peroxidase activity and cell wall bound phenols were observed in the inoculated tissues compared to controls. There was differential gene activation within 24 h. In the cultivar ‘Karutha Colombo’ resistant to C. gloeosporioides, six cDNA’s were differentially expressed as opposed to one cDNA in the susceptible ‘Willard’. The study revealed that both constitutive and inducible defences play a role in the resistance of unripe mango to C. gloeosporioides. A part of the latex could be retained by harvesting fruit with 1 inch stalk intact and such fruits developed lesser anthracnose disease. Salicylic acid and Bion® applied as postharvest sprays enhanced fruit resistance lowering anthracnose development.

Preliminary studies on the biology, culturing and field release of Puccinia speazzinii de toni.: a classical biocontrol agent for Mikania micrantha Kunth (mile-a-minute) in Papua New Guinea

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Laboratory and field studies were conducted on the neotropical rust fungus, Puccinia speazzinii, de Tonii, a classical biocontrol agent of the invasive weed, Mikania micrantha Kunth to gain knowledge on its life cycle and to develop efficient mass rearing and field release techniques.
Studies were also conducted to determine its potential impact on the weed. *P. spegazzinii* is a microcyclic and autoecious rust, with a life cycle of 18-22 days. Eight mass rearing techniques were evaluated to determine the most efficient inoculation technique. The highest levels of infection were obtained when 3-4 week old plants grown in polycups were placed under infected plants in an inoculation chamber for 48 hours at 26±1°C. Comparative growth trials found that the rust significantly reduces the growth rate of *M. micrantha* and suppresses the growth of secondary stems. Transplanting infected potted plants amongst *M. micrantha*, such that the infected plants trailed over the young growth stages compared to mature plants was the most successful release technique. The rust has been released in all 15 lowland provinces where *M. micrantha* is present and pustules have been observed in four provinces to date. In East New Britain Province, establishment was greater in wetter areas and the rust has spread about 7 km in about 12 months. Detailed field monitoring found that the rust is beginning to suppress *M. micrantha* infestations. These studies suggest that *P. spegazzinii* has the potential to control *M. micrantha* in PNG.
Fusarium sacchari, the cause of pokkah boeng in sugarcane is a colonist of wild rice (Oryza australiensis) in the Northern Territory, Australia

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Fusarium sacchari, the cause of sugarcane pokkah boeng disease in tropical and subtropical regions worldwide, is also considered a potential pathogen of sorghum, maize and rice. Banaanase disease of wild and cultivated rice in south-east and southern Asia is caused by F. fujikuroi, a member of the Gibberella fujikuroi species complex. We hypothesise that F. fujikuroi is likely to be the dominant species of the G. fujikuroi complex associated with wild rice (Oryza australiensis) populations in tropical Australia.

A total of 92 Fusarium isolates representing six morphospecies were recovered from 137 stems of O. australiensis sampled in the Roper River area (NT). Species included F. semitectum (38%), F. sacchari (26%), F. equiseti (17%), F. longipes (14%), F. nygamai (1%) and F. sp. (3%). F. fujikuroi was not detected from this O. australiensis population, indicating it is unlikely to serve as a reservoir of this rice pathogen in tropical Australia.

Sequencing and parsimony analysis of a portion of the TEF gene from 24 putative F. sacchari isolates confirmed their identities as F. sacchari, a result further supported by AFLP analysis. Sexual compatibility tests detected both mating types (15 MAT-1:9 MAT-2), with all MAT-2 isolates cross-fertile, whereas all MAT-1 isolates failed to cross with the F. sacchari tester strains. This study revealed that F. sacchari is able to colonise O. australiensis. The pathogenicity of F. sacchari genotypes to sorghum, maize and rice is currently being assessed.

Molecular characterisations of cereal cyst nematode (Heterodera avenae group) from Huanghui winter wheat area China using RFLP and sequence of ITS-rDNA

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Twenty-one populations of cereal cyst nematode (CCN), collected from the Huanghui winter wheat area of China, were studied by restriction fragment length polymorphism (RFLP) and ribosomal DNA internal transcribed spacer sequence analysis. RFLP profiles were generated by 8 restriction enzymes; Alu I, Cfo I, Hae III, Hin F, Pst I, Rsa I, Taq I and Tru9 I. Populations from Huaiyang, Jiaozuo, Shangshui and Xuchang (Henan) matched the known profile for Heterodera filipjevi. However, the Hae III digests for the Jiaozuo population had one additional fragment. Populations from Xinyang and Xushui (Henan) matched Subbotin’s Heterodera australis, which represents the first detection of this H. avenae type in China. Fuyang (Anhui), Handan and Baoding (Hebei), Anyang, Qingfeng, Qixian, Yanjin, Yiyang and Yuzhou (Henan), Xiangfan (Hubei), Xi’an (Shaanxi), Heze (Shandong), and Linfen (Shanxi) populations were all Subbotin’s Heterodera avenae type C. Luolong and Shangqu (Henan) had mixed populations of H. avenae type C and H. filipjevi. Phylogenetic analysis of the sequences (including reference species from Genbank) showed H. filipjevi to be distinct, but did not provide unequivocal support to separation of H. australis and H. avenae type C from H. avenae. These data further highlight the complexity for management of CCN in China unless broad-based resistance can be found.

Current status and progress of the cereal cyst nematodes Heterodera avenae and H. filipjevi on wheat in China

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China is the world’s largest producer of wheat with more than 120 Mt produced per year at an average yield of 4t/ha. The cereal cyst nematode (CCN), Heterodera avenae has been confirmed in 13 wheat growing provinces up to 2010, covering central, north, northwestern and eastern China, including both the optimal (high rainfall/irrigation) and rainfed (dryland) wheat production systems. Yield losses have been confirmed from several important wheat growing provinces including Henan, Hebei and Anhui and based on survey data approximately 22% of the wheat growing area of China may potentially suffer 10–15% yield losses. A cyst nematode, H. filipjevi, has been confirmed and reported from Henan province based on both morphological and molecular identification. Molecular data of rDNA-ITS and D2D3 region were submitted to GenBank, this is the new record of H. filipjevi in China. The resistance of 116 wheat lines provided from CIMMYT and Turkey to Baoding CCN populations were screened and evaluated in a growth chamber, The results showed that there are 15 highly resistant, 15 moderately resistant, 36 moderately and 50 highly susceptible varieties, (Chen, 2010). Whilst most Chinese cultivars are susceptible a few appear to provide some level of resistance. H. filipjevi was detected in four wheat-growing areas of Liying, Xuchang, Weihui and Yanjing in Henan Province and first reported from China in 2010. Molecular data of rDNA-ITS(GU083595, GU083596, HM147944, HM147945) and D2D3 (GU083592, GU083593, GU083594, GU083597)region of H. filipjevi were submitted to GenBank. Three new parasitism genes including Ha-cbp-1(GenBank accession GQ178086), Ha-pel-1(GenBank accession GQ998895) and Ha-pel-2 (GenBank accession GU138156) were cloned. This research is supported by Special Fund for Agro-scientific Research in the Public Interest—Crop Cyst Nematodes management (No.200903040)
Aetiology and epidemiology of Fusarium head blight on the Liverpool Plains 2005–2009

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Several localised epidemics of Fusarium head blight (FHB) of wheat occurred on the Liverpool Plains, in northern New South Wales, between 2005 and 2009. Both F. graminearum and F. pseudograminearum are reported as FHB pathogens in Australia, and both are found in the Liverpool Plains region. The epidemiology and control of FHB varies between pathogens, and thus, a clear understanding of the aetiology of the outbreak is required. A field study of 25 wheat crops affected by FHB was undertaken to investigate the aetiology of these outbreaks and the source of inoculum for infection, as well as the role of cropping history. Both F. graminearum and F. pseudograminearum were associated with the disease in all years surveyed. Sites where F. pseudograminearum was responsible for FHB infection always had a high level of stem colonisation by this pathogen, while sites with FHB caused by F. graminearum were often associated with the presence of maize, sorghum and durum in frequent rotation. At a number of sites, FHB occurred in the absence of inoculum sources, suggesting that dispersal of ascospores from remote sources may play a role in the epidemiology of the disease. This information has contributed to the development of integrated disease management strategies for FHB.

Quantitative PCR and histopathological investigations of cereal tissues during infection by the crown rot pathogen Fusarium pseudograminearum

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Crown rot of wheat is a significant cause of yield losses in many wheat producing countries, particularly Australia where the predominant cause is the fungus Fusarium pseudograminearum. Other cereals such as durum wheat and barley can also be affected. Partial resistance has been identified in a small number of wheat lines, such as 2-49 and Sunco, but the mechanisms of resistance shown by these lines have not been identified. Using quantitative PCR based on fungal translation elongation factor α DNA we have established that fungal biomass in partially resistant genotypes is reduced compared to susceptible genotypes in both seedling and adult cereal tissues. Histopathological examination of infection and colonisation of seedling and adult tissues, using the fluorescent dye solophenyl flavine, has not revealed any differences in tissue responses between partially resistant and susceptible host tissues, although there is a significantly slower spread of the fungus in the tissues of resistant genotypes. Infection is initiated predominantly through the stomata of surface-inoculated leaf sheaths. Colonisation of expanded stems frequently originates in the parenchymatous hypoderm, which becomes highly discoloured. Early infection of pith parenchyma cells is also frequent. Vascular tissues become colonised by anthesis and this occurs more rapidly in susceptible genotypes. Occlusion of large xylem vessels was rare during moderate infections while infection of phloem sieve tube elements is common.

Meta-analysis of stripe rust epidemiology, severity and yield loss in wheat in Western Australia

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Stripe rust, caused by Puccinia striiformis f.sp. tritici, is a destructive foliar disease of wheat and globally causes considerable yield loss. Western Australia had been free from this disease for decades, although it prevailed in most of the regions of eastern and southern Australia. Stripe rust first appeared in Western Australia in 2002. Since then efforts have been made through controlled and field experiments in understanding the epidemiology of the disease, its variation in severity and resulting yield losses. Those experiments were conducted in years of varying disease incidence in contrasting environments using wheat varieties of varying resistance to stripe rust. While the experiments provide vital information related to the disease and its consequences, analysis and interpretation of individual experiments may not be enough to generalise information relating to disease across the state. Meta-analysis provides a better opportunity to address the issue. Meta-analysis is a quantitative approach that estimates a relative response from individual studies to find general trends and differences. In this paper, we present a meta-analysis of epidemiology, disease severity and yield loss in relation to stripe rust of wheat in Western Australia. From an application perspective, this analysis may form a basis to derive algorithm(s) for models to predict the severity of stripe rust and its consequences on wheat yield.

Characterisation of stripe rust resistance in selected South African wheat lines

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Stripe rust, caused by Puccinia striiformis f. sp. tritici (Pst), became endemic in South Africa, since its introduction in 1996 and can cause extensive yield loss. Low annual yields, erratic rainfall and high cost of chemical control, renders resistance breeding the most cost-effective means of controlling stripe rust. The ability of rust pathogens to mutate and form new, virulent pathotypes necessitates the need for the identification and introduction of new resistance genes. To address this issue, a recurrent mass selection (RMS) breeding program was conducted at the Plant Breeding Laboratory, University of Stellenbosch, South Africa in order to combine rust resistance genes in acceptable agronomic breeding material. Sixty-five advanced lines from the RMS program, underwent
Multipathotype seedling tests with selected Australian Pst pathotypes. Multipathotype tests confirmed the presence of seedling resistance genes Yr3, Yr4, Yr6, Yr7, Yr9, Yr17 and Yr27. Field evaluation using pathotypes of known virulence revealed useful levels of adult plant resistance (APR) in addition to the seedling genes. Molecular markers for APR genes Yr18, Yr29, Yr30 and Yr36 will be applied to further characterise the material. In addition, genetic studies in backcross populations with 8 selected South African lines have been used to identify the number of effective resistance genes in these lines. A subset of these characterised lines will be distributed as parental candidates for breeding programs.
Cryptic species of *Phomopsis* from sunflower in Australia revealed by molecular, morphological and pathogenicity studies

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Pathogenic species of *Phomopsis* have been identified by molecular, morphological and pathogenicity studies as being responsible for disease outbreaks in Australian sunflowers in 2009. Significant yield losses occurred in affected crops in New South Wales (Liverpool Plains) with some sites in Queensland (Darling Downs, Lockyer). The outbreak followed a period of extremely wet and humid weather. Symptoms included light brown to dark brown irregularly shaped lesions centred at the stem nodes, pith deterioration and mid-stem lodging and appeared similar to those caused by the exotic pathogen *P. helianthi*. Pathogenic *Phomopsis* isolates were collected from both stems and harvested seed of infected crops, as well as wild sunflower stems. Surveys have detected a wide geographical distribution of *Phomopsis* in the Australian sunflower growing areas. With the high likelihood of pathogenic isolates being identified in nurseries, surveillance of nurseries and seed production areas is now under way. Outside Australia, *P. helianthi* causes yield losses of 40-60%, so the potential of this putatively identified *Phomopsis* sp. to cause significant yield loss in Australia is high. Future work will include continuing molecular characterisation and taxonomic description of previously undescribed pathogenic species, identification of alternative crop and weed hosts and investigating the role of seed-borne infection.

Water sampling for the detection of *Phytophthora cinnamomi*: is it a valid tool or are we just fishing?

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Stream baiting is a useful tool to determine if *Phytophthora* species are present in a catchment. The method assumes that *Phytophthora* species accumulate in water bodies and then spread throughout catchments with water movement. However, it is poorly understood how well *Phytophthora* species accumulate, survive and move within water catchments. This study investigated the ecology of *P. cinnamomi* collected from seven water bodies within a single mine site. Each water body varied in terms of the organic particulates, dissolved chemicals, water influx and water recycling regimes. Water quality had a significant impact on the sporulation and infection of plant baits by *P. cinnamomi* in each water body. The findings and implications of stream baiting as a catchment-level monitoring tool will be discussed.

Symptoms of stress and decline of *Corymbia ficifolia* in urban and natural environments in Western Australia

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*Corymbia ficifolia* is a widely planted amenity tree worldwide. Recently, the species has been observed to be in decline in urban environments. This study investigated the causes of the decline in 246 trees in roadsides/median islands, parks, streets within residential areas in five urban areas in the City of Melville, 77 trees on the Murdoch University campus, and 82 trees in other urban areas and in its natural habitat in south-western Australia. Tree diameter, height, and canopy/crown densities ranged from 5.5-104.1 cm, 2.4-18 m and 5-100%, respectively. Most adult trees in urban areas suffered from canker disease caused by *Quambalaria coyrecup* which was commonly associated with branch flagging and dieback. No canker symptoms were found in natural stands of *C. ficifolia*. Occurrence of canker, dieback, flagging, and foliar diseases across all sites ranged from 0-80%; 26.6-80%; 4.7-57.1%; and 29.2-100%, respectively. Foliar symptoms caused by biotic and abiotic causal agents were also present. Whilst leaf disease is widespread, stem cankers are of major concern in larger trees. The health and structural condition of trees were scored and correlation among tree parameters with disease presence was assessed. Some diseases were common on *C. ficifolia* at a particular plant growth stage or in particular areas. The research indicates that disease problems in urban *C. ficifolia* trees are common and that more than one causal agent is responsible.

Prevalence of diseases in mango nurseries in Punjab, Pakistan

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The sources of most field diseases on mangoes in Pakistan can be traced back to the nurseries where the seedlings were obtained to establish the new orchards. This is because most mango nurseries in the country are established inside orchards and sometimes directly under disease infected trees with high incidences of mango sudden death, malformation, anthracnose and powdery mildew. Seedlings from these nurseries become infected by the prevailing diseases and are the immediate source of spread to new orchards. The objective of this study was to survey a range of mango nurseries in production districts of Punjab, to determine the prevalence of diseases occurring in these nurseries so that growers could be advised on strategies to produce healthier nursery seedlings. The surveys were conducted in the production districts of Faisalabad, Jhang, Multan and Shujabad, to determine the incidence of the different diseases and physiologic disorders occurring in the nurseries. Based mainly on symptoms typical for each of the diseases, anthracnose was found on 30% of the seedlings, mango malformation on 70%, mango sudden death on 43% and powdery mildew on
6%. These symptoms included leaf spots on young flushes for anthracnose, malformed florets for malformation, ooze and/or gummosis on seedling stems for mango sudden death and powdery coatings on leaves for powdery mildew. Up to 79% of the seedlings exhibited salt injury symptoms and 50% showed signs of nutrient deficiency. The surveys drew attention to the issues identified and follow up discussions with the nursery owners are helping to improve their nursery management strategies.

A survey of root and collar rot pathogens of peas (Pisum sativum) in New Zealand

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Pea seed crop yields vary considerably in New Zealand from year to year and from district to district. Many agronomic factors have been considered as the cause of these variations, and diseases have also been implicated and shown to be a factor. However, although root and collar rots have been observed to be prevalent in many crops, their incidence, severity, distribution and role in restricting yield potential has not been full investigated. Thus, a survey of pea crops in a number of growing areas in New Zealand has been made over the past three years. A disease index (DI from 0-100) based on visual necrosis scores for roots and stems was calculated from samples (30 plants) taken from each crop surveyed. This DI ranged from 20 to 95 with the average DI being slightly higher in 2009/10 than in 2008/09. The major pathogens isolated from the necrotic roots and stem bases were Fusarium species (in particular Fusarium solani and F. oxysporum), Ascochyta pinodes, and Phoma medicaginis var. pinodella. Thielaviopsis basicola (the cause of black root rot) and Aphanomyces euteiches (common root rot) were also isolated and observed but were less common. Crop information was also collected and analysed, but there was no clear relationship between the above-detected pathogens and final yields and other factors such as previous crops. A fungicide trial aimed at determining if these pathogens could be controlled and then give an indication of their role in restricting yield was set up in the second and third year, but results were variable. The results of these surveys and trials may have considerable influence on pea breeding directions in the future.

Interesting new fungal and bacterial associations on horticulture and forestry hosts in New Zealand

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MAF Biosecurity New Zealand’s Plant Health and Environment Laboratory (PHEL) is responsible for the identification and verification of all suspected exotic, new, and emerging pests and diseases affecting plants and the environment in New Zealand. Plants and plant products exhibiting symptoms caused by suspect new to New Zealand fungi and bacteria are regularly submitted to the PHEL Mycology and Bacteriology team through a passive surveillance program. These submissions often result in detection of new to New Zealand fungi and bacteria on plants for which information on fungal and bacterial associations are generally sparse. Between 2007 and 2010, more than 30 new to New Zealand fungi and bacteria were identified or confirmed at PHEL, and over 100 new host associations were detected. Details are provided of fungi and bacteria associated with a number of plants in New Zealand, including Fusarium spp. and Cylindrocarpon destructans on saffron (Crocus sativus), Pseudomonas aff. marginalis on yacca (Smallanthus sonchifolius), Physalospora vaccinii on cranberry (Vaccinium macrocarpon), and Diplodina neotheica and Diplodina acerina on Acer palmatum.

Pests and diseases remain the main complaint of banana farmers in Indonesia

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Indonesia banana production in 2007 reached 5.45 million tons, and supplied 32.36% of the national fruit production. Survey conducted within 2006–2009 in fifteen provinces in Indonesia was objected to figure out farmer perception on their banana industry. Two banana production centers (represented by regency) were selected from each province, respectively encompassed two banana production areas. Fifteen to twenty banana farmers were interviewed from each area followed by actual field observation. Fifty-eight per cent respondents complained pests, in general, as major constraint of their banana orchards. Fusarium wilt, blood disease and weevil borer sat at the first three problems. Besides the 14 pests and diseases mentioned by the farmer, field observation showed that there were 24 pests, diseases, and disorders came along with banana cultivation. Due to the distribution, dispersion, and the farmer perception to the pests; banana bunchy top virus (BBTV), bacterial corm rot, and weevil borer is considered as new potential threats after blood disease and fusarium wilt.
Dormant bulb, dormant risk? Developing real-time RT-PCR assays for detecting viruses in dormant bulbs

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Dormant bulbs may be infected by a number of damaging viruses of potential economic importance for the New Zealand bulb industries. TaqMan® real-time reverse-transcriptase polymerase chain reaction (RT-PCR) for five important viruses of dormant bulbs were successfully developed: Arabis mosaic virus (ArMV), Cucumber mosaic virus (CMV), Lily symptomless virus (LSV), Tobacco rattle virus (TRV) and Tulip virus X (TVX). Nucleic acid of appropriate quality and quantity for RT-PCR was extracted from nine bulb species using the Qiagen RNeasy Plant Mini Kit. The sensitivity of the TaqMan® real-time RT-PCR varies from similar to 1,000 times more sensitive than the conventional RT-PCRs, depending on the virus tested. The reliability of the TVX TaqMan® real-time RT-PCR was further assessed against ELISA and conventional RT-PCR using leaves and bulbs of the same 24 Tulipa × hybrida plants. TVX was detected in about three times more leaf samples by both RT-PCR techniques than by ELISA. TVX was detected in twice the number of leaf samples than bulb samples for both conventional and real-time RT-PCRs. The reliability of TVX detection was less in bulbs than leaves; it is anticipated that virus detection in bulbs would also be less reliable than in leaves for the other four viruses.

The occurrence of the Southern Rice Black-Streaked Dwarf Virus in Viet Nam

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A disease characterised by novel dwarf and twisting symptoms was first observed on rice in Nghe An, Vietnam in 2009. It spread rapidly to north and central Vietnam. The infected plants are stunted, and show darkening of the leaves, twisting of leaf tips and splitting of leaf margins. At a later stage, white waxy venations develop on the underside of leaf blades, leaf sheaths and culms, and eventually turn black. The symptoms are similar to those of the Rice Black-Streaked Dwarf Virus disease, which occurs in Japan, Korea and China. Corn is also a host and infected plants become stunted and dark green with small venations along the minor veins on the back of leaves. Virus particles, approximately 70-75 nm in diameter, were observed under the EM. The virus was shown to be transmitted from rice plants to rice and to maize seedlings by the white-backed plant hopper (Sogatella furcicera). RT-PCR confirmed the presence of RBSDV in 477 samples of rice and maize from 29 provinces in north and central Vietnam. Subsequently phylogenetic analysis showed that the virus in Vietnam is similar to the Southern Rice Black-Streaked Dwarf Virus (SRBSDV), which occurred in Southern China in 2001 and belongs to the Fijivirus-2 group, Reoviridae family. The IDM strategies promoted for rice include the use of resistant varieties, adjusting sowing and transplanting times to ‘escape’ the peak in the vector population, ‘synchronised planting’, and the application of pesticide to rice seedlings within the IPM program.

Virus surveys of zucchini crops and alternative hosts in the Sydney Basin

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Potyviruses are a significant impediment to summer production of zucchini in the Sydney Basin. Many crops can be 100% infected by mid-summer. Commonly, losses of greater than 50% result because lumpy and misshapen fruit are unmarketable. The potyviruses responsible have been previously determined to be Watermelon mosaic virus (WMV), Zucchini yellow mosaic virus (ZYMV) and Papaya ring spot virus (PRSV). This study aimed to quantify the relative contribution of these three viruses and identify alternative crop or weed hosts that may act as virus reservoirs. Crop surveys were conducted over four consecutive seasons from 2005 to 2008. Leaf samples were tested for the three potyviruses by DAS-ELISA (Agdia Inc, Elkhart, IN). Results confirmed that individual or, more commonly, any combination of the three potyviruses infected zucchini crops. Weed samples of fleabane (Conyza spp.) were shown to be infected with PRSV. This was confirmed by mechanical inoculations and transmission with green peach and cotton aphids previously fed on infected zucchini leaves. Both WMV and ZYMV were also transmitted to fleabane by aphids. To our knowledge these are new host records for PRSV and ZYMV. In contrast, field samples of other common weeds including sow thistle, wild fennel, pigweed, blackberry nightshade, amaranth, fat hen, marshmallow and purple top were not infected with any of these potyviruses. White clover was infected with WMV while no further alternative hosts were recorded for ZYMV. One further season of surveys and virus testing will finalise this work in an effort to identify alternative hosts for these viruses.

A novel species of Polerovirus with two genotypes infecting cruciferous crops in China

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Turnip yellows virus (TuYV), as a viral agent involved in yellowing disease of cruciferous crops, was first reported in the Mainland China in 2007. Here we reported two genotypes of TuYV (TuYV-A and TuYV-B) infecting oilseed rape isolated from Beijing and Jiangsu, respectively. The complete RNA genomes of TuYV-A and TuYV-B were determined and compared to other reported poleroviruses. The Chinese TuYVs were 5666 nt in length compared to 5642 nt of TuYV-FL, and had typical poleroviral genomic organisation. The entire genome of TuYV-A shared 94.6%
nucleotide sequence identity with TuYV-b, and the 5' terminal ORFs performed more divergent (88.8% to 92.5%) than the 3' terminal ORFs (99.2% to 99.8%). The amino acid sequences identities of gene products except CP of both TuYV-A and TuYV-B shared less than 90% with other reported poleroviruses. The TuYV-A and TuYV-B showed the similar results. Furthermore, the full length cDNA clones of TuYV-A and TuYV-B were inserted into pCas4-RZ vector named as pCaTuA and pCaTuB respectively, followed by agro-infiltration in Arabidopsis thaliana, Nicotiana benthamiana. RT-PCR detection results showed that pCaTuA and pCaTuB could systemically infect A. thaliana and N. benthamiana. Thus we proposed the Chinese TuYV as a tentative distinct species in Polerovirus genus, and named temporarily as Canola leaf roll virus (CaLRV) according to the leaf roll symptoms of oilseed rape in Jiangsu.

The length of an internal poly(A) tract of Hibiscus latent Singapore virus affects its infectivity in Nicotiana benthamiana

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The 3'UTR of Hibiscus latent Singapore virus (HLSV) contains an internal poly(A) tract. Different lengths of poly(A) in the viral cDNA sequences were found and a HLSV full length cDNA clone (HLSV-87A) containing 87 nucleotides-long internal poly(A) was constructed. To elucidate the biological functions of the internal poly(A), we constructed two mutants containing 22 and 40 nucleotides-long internal poly(A), named as HLSV-22A and HLSV-40A, respectively. With an in vitro transcription system, the biological functions of the internal poly(A) were tested in both N. benthamiana protoplasts and plants. Protoplasts transfection results showed that all three transcripts from HLSV-22A, HLSV-40A and HLSV-87A could replicate to different levels, as determined by Northern blot and quantitative RT-PCR analysis. Coat protein accumulation was not observed in HLSV-22A inoculated leaves, as compared to the other two constructs. No viral RNA accumulation was detected on upper leaves of plants inoculated with HLSV-22A, whereas HLSV-40A and HLSV-87A were able to move systemically, although the replication level of HLSV-40A was less than that of HLSV-87A. Further investigation on upper leaves showed that the internal poly(A) of HLSV-40A extended its length when moved to upper leaves by RT-PCR analysis. In addition, under transmission electron microscope, the rod-shape virions were found on the leaves inoculated with HLSV-40A and HLSV-87A, but not in HLSV-22A inoculated leaves. These data indicates that the length of the poly(A) tract in 3'UTR of HLSV affects the replication of HLSV and its systemic movement in N. benthamiana.

Influence of ZmROP1 expression on the infection of maize by sugarcane mosaic virus

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Identification of differentially expressed host genes in response to virus infection and further investigation of the functions of these genes may contribute to reveal molecular mechanisms of virus-plant interactions. The changes in gene expression profile in systemic leaves of maize infected by Sugarcane mosaic virus (SCMV) were investigated using suppressive subtractive hybridisation. ZmROP1, encoding a Rho-related GTPases (ROP), was identified as an up-regulated and differentially expressed gene. ROPs are versatile plant signaling regulators involved in different cellular process. The possible role of ZmROP1 in viral infection of maize was investigated. The results showed that the ZmROP1 gene expression level changed with the development of SCMV infection in maize leaves; knockdown of the ZmROP1 gene through virus-induced gene silencing in maize plants enhanced the accumulation and systemic infection of SCMV, while transient over-expression of ZmROP1 in maize protoplasts impaired SCMV multiplication. These data suggested that ZmROP1 might play an inhibitory role in SCMV infection.
Integrated management of Phytophthora root rot of papaya in the wet tropics of far northern Queensland, Australia

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Fifty per cent of Australia’s papaya is grown on the wet tropical coast of far north Queensland (average annual rainfall of 3750 mm) with the majority of rain falling between January and May. Phytophthora palmivora, which causes decay of the tap root and eventual plant death, is widespread in the growing area. Mounding, organic and plastic mulches, metalaxyl granules, plant age and potassium phosphonate foliar sprays were evaluated for the control of Phytophthora root rot of papaya. Mounds and plastic mulch, mounds and organic mulch, and mounds alone effectively reduced the incidence of root rot by 58%, 48% and 38% respectively compared to flat bare soil. In glasshouse experiments, plants treated with metalaxyl-M at 1.25 and 0.625 g a.i./m² were less affected by root rot than plants treated with metalaxyl-M at 0.312 g/m² and the inoculated control. Sixteen-week-old plants sprayed with 0, 3, 6 or 12 g/L phosphonate developed less root rot than 8 and 12 week-old plants sprayed with phosphonate. In the field, metalaxyl-M at 0.625 g/m² plus 12 g/L phosphonate effectively reduced the incidence of root rot by 28% compared to metalaxyl-M alone and 73% compared to the untreated control. Growers are encouraged to use an integrated strategy encompassing both chemical and cultural control methods.

Integrated pest and disease management on cocoa is profitable in Papua New Guinea

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In the past the different cocoa research disciplines trained extension officers and farmers separately according to each discipline. Therefore, the farmers and extension officers would go out into their cocoa farms and do management whenever resources are available. There was very little knowledge of the different cocoa pests and diseases compounded with cocoa and Gliricidia sepium shade pruning. In addition due to very little to nil recognition of the different pest and diseases, the extensionists and farmers alike did not know how to control these pests and diseases.

Four management options were established in 2003 at the Papua New Guinea Cocoa Coconut Institute (PNGCCI) for comparison. During the discovery of the notorious Asian cocoa pod borer Conopomorpha cramerella in March 2006 the trial was pruned back in the eradication exercise. Sketchy records of pod counts recommenced in May 2007. Regardless of the CPB infestation, production in the different options followed the trend of higher the inputs higher the crop peaks. Earlier results showed that the more inputs applied at the appropriate times in relation to the crop cycle more crop was harvested. With the continuation of the trial the trend in the yielding pattern showed it is best to apply the inputs according to the weather pattern rather than the calendar year.

The Queensland sugarcane smut epidemic: research outcomes

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Sugarcane smut (Ustilago scitaminea) was first identified in the major east coast production areas of Australia in June 2006. As most commercial varieties at the time were susceptible, the incursion represented a major threat to the Australian sugarcane industry. Several strategies were employed by the industry to prevent large scale yield losses, including early warning in areas where the disease had not yet been detected, assessment of the speed of spread and build up in susceptible crops in infested districts, accelerated screening of clones for resistance to the diseases and yield loss studies.

Spore trapping investigations (early warning) were able to warn farmers up to two years before disease symptoms of smut appeared in the field. This allowed farmers to transition to more resistant varieties well before a district incursion was identified. Monitoring of smut spread in affected districts suggested that the disease took only 18 months-two years to spread to all farms within a region. In susceptible crops, a 7-11 fold increase in infested plant populations per annum indicated to farmers when affected crops needed to be terminated. Yield loss studies have confirmed that the disease is able to reduce yields very substantially (up to 60% yield losses). The epidemic is currently being managed through the planting of resistant varieties and the early termination of badly infested crops. The information generated by work in the listed areas has minimised losses to smut in the Australian industry.

Screening and evaluation of fungicides for the control of sugarcane smut in seedcane

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Sugarcane smut caused by Ustilago scitaminea is one of the most devastating diseases of sugarcane. Two triazone fungicides, propiconazole and triadimefon, have been registered to protect seedcane from infection with sugarcane smut overseas, particularly after hot water treatment. These fungicides were registered under an emergency permit in Australia when smut was found for the first time in Queensland in 2006. A research program was initiated to screen and evaluate a range of fungicides against sugarcane smut. In vitro and field experiments were conducted at BSES Southern Experiment Station, Bundaberg in 2008 and 2009 to screen a range of fungicides against
sugarcane smut. Nine fungicides were tested in vitro at various concentrations for their efficacy on teliospore germination. Azoxythrin (Amistar®), quintozene (Quintozone® 750) and didecyl dimethyl ammonium chloride (Steri-max®) completely stopped germination of teliospores at 2.5 mg a.i./L. Propiconazole (Tilt®), triadimefon (Bayleton®), cyproconazole (Alto®) and acibenzolar-s-methyl (Bion®) significantly (P<0.05) reduced teliospore germination at 50, 100 and 200 mg a.i./L. Two field trials were conducted in 2008 and 2009, where seedcane were dipped in a range of fungicide suspensions for five minutes at ambient condition prior to planting. No smut were observed over nine months when seedcane were treated with cyproconazole at 16 g a.i./100 L, propiconazole at 25 g a.i./100 L and triadimefon 48.5 g a.i./100 L. Strobilurin fungicide, azoxythrin, was effective and showed <10% smut after nine months. The results have important implication for selecting new fungicides for the control of sugarcane smut in seedcane in Australia.

Management of the major foliar diseases of mungbeans and peanuts in Australia

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Mungbeans (Vigna radiata and Vigna mungo) and peanuts (Arachis hypogaea) are important summer pulse crops in northern New South Wales and Queensland. Mungbeans are grown as a short season, often opportunistic, crop from northern New South Wales to central Queensland. The bacterial diseases tan spot (caused by Curtobacterium flaccumfaciens pv. flaccumfaciens) and halo blight (Pseudomonas savastanoi pv. phaseolicola) and the fungal disease powdery mildew (caused by Podosphaera fusca) commonly occur at damaging levels on mungbean crops in all regions. Peanuts, traditionally grown as a non-irrigated crop, are being increasingly grown under irrigation and in the sugarcane farming systems of coastal Queensland. Rust (caused by Puccinia arachidis) and late leaf spot (caused by Mycosphaerella berkeleyi) cause significant yield losses in these areas. Management of the important foliar diseases of mungbeans and peanuts is being achieved through the integration of different strategies, with resistance playing a pivotal role for all of them. Targeted fungicide applications also play a key management role for both peanut diseases and for powdery mildew on mungbeans, while the use of seed with minimal contamination levels is important for the mungbean bacterial diseases. For both pulse crops, new varieties with improved resistance to these important foliar pathogens combined with other practices will improve their management in the future.

Impacts of bacterial blast and orchard management on pear productivity

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Low productivity and profitability of pear production have been an on-going concern to the Australian pomefruit industry. As many pear orchards have been in long term production for 20-60 years, a combination of factors may have an impact on tree health and productivity. Studies were conducted in seven pear orchards in the Goulburn Valley in Northern Victoria, a major production area in the largest pear producing state in Australia, to gain an understanding of the problem. Bacterial disease and orchard management issues were shown to be key factors contributing to poor tree health, low productivity and poor fruit quality. Bacterial blast, also known as pear blossom blast, caused by Pseudomonas syringae pv. syringae, had a significant impact on pear blossom and fruit numbers. Detailed analysis of fruit numbers and quality from fruit set to pack-out was useful for identifying biotic and abiotic factors contributing to poor fruit quality and low returns. Leaf and soil analyses showed an imbalance in micro- and macro-nutrient levels in these orchards. The data highlighted that both soil and leaf analyses are needed to provide sufficient information to determine the impact of nutrient status on tree health. Inadequate pruning was also identified as a factor contributing to poor tree structure and fruit yield.
Common spear rot of oil palm: identification of pathogenic agents and potential role of water-related stress as predisposition factor

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Common spear rot (CSR), or crown disease, is widespread in oil palm growing countries and causes considerable losses in young oil palm plantations. The pathogenic agent of the disease has remained inconclusive. Of ten fungal species identified based on morphological characteristics and sequence analyses of either the translation elongation factor (EF-1α) or the internal transcribed spacer (ITS) region, *Fusarium incarnatum*, *F. solani*, an undescribed *Fusarium* sp., and *Ceratocystis paradoxa* were recovered most frequently from symptomatic leaves. Inoculation and Koch’s postulate experiments showed that the most commonly recovered fungi and *F. sacchari* were able to infect oil palm leaves, causing a symptom of extensive rotting similar to that found in the field. The extensive rotting symptoms were more frequently observed in seedlings exposed to a brief episode of drought stress prior to inoculation than in nonstressed seedlings. However, most isolates were weakly aggressive. Interestingly, growing of the weakly aggressive isolates on water-stress medium as imposed by addition 0.6 M NaCl enhanced the aggressiveness of the weak pathogens. The results suggested that brief episode of water-related stress may predispose oil palm to CSR through increasing the host susceptibility and enhancing the pathogen aggressiveness.

Unraveling the anthracnose disease complex of capsicum spp.—species, *formae specialis*, pathotypes

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Anthracnose disease of *Capsicum annuum* (chili) is caused by a complex of *Colletotrichum* species with *C. truncatum*, *C. acutatum*, *C. gloeosporioides*, being the most severe pathogens in SE Asia and Australia. These species were isolated separately or together from the one plant and have a wide host range. Elucidation of the disease cycle for *C. truncatum* indicated that seed infection and quiescent leaf infection were important sources of inoculum thus necessitating more efficient use of integrated disease management practices to prevent fruit infection.

Taxonomy: Taxonomy of the *Colletotrichum* spp was validated using three fungal gene sequences (ITS rDNA, partial β-tubulin; translation elongation factor 1-alpha) and species-specific microsatellite markers (STMS). Pathogenicity analysis of *C. truncatum*/C. *capsici* isolates collected from various hosts in Australia identified the existence of *formae specialis* subgroups that were host specific to soybean and custard apple.

Pathogenicity: Differential reactions on mature green and ripe chili fruit of 10 genotypes of cultivated *Capsicum* spp identified five, 11 and three pathotypes of *C. truncatum*, *C. gloeosporioides* and *C. acutatum* respectively. This will have profound effect on chili breeding programs where novel sources of resistance genes from related species are being incorporated into commercial *C. annuum* varieties. Putative PR genes have been identified through transcriptional analysis from a virulent pathotype of *C. truncatum* and an *Agrobacterium*-mediated fungal transformation system developed for assessing function of these genes.

Interactions between *Phoma koolunga*, *Didymella pinodes* and *Phoma medicaginis* var. *pinodella*, causal agents of ascochyta blight on field pea in South Australia

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Interactions between *Didymella pinodes*, *Phoma medicaginis* var. *pinodella* and *Phoma koolunga* were investigated in controlled experiments. Zones of inhibition occurred between cultures of each species co-inoculated onto *Potato-Dextrose-Agar* (PDA). Radii of cultures of *D. pinodes* and *P. medicaginis* var. *pinodella* were reduced on PDA amended with filtrate from broth culture of *P. koolunga*, and radii of cultures of *D. pinodes* were also reduced on PDA amended with filtrate from *P. medicaginis* var. *pinodella* or *D. pinodes*. Effects were negated when cultures were transferred to normal PDA. Radii of *P. koolunga* cultures were not influenced by filtrate-amended PDA. When co-inoculated onto field pea in a greenhouse, the quantity of DNA of *D. pinodes* and of *P. medicaginis* var. *pinodella*, measured using real-time PCR, reduced when co-inoculated with *P. koolunga* but quantity of DNA of *P. koolunga* was not affected. Lesion size was not affected. On detached leaves, the diameter of lesions caused by *D. pinodes* and *P. medicaginis* var. *pinodella* were reduced when co-inoculated with one isolate of *P. koolunga*. Lesions caused by *D. pinodes* were also reduced when the pathogen was paired with itself. The quantity of DNA in detached leaves was not influenced by the co-inoculated pathogen.
Molecular and morphological characterisation of variation of sugarcane smut (Ustilago scitaminea Sydow) in the Philippines

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Sugarcane smut, Ustilago scitaminea Sydow in the Philippines was evaluated using molecular, pathogenicity and morphological approaches. Isolates were analysed for their polymorphism at 10 microsatellite loci. Cluster analysis showing genetic relationship among isolates was derived using simple matching coefficient. Principal component analysis was also done to structure the different U. scitaminea isolates. From both analysis, there were three major cluster groups (A, B, C) observed and clustering based on geographic origin was not evident.

Analysis of molecular variance results for the SSR data indicated that the within population variance accounted for 76% of the total genetic variation while the among population variance accounted for 21% of the variation. Only 3% of the variation was attributed to among group of isolates.

Highly significant (P<0.01) effect of variety, isolate and variety x isolate interactions were observed for virulence and aggressiveness of eight representative isolates using five differential hosts. Virulence and aggressiveness varied among the isolates studied.

There was no appreciable variation in spore morphology of the smut fungus and no associations was established between morphological variation and pathogenicity.

Based on the three categories established as R (Resistant), I (Intermediate) and S (Susceptible), there were seven distinct groups of isolates producing distinct reaction types on the five differential varieties indicating that isolates of U. scitaminea in the Philippines were highly diverse and race of the fungus probably existed.

Characterisation of Alternaria species causing leaf blotch and fruits spot in apples in Australia

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Alternaria fruit spot (AFS) and leaf blotch (ALB) are emerging diseases in Australian apple industry. Prevalence of AFS is widespread but AFS is limited. There is currently little knowledge about the identity of the pathogen(s) causing both diseases. The aims of this study were to determine if the same organism causes both ALB and AFS, and are common in different apple growing areas in Australia. We used DNA sequencing of three loci (Internal transcribed spacer region of nuclear ribosomal DNA, translation elongation factor 1-alpha and actin) and morphological techniques to characterise fungal isolates obtained from ALB and AFS in Australia. NCBI search showed that 97% of the isolates are homologous to Alternaria alternata sensu lato. A concatenated phylogenetic tree constructed with the loci grouped most of the isolates into two distinct clades. DNA sequences of the Australian A. alternata isolates from apple were generally dissimilar to A. mali isolates that cause ALB on apples in other countries. AM-toxin gene commonly detected in A. mali in other countries was not detected in any of the Australian apple A. alternata isolates. Cross-pathogenicity assays of leaf and fruit with the Alternaria isolates on apple leaf and fruit mostly did not induce typical ALB and AFS symptoms. However, Alternaria was recovered from the diseased leaf and fruit assays.
Eradication and containment of Phytophthora cinnamomi from natural ecosystems

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We have developed protocols to contain and eradicate spot infestations of P. cinnamomi. The strategy is based on two assumptions: In the absence of living hosts, P. cinnamomi is a weak saprotroph, and at many sites transmission is probably by root-to-root contact and not by propagule movement through soil water. At two P. cinnamomi infested sites, within scrub-heath in south-western Australia and woodland in Tasmania, we applied a succession of treatments that included (1) vegetation (host) destruction, (2) fungicides, (3) fumigation, and (4) physical root barriers. Phytophthora cinnamomi was never recovered at any of three assessments up to 24 months after treatments. Given the high rates of recovery of P. cinnamomi from untreated infested soil and the sampling effort, the probability that we failed to detect the pathogen in treated soil was low to very low. This study demonstrates for the first time that P. cinnamomi can be eradicated from natural ecosystems. The methods have application in the containment of large infestations of P. cinnamomi, and we are now looking at applying the methods over large areas. These will be discussed.

The potential risk of Phytophthora dieback in the Greater Blue Mountains WHA

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The distribution of Phytophthora cinnamomi has been modelled in the Greater Blue Mountains World Heritage Area (GBMWHA). This understanding of the disease distribution is required to develop management strategies in natural ecosystems like the GBMWHA. However where only sporadic information is available, conservation efforts may be limited by incomplete sampling for pathogen presences due to remoteness and inaccessibility of many sites. Risk models can overcome some of these drawbacks. Hence, we modelled the distribution of P. cinnamomi in the GBMWHA by combining landscape and environmental information using a GIS approach. Data layers were reclassified into risk layers using FUZZY logic such that localities conducive to dieback were given the highest risk rating enabling the compilations of a relative risk surface. The area identified with the highest risk was the Blue Mountains National Park primarily due to optimal temperatures for pathogen development, known infestations and an abundance of roads, tracks and paths.

Management within the WHA should prioritise this park. This information is currently being used by NSW authorities to spatially prioritise control measures and identify areas were comprehensive P. cinnamomi testing needs to be undertaken.

Bacterial diseases of Eucalyptus

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Plantation forestry, based on rapidly Eucalyptus species, hybrids and clones, supports important timber as well as paper and pulp industries in many parts of the world. Pests and pathogens represent one of the most important constraints to the future sustainability of these plantations. Phytopathogenic bacteria affect Eucalyptus trees in nurseries, at establishment and during their first two years of growth. They are capable of causing wilt (root infection), blight and die-back. Bacterial wilt, caused by Ralstonia solanacearum, is a serious disease in tropical parts of Asia and has also been reported from Africa and South America. A number of bacterial species appear to be able to cause blight and die-back. These include Xanthomonas campestris pv. eucalypti, Pantoea ananatis, X. axonopodis and X. vasicola. The occurrence of leaf- associated bacterial pathogens appears to be country specific with Xc pv. eucalypti only known from Australia, P. ananatis and X. vasicola from South Africa and X. axonopodis from Brazil. To complicate the identification of the causal agent of this disease, Pantoea vagans and P. eucalypti have also been isolated from leaf tissue exhibiting leaf blight but their role, if any, in disease development has not been clearly established. Erwinia psidii has recently been found causing shoot and branch die-back and appears to have jumped hosts from guava (Psidium guajava) trees to Eucalyptus in Uruguay and Argentina. Bacterial diseases of Eucalyptus in plantations appears to be growing in importance. They not only threaten the sustainability of forestry operations in some countries but some of the pathogens could serious damage Myrtaceae in their native range.

Ceratocystis species: increasing threats to tree health

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The genus Ceratocystis includes numerous well-known agricultural and forestry pathogens of global importance. During the course of the last two decades these fungi have increasingly been found causing disease and death of plantation-grown Eucalyptus and Acacia species where...
these trees are grown as non-natives. In South Africa, for example, Ceratocystis albifundus causes rapid wilt and death of A. mearnsii trees, native to Australia. This fungus has the capacity to infect numerous tree species, spanning at least eight different families and is most likely native to Africa. The origin of other plantation tree pathogens, such as C. acaciivora is not known. Australia might be the origin of several Ceratocystis spp., as has been suggested for C. pirilliformis, which occurs on Eucalyptus in that country. Little is, however, known about the diversity of Ceratocystis spp. in Australia. Recent collaborative projects between researchers from Australia and South Africa, studying the species diversity of Ceratocystis on eucalypts in Tasmania, New South Wales and Queensland, has led to the discovery of three previously unknown Ceratocystis spp. from these trees. Studies on Ceratocystis spp. are, however, hampered by problems relating to the taxonomy of these fungi, including the fact that hybrids between species appear to have arisen. Advances in technology, such as 454 sequencing and a newly initiated genome project, should resolve taxonomic confusion and provide valuable opportunities to better understand the biology and species boundaries of these important pathogens in the future.

**Silvicultural options for field management of Ganoderma root rot in Acacia mangium plantation**

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The reforestation effort in Indonesia is aimed at sustaining the supply of forest products while preserving the natural forests. This is to maintain not only the economic importance of the forests, but also their environmental and social roles. The Forestry Department of the Republic of Indonesia has progressively set a development of plantation forests, including both industrial and community-based plantation forests. In line with the policy, industrial plantation forests of fast-growing species, especially acacias, are being established on a large scale basis. A number of diseases have since been recorded. Root-rot is among the most economically damaging diseases of Acacia mangium Willd. Ganoderma philippii Karst. has been found to be the fungal species most commonly associated with the disease in A. mangium plantation in Indonesia. The damage and incidence level of this disease require that effective management be developed to secure sustainable production of plantation forests. This presentation outlines results of field trials on silvicultural practices to manage the disease in the field. This is in addition to the continuing investigation into the implementation of cost-effective and environmentally sound biological control measures using Trichoderma spp. and other biological agents.

**Spring needlecast in Tasmania—fungal communities and environmental factors**

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Spring needle cast (SNC) is currently classified as a serious disease of Pinus radiata growing in closed-canopy stands on high altitude, wet sites in Tasmania. SNC affects about 30% of the Pinus radiata estate in Tasmania and causes the premature casting of needles at the end of their first year, causing growth reductions and potential losses in clearfall volume of 30-50%. Unlike other serious needle cast diseases, SNC in Tasmania is not considered to be caused by a fungus acting in a primary pathogenic role. Rather, it is thought to be due to a suite of endophyte fungi that are triggered into secondary pathogenic activity by an as yet unidentified environmental stress. This study aimed to characterise needle fungal communities at several sites across Tasmania by DNA analysis directly from pine needles, combined with isolation and DNA characterisation of needle fungi. DNA was extracted from pine needles and fungal DNA was amplified by PCR then cloned using a commercial kit. Fungal sequences were assigned to Operational Taxonomic Units (OTUs) and fungi identified by DNA sequence similarity. The relationship between fungal communities, host genetics and environmental factors was examined.
Characterisation of resistance to clover yellow vein virus in pea

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Two resistance genes, cvy1 and cvy2, in pea to Clover yellow vein virus (CYYV) has been reported and cvy1 is tightly linked with mo, sbm-2, and eukaryotic translation factor 4E isoform (eIF(iso)4E) gene on Linkage group. We have previously shown that there are two different modes of resistance in pea (Andrade et al., 2006) and one is controlled by cvy2 encoding eukaryotic translation initiation factor 4E (eIF4E). The other resistance mode operates by limiting cell to cell movement of the virus and is controlled by a gene tentatively designated as non-cvy2. Present study indicates non-cvy2 gene is likely to be cvy1. Molecular mapping was carried out using SSR markers of Lordon et al. (2005) on LGu and a newly designed primer based on plastidial phosphoglucomutase 2 (PGM2) gene sequence. F2 population of susceptible PI 250438 and PI 429853 carrying non-cvy2 was inoculated with CYYV No.30 tagged with green fluorescence protein (GFP) and the infection and viral spread were monitored by GFP fluorescence. Segregation of susceptible and resistance plants was 48:18 and fits the expected ratio of 3:1 for a single recessive gene, indicating that the resistance gene in PI 429853 is inherited monogenically. The resistance gene in PI 429853 was mapped between the SSR marker AB40 and PGM2 on LGu. The mapped locus is close to both eIF(iso)4E and cvy1. We therefore sequenced the eIF(iso)4E gene from PI 429853 and PI 250438 and no differences were found between the two coding regions. We also compared about 2,000 nucleotides upstream of the ATG initiation codon to find only one nucleotide difference.

Occurrence and epidemiology of wheat dwarf virus in China

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Wheat dwarf virus (WDV) is a member of the genus Mastrevirus, and is transmitted by the leafhopper (Psammotettix striatus L.). Its host range includes wheat, barley, oats, and many wild grasses. It was first described by Vacke in 1961 in the western parts of the former Czechoslovak Socialist Republic (CSR) and then found in many parts of the world. Its distribution areas are increasing in recent years in the world. Until our studies, no one has reported the occurrence of WDV in China

In the spring of 2004, 2005 and 2006, several diseased wheat plants showing extreme dwarfing, various types of yellowing, and reduced or no heading were found in many wheat fields of China during the process of field surveys. The samples were identified as WDV positive by PCR and ELISA. Wheat and barley samples collected from 13 provinces in China during 2004-2008 were also infected with WDV as indicated by PCR and ELISA. This suggested a broad distribution of WDV in China.

Severe epidemics of wheat dwarf disease were found in Hancheng, Shaanxi province during 2007-2009. The rate of diseased plants was about 80%. Among them, 20% plants showed extremely dwarf, and the yield loss was 50-80%. The reasons for WDV epidemics in this area have been investigated, including planting susceptible wheat varieties (cv. Xiaoyan 22 and Xiaoyan 6), high density of the vector leafhopper (>600 insects/m²), and warmer winter during those years.

Molecular characterisation of a phytoplasma associated with sugarcane grassy shoot disease in Viet Nam

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Sugarcane is an important cash crop in Vietnam and has been widely promoted at national and provincial level. In 2006 a new disease was discovered in sugarcane in the NAT&L factory area, Quy Hop, Nghe An Province in north-central Vietnam. The key symptoms are the formation of green grassy shoots around the base of mature stools in the first season. Infected rattoon crops are affected more severely and may suffer severe yield loss. The disease had reached epidemic proportions in this mill area by 2008. It was thought to be either GSSD and/or SCGS phytoplasma. We applied nested PCR using P1/P7 and R16F2/S1R6F2 for detection and characterisation of putative phytoplasma(s) from infected tissues. PCR products of the expected size (about 1200 bp) were obtained from the 16S rRNA of the phytoplasma. The RFLP profiles indicated that all samples were infected by the same pathogen. Phylogenetic trees showed that the SCGS phytoplasma from Viet Nam and other reported SCGS phytoplasmas belong to the 16SrXI subgroup, RYD (Rice Yellow Dwarf) 16S rRNA Group. Further studies are on the nature of the phytoplasmas in sugarcane in the region are justified. Attempts to determine the vector have failed. The provincial and national governments and mill staff are promoting two key control strategies namely plough-in of diseased plants/crops, and replanting with pathogen-free sets from other provinces. Strategic spraying is being evaluated to control the presumed plant hopper vector.
Identification of the virulence factors and suppressors of posttranscriptional gene silencing encoded by Ageratum yellow vein virus, a monopartite begomovirus

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Ageratum yellow vein disease is caused by the association of Tomato leaf curl Java betasatellite [Indonesia, Indonesia:1:2003] [ToLCJ-B-[ID:ID1:03]] with a begomovirus component. Ageratum yellow vein virus-Indonesia [Indonesia:Tomato] (AYVV-[ID:ID1:Tom]) alone could systemically infect the plants and induced upward leaf curl symptoms. ToLCJ-B-[ID:ID1:03] was required, in addition to AYVV-[ID:ID1:Tom], for induction of severe downward leaf curl disease in N. benthamiana plants. However, DNA801fsBC1, which encompasses a frameshift mutation, did not induce severe symptoms in N. benthamiana when co-inoculated with AYVV-[ID:ID1:Tom]. The infectivity analysis of AYVV-[ID:ID1:Tom] and its associated betasatellite encoded genes using PVX vector were carried out in N. benthamiana, indicate that the V2 and BC1 genes are symptom determinants. We have identified the DNA encoded V2 and its betasatellite, ToLCJ-B-[ID:ID1:03], encoded BC1 proteins as efficient silencing suppressors of posttranscriptional gene silencing by using an Agrobacterium co-infiltration or heterologous PVX vector assays. However, the results also showed weak suppression of gene silencing activities for C2 and C4 induced by GFP and mRNA associated with GFP was detected. Furthermore, confocal imaging analysis of ToLCJ-B-[ID:ID1:03] BC1 in the epidermal cells of N. benthamiana shows that this protein is accumulated toward the periphery of the cell and around the nucleus, however, V2 accumulated in the cell cytoplasm, C4 associated with plasma membrane and C2 exclusively targeted into nucleus. In this study, we identified as many as four distinct suppressors of RNA silencing encoded by AYVV-[ID:ID1:Tom] and its cognate betasatellite in the family Geminiviridae, counteracting innate antiviral response.

New plant virus and viroid records in New Zealand: update 2008–2010

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MAF Biosecurity New Zealand is responsible for the surveillance of regulated pests and diseases in New Zealand. Between 2008–2010, 12 viruses and 4 viroids were reported in New Zealand for the first time or in significant new hosts. Iris yellow spot virus and Garlic virus A were detected in Allium cepa (onion), Shallot virus X in A. ascalonicum (shallot), Sweet potato virus 2 and Sweet potato virus G in Ipomoea batatas (sweet potato), and Little cherry virus 1 in Prunus avium (sweet cherry). Other new virus records include Helleborus net necrosis virus in Helleborus sp. (hellebore), Fuchsia latent virus in Fuchsia × hybrid (fuchsia), two carmoviruses in Persicaria odorata (Vietnamese mint), a caulimovirus in Clematis flammula and C. viticella (clematis), and Tobacco ringspot virus in Sophora microphylla (kowhai), Fraxinus sp. (ash) and Hemerocallis sp. (day lily). The viroids detected were Hop stunt viroid in Humulus lupulus (hop) and in Vitis vinifera (grapevine), Grapevine yellow speckle viroid-1 in grapevine, Citrus viroid III in Citrus sinensis (sweet orange) and C. limon (lemon), and Potato spindle tuber viroid in Physalis peruviana (cape gooseberry). The significance of these findings in New Zealand is discussed.
Onion stunt: factors associated with severity and management options

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Onion stunt is a severe disease of onions particularly those grown in the Mallee region of South Australia. The disease is characterised by apparently random scattered patches of stunted plants with reduced bulb size. The disease is primarily associated with the soil-borne fungus *Rhizoctonia solani* AG 8. Observations have shown that disease severity is influenced by soil type, being more severe in coarse-textured and drier, cooler soils. This suggests that the severity of onion stunt may be alleviated by delaying the timing of sowing from winter to early spring, especially in coarser soil types, modifying soil type by clay spreading and maintaining appropriate soil moisture. Investigations into these management options are under way. Other management strategies that have been investigated include soil fumigation, cultivar susceptibility, organic soil amendments, biologicals and fungicides. While fumigation effectively reduced soil-borne disease inoculum, none of the varieties screened showed tolerance and none of the biological and organic soil amendments evaluated provided satisfactory disease control. Fungicides, including tolclofos-methyl, azoxystrobin, fludioxonil and several experimental products reduced disease severity in seedling bioassays when applied as a soil drench. Initial trials on commercial properties demonstrate that further refinement of fungicide application method and rate is required to reproduce disease control to the same magnitude under field conditions.

Australian essential oils as potential biocontrol agents for potato storage diseases

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*Fusarium* dry rot, *Erwinia* soft rot, and sprouting are the major causes of postharvest losses of potatoes in Australia, and are of particular concern for long-distance market transporters and for seed-piece storage. Whilst chemical options are available for potato postharvest disease management, alternative control methods are needed to reduce the pressure on, and thereby manage the risk of pesticide resistance development. The aim of this research was to assess the efficacy of some Australian essential oils both in vitro and in vivo against the potato storage pathogens *Fusarium* and *Erwinia*. Preliminary results have shown that in vitro growth of *Fusarium* species can be reduced by over 40% by lemon myrtle oil, while *Erwinia* (*Pectobacterium carotovorum* ssp. *carotovorum*) is also highly susceptible to lemon myrtle, tea tree, and a combination of lemon myrtle and tea tree essential oils. Cost-effective in vivo application methods are being tested to enable potential adoption of these products by the potato industry. It is hoped that the essential oils may prove to be an effective alternative to synthetic pesticides at a commercial level, broadening the range of biocontrol options available to growers and the supply chain.

Silicon enhances tolerance of banana to *Fusarium* wilt

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*Fusarium* wilt of banana (caused by the fungus *Fusarium oxysporum* f. sp. *cubense*) represents the greatest threat to the long-term survival of the world banana industry. No resistant commercial varieties exist and breeding programs have so far failed to produce a replacement for Cavendish, the dominant trade variety. For these reasons, alternative control methods for *Fusarium* wilt are being sought. One area of interest is elemental silicon. The application of silicon as a fertiliser has been demonstrated in some plant/disease interactions to lessen disease severity.

The goal of this research was to evaluate the use of silicon as a control for *Fusarium* wilt and to investigate the mechanism of silicon-mediated tolerance in banana. Treatment of potted banana plants with silicon dioxide showed a modest but significant decrease in *Fusarium* wilt symptoms. Additionally, the location of deposited silicon within the plant was mapped by x-ray spectroscopy and the infection process of *Fusarium* on silicon treated banana plants was investigated by electron microscopy. Results suggest that silicon is enhancing banana tolerance to *Fusarium* wilt, but a causal relationship is yet to be elucidated.

Although silicon application does not confer total resistance to *Fusarium* wilt, it provides another tool for banana growers to use in conjunction with other cultural control methods. Further research into efficient silicon application is ongoing.

Biological control of *Pythium* root rot in hydroponic coriander

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A decade ago Australian production of hydroponic leafy vegetables and herbs was estimated to be 242 ha and with a gross farm gate value of $44.9 million. Since then overall production has remained static except for an increase in hydroponic coriander and leafy brassicas, mostly due to greater productivity and consistently better quality compared with soil-grown produce. Hydroponic production systems utilise the nutrient film technique where plants are suspended in white PVC channels and nutrients are recirculated from a sump tank. Diseases such as those caused by *Pythium* species are favoured in these systems, primarily because the aqueous environment of the root-zone is conducive to formation and dispersal of zoospores. Other factors favouring disease development relate to physiological stresses due to temperature extremes, low oxygenation, accumulation of excess mineral salts, and low populations and diversity of antagonistic microbes in the
Biofumigant green manure crops for use in disease management

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Brassica biofumigant crops sown as green manures in between crops have the potential to replenish organic matter, improve soil health and help suppress soil-borne pathogens including Sclerotinia. The biofumigant crops are selected based on their ability to produce high levels of glucosinolates. When plants are crushed, these compounds are converted to isothiocyanates (ITCs), which are toxic to many soil-borne pathogens. The ITCs acts as natural soil biofumigants. The selection of biofumigant crops that are suitable for the cold Tasmania conditions was very limited. Therefore, nine new biofumigant seed varieties were evaluated at three sites in Tasmania in 2009 and 2010 for their suitability in winter and spring sowing and to determine their potential for Sclerotinia disease control. The new varieties evaluated were Indian mustard (Brassica juncea), white mustard (Sinapis alba), forage rape (B. napus), oilseed radish (Raphanus sativus) and Ethiopian mustard (Brassica carinata). The susceptibility of the new varieties to frost damage in winter and their growth habits will be presented. The biomass of all the biofumigant varieties sown in spring was 3 to 6 times higher than that of ryegrass. In a paddock that had a very high disease level, lettuce planted after Mustclean® (B. juncea) reduced lettuce drop incidence by 62% compared to those planted after ryegrass.

Evaluation of Ochrobactrum sp. as a potential bioherbicide for angled onion (Allium triquetrum L.) in laboratory conditions

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Angled onion (Allium triquetrum L.) is a noxious weed in Australia and is a member of the family Alliaceae (onion family). It invades periodically wet habitats and reduces biodiversity of native flora and, due to its strong onion odour, can detract from the quality of meat and dairy products. Biological control offers the only long-term cure and the fungus Stromatinia cepivora Berk. has previously been shown to be pathogenic and virulent but its use is problematic because it is also a virulent pathogen of cultivated Allium species, e.g. garlic, onions. An endogenous bacterium was isolated from shrunken bulbs collected from the Dandenongs. The bacterium was identified as close to Ochrobactrum anthropl using physiological tests and sequencing of the 16S region of the bacterial genome using the polymerase chain reaction (PCR) and the Big Dye method. Both potential biological control organisms were tested for pathogenicity and virulence on angled onion plants in test-tube trials. Both the bacterium and the fungus were separately pathogenic and highly virulent; infected plants died. However, the bacterium inhibited the fungus from growing when tested together, though host plants still died. The bacterium thus is potentially an effective and suitable biocontrol agent in wet areas, (where S. cepivorum is unable to germinate) and has the potential to be developed as a bioherbicide for A. triquetrum. Further studies need to be undertaken to test the bacterium host specificity for cultivated and ornamental Allium species in vivo to assess the risk of using it in field trials.
An oxidised derivative of linoleic acid (Mag-toxin) produced in Pyricularia oryzae

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Pyricularia isolates consist of several host-specific subgroups. This specificity may result from not only avirulence factors, but also active factors such as host specific toxins. Some phytopathogens have been isolated from cultures of Pyricularia isolates. These were necrosis-inducing factors except pyricularalan H³, but their yields have not been compared in Pyricularia isolates. We re-examined about necrosis-inducing factors in oatmeal agar culture and soy sauce liquid culture of Pyricularia isolates from oat, foxtail millet, finger millet, crabgrass and common millet. Pyriculol and epipyriculol were isolated as main factors in their all cultures². We found that conidia germination fluid and culture filtrate from an Avena isolate had chlorosis-inducing activity on oat leaf segments. We showed that the toxin (Mag-toxin) was the oxidised C18 unsaturated fatty acid by NMR and LC/MS. Chlorosis was induced by Mag-toxin in the light but not in the dark. Reactive oxygen species (ROS) and cell death were also induced by Mag-toxin in cells. The localisation of ROS generation correlates with the location of mitochondria. Interestingly, their induction was light-independent³.

REFERENCES

Genetic transformation in Colletotrichum truncatum associated with anthracnose disease of chili

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Colletotrichum truncatum is the causal agent of chili (Capsicum spp.) anthracnose causing severe economic loss through reduced yield and marketability of infected fruit. To this extent an efficient and reliable transformation system of the pathogen is required to understand its infection and colonisation lifestyle and also to assess the function of isolated pathogenicity genes through gene silencing or mutagenesis. An Agrobacterium tumefaciens-mediated transformation (ATMT) system was developed for C. truncatum. A. tumefaciens carrying a hygromycin phosphotransferase gene (hph) and a green fluorescent protein (GFP) gene was used to transform the conidiospores of two C. truncatum pathotypes (F8-3B and BRIP26974). Optimum transformation efficiency was obtained when equal amounts of A. tumefaciens strain AGL1 carrying either the pPJ1 or pPK2 binary vector was transformed with 10⁶ C. truncatum conidiospores ml⁻¹ and co-cultivated at 24°C for three days. Southern blot analysis and TAIL-PCR indicated that most of the transformants contained randomly inserted, single copies of the T-DNA. Infection and colonisation of chilli pepper fruit at the mature red stage with F8-3B-GFP and BRIP26974-GFP confirmed the virulence of these transformed pathotypes. Analysis by fluorescent microscopy showed that colonisation of parenchyma cells of fruit pericarp tissue occurred by subcuticular intramural infection. In the susceptible Capsicum annuum genotype, fungal hyphae were detected between the cell walls of parenchyma cells up to 1 cm in advance of the visible lesion, indicating that C. truncatum entered a short endophytic stage in its disease cycle before becoming necrotrophic. The application of the established ATMT system was further used to prove the function of the CcCut1 gene which encodes a C. truncatum cutinase protein. Preliminary results of CcCut1 RNA gene silencing revealed that expression of this enzyme is essential to establish infection of chili.

An aldehyde dehydrogenase gene and a phosphinothricin N-acetyltransferase gene compose of a pathogenicity island with hrp genes of Pseudomonas cichirii

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Pseudomonas cichirii harbors hrp genes (hrp) that encode a type III secretion system, essential for its virulence on eggplant. Their nucleotide sequences and gene composition are homologous to those of the single pathogenicity islands (S-PAIs) in P. viridiflava. An aldehyde dehydrogenase gene (aldH) and a phosphinothricin N-acetyltransferase gene (pat) are located in the flanking regions of hrp in both P. cichirii and S-PAI. An aldH-deficient mutant (ΔaldH) and a pat-deficient mutant (Δpat) from P. cichirii strain SPC9018 (SPC9018) lost their virulence on eggplant. Virulence of ΔaldH and Δpat was restored by transformation with aldH and pat originating from SPC9018, respectively. Expression of aldH and pat was not regulated by HrpL. These results demonstrate implication of aldH and pat in P. cichirii virulence, independent of hrp. Phylogenetic analysis based on the nucleotide sequences of aldH among P. cichirii, P. viridiflava and P. syringae strains showed that all these species represent different clusters of the phylogenetic tree. On the other hand, phylogenetic analysis based on deduced amino acid sequences of pat showed that P. cichirii strains formed monophyletic branches with P. viridiflava strains harboring S-PAI. Virulence of Δpat was restored by transformation with pat originating from Pv9504. Therefore, P. cichirii may acquire pat with hrp from the common ancestor with S-PAI and they might compose the PAI with aldH. Furthermore, inoculation to several host plants showed that aldH, pat and hrp may be involved in pathogenic diversity of P. cichirii.
Pathogenicity mechanism on *Verticillium* wilt of *Cotinus coggygria*

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Histopathological changes of *Cotinus coggygria* inoculated with *Verticillium dahliae* were observed by using paraffin sections and optical microscope photography. The results show that the different parts of *C. coggygria* had different infection levels, leaves was the highest (18.83%), while the lowest branches (6.72%). After inoculation, the elongation zone and mature zone of plants were initially invaded by hyphae, it appeared in the gap of cortex parenchyma cells within 1-3 cm of the root tip, and went into the vessels of the roots, then reached leaves through the vessels of stems and branches finally. *V. dahliae* mainly existed in the vessel of xylem in the form of hyphae. In order to prevent the expansion of pathogen during the process, the wall of vessel was thickened, the inside diameter of vessel was decreased by using jelly and tylosis generated in the vessel, or even the vessel was totally blocked. When *C. coggygria* was affected, the vessel walls, parenchyma cells and cortical cells were thickened, the inclusions of pith, resin canals and secretory cells nearby increased. The blocking of vessels would cause plants wilt, but couldn’t affect normal activities, thus it was not the primary reason of plants wilt. *Cotinus coggygria* were inoculated with crude toxin isolated from *V. dahliae*. The dynamic changes of SOD, POD, CAT, PAL and PPO in Cotinus tissues were analysed during induction procedure. The results showed that in the procedure of induction, CAT activity has decline apparently compared with initial activity, the other four enzyme activity increased, and activity peaks were accompanied. SDS-PAGE gel electrophoresis results shows that 25 kD, 27 kD pathogenesis related proteins expressed.

A change in the symptoms of vascular-streak dieback of cocoa in Southeast Asia and Melanesia


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Vascular-streak dieback caused by the basidiomycete *Ceratobasidium (Oncometabolus) theobromae* is a serious disease of cocoa in Southeast Asia and Melanesia. Remnant small green spots on leaves becoming chlorotic following invasion of the fungus through the xylem has been a distinctive symptom. Since 2004 markedly different leaf symptoms have been observed throughout the region — leaves develop large necrotic blotches, often without chlorosis, and infected leaves remain attached to branches for prolonged periods. The occurrence of first symptoms on about the second flush behind the shoot tip, vascular streaking, blackening of the vascular traces in leaf scars, infection only of xylem vessels, and the resistance originally selected in Papua New Guinea and elsewhere are largely unchanged. Corticioid basidiocarps characteristic of the species are still formed on leaf scars resulting from the fall of diseased leaves but the prolonged adherence of leaves allows their formation also on cracks in the petiole and the main veins by mycelium emerging through the cracks. Possible reasons for the occurrence of the new symptoms will be discussed.
Disease surveys of vegetable and flower crops in the Dalat area of Vietnam, and selected IDM strategies

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Over the past decade the Dalat area of Lam Dong Province in Vietnam has become a major centre for protected cropping of flowers and vegetables, as well as intensive field production of vegetables. The flowers and vegetables are produced for export and local distribution. The area is also a key centre for biotechnology, and nursery production of vegetable and flower transplants for distribution across Vietnam. Dalat is located in the southern highlands with moderate temperatures throughout the year and a distinct wet season. Consequently both temperate and tropical plant pathogens are common. The authors have conducted a series of disease surveys of most crops over the past six years. The intensive nature of crop production, and other factors have favoured the build-up of a range of serious pathogens. For example club root has been a major constraint to cabbage production. As in other parts of Vietnam, Pythophthora capsici has caused serious losses in chilli, and Pythium aphanidermatum has caused problems in some nurseries. Vascular wilts caused by formae speciales of Fusarium oxysporum have caused losses in some crops including carnations. Sclerotinia sclerotiorum has caused serious losses particularly in lettuce, lollo rosso, cabbages and other leafy crops. Root knot nematode is also common in a wide range of crops. Bacterial wilt has been a serious problem in tomatoes but the use of transplants grafted onto resistant rootstocks has provided an effective control measure. Viruses such as TMV also occur and can be of concern. We will briefly discuss and illustrate some of these diseases, and report on several integrated disease management strategies.

Evidence of absence or absence of evidence? Testing for viruses in Australian cereal crops

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Cereal viruses are economically important pathogens internationally but of the viruses recorded overseas only barley yellow dwarf virus and wheat streak mosaic virus have been tested for or identified in Australia in recent years. Soil-borne viruses have not been reported in Australia and pose a serious threat to Australia’s wheat industry should they arrive and become established. Foliar viruses can be difficult to diagnose because symptoms can easily be mistaken for a response to nutrient stress. The recent advances in molecular technology for diagnosis and identification have allowed the development of group-specific assays for the detection of furoviruses, hordeiviruses, rymoviruses and tritimoviruses. In addition, specific assays for barley yellow dwarf virus, wheat streak mosaic virus and high plains virus are available. These tests provide the first opportunity to survey for many of these viruses in Australia and results from a preliminary survey in Victoria will be presented.

White leaf disease of sugarcane in the Lao PDR

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Sugarcane (Saccharum spp hybrid) is a major tropical crop providing significant financial returns in many Asian countries. At least three sugarcane phytoplasma diseases occur in S. E. Asia—grassy shoot (GSD), green grassy shoot (GGSD) and white leaf (WLD). WLD symptoms are spectacular and include the emergence of pure white leaves from affected developing shoots. Initial symptoms include striped or mottled leaf patterns, but these give way to entirely white leaves; older leaves often remain green. Reduced shoot growth and stalk populations occur in diseased crops. Recommended options for disease management include: i. termination of badly-infested crops, ii. replanting with disease-free planting material, and ii. use of resistant varieties.

A visit to Lao PDR was made in April 2010. A survey of commercial crops showed that WLD was widespread; samples were collected for molecular analyses. Most farmers were unaware of the disease and the importance of using disease-free planting material; infested planting material is no doubt a contributing factor to the current disease epidemic. Losses from WLD in the 2010 crop will be very significant. Little knowledge of WLD varietal resistance was apparent. A number of commercial Lao varieties originated in Thailand and it is probable that diseases such as WLD were introduced via this material. The WLD epidemic is very significantly affecting Lao PDR sugarcane crops. There is an urgent need to improve WLD management in the local commercial sugarcane industry. The most pressing issue is the establishment of disease-free plant sources.

Plant health surveillance in Timor Leste

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Timor Leste is a recently independent nation in which approximately half the population live below the poverty line. Agricultural trade is an important factor in planned development, so there is a need to conform to International
Plant Protection Convention (IPPC) requirements. Specimen based pest lists are a key component of IPPC requirements. However, little is known about the plant health status of Timor Leste.

In April 2010, a joint Timor Leste Ministry of Agriculture and Fisheries/Australian Department of Agriculture Fisheries and Forestry plant health survey was conducted. The three week survey focused on central and western Timor Leste. Plant pathology specimens were returned to Australia, treated with gamma irradiation under quarantine import permit and identified at various laboratories.

Further surveys, of different regions and during different seasons, will provide a more robust and comprehensive picture of the nation’s plant health status and the quarantine risks that face both Timor Leste and Australia.

**Surveys for stem canker and stem borer of durian in the coastal areas of Cambodia**

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Surveys for the incidence of stem canker (*Phytophthora palmivora* Butl.) and stem borer (*Batocera rufomaculata* De Geer) of durian (*Zurio zibethinus* L.) were conducted in the major production area of Cambodia, from May to July 2010. In addition, participatory research among farmers, agricultural officers, and extension workers was initiated. Results indicated that the incidence of durian stem canker and stem borer were high in most orchards throughout the study area. Within three locations (Teuk Chhou, Kampot and Kep) in Kampot and Kep provinces, of the 300 trees examined over three-quarters and one-quarter were severely infected by stem canker and stem borer, respectively. Durians over 20 years-old have the most critical damages. Older trees displayed increased incidence and severity of stem canker ($r^2=0.071$ and $0.098$, respectively), while for stem borer the incidence was relatively low ($r^2=0.015$). Stem borer tended to attack trees affected by stress or stem canker rather than healthy trees ($r^2=0.23$). Farmers tended to lack knowledge in pest control, resulting in heavy infestation by these pests, and the death of trees after 4 to 5 years. Low available capital and price competition from imported fruit also contributed to lower pest control.

**Fusarium thapsinum is the dominant species associated with sorghum stalk rot in Queensland and northern New South Wales**

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Stalk rots and lodging are a continual threat to sorghum producers across Australia, particularly on the Darling Downs and central Queensland regions. The fusarium stalk rot pathogen was previously known as *Fusarium moniliforme* sensu lato, however it has now been separated into a number of species. These changes in taxonomy have led to the need to gain an understanding of the role that different *Fusarium* species play in sorghum stalk rots and lodging in Australia. Surveys have been undertaken throughout the major sorghum-producing regions in Queensland and northern New South Wales to identify the *Fusarium* species associated with stalk rot, and to determine their distribution and relative importance. To date, 296 *Fusarium* isolates have been collected from 64 sites. Of those, 197 isolates have been identified to species using either morphological characters alone, or both morphological and molecular techniques. *Fusarium thapsinum* is the dominant species in all regions and from all plant types sampled, followed by *Fusarium andiyazi*. The findings from these activities will assist in the development of an integrated disease management package for sorghum stalk rot in Australia. This study is a component of the GRDC funded Northern Integrated Disease Management project.
Occurrence of branch dieback and canker of mangoes in Derby, north Western Australia

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Canker, branch dieback and stem-end rot of mango (Mangifera indica) are important diseases causing by Botryosphaeria spp. Several species of Botryosphaeria have been reported to occur on mangoes orchards in Australia. Diseases associated with the Botryosphaeriaceae are often stress-related requiring a predisposing incident to trigger the disease expression. During the spring of 2009 branch dieback and canker caused severe damage in mangoes orchards in Derby. Samples of the declined trees were collected. Pathogen isolations were made from infected tissues. The growth rate, colony morphology and morphological characteristics of the isolated fungi were determined. Representative isolates were used for sequencing of the internal transcribed spacer (ITS) region of the ribosomal DNA following morphological identification. Pathogenicity tests were performed by using excised mangoes branches and Koch’s Postulates were fulfilled by re-isolation of representative fungal isolates. Morphologic identification and phylogenetic analysis of the partial ITS gene sequences showed that Lasiodiplodia theobromae, Neoscytalidium novaehollandiae and Pseudofusicoccum adansoniae were associated with the branch dieback and canker of mangoes in Derby. Lengths of lesions on the excised branches inoculated with representative isolates were indicated the significant potential of pathogenicity for all identified species. Cultures of P. adansoniae (WAC 13373), L. theobromae (WAC 13374) and N. novaehollandiae (WAC 13375) were deposited in the Western Australia Plant Pathogen Collection.

Timing of field fungicide applications to manage postharvest diseases of mangoes

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The two main postharvest diseases affecting mango fruits in most tropical environments are anthracnose (Colletotrichum gloeosporioides), and stem end rots (Fusicoccum parum, Lasiodiplodia theobromae and Phomopsis mangiferae). The application of strategically timed fungicides in the orchards and the use of postharvest fungicide dips are critical in minimising the effects of these diseases. Two fungicides, Amistar® SC and Aero® were each applied at different stages of fruit development (early, mid or late season), as single, double, triple or combination sprays in a replicated field trial. Fruits were harvested at maturity and rated for disease development. Disease pressure was quite high in the trial block with up to 85% of fruit infected by postharvest rots in the untreated controls just 14 days after incubation. There were significant disease incidence differences between the various treatments but no treatment differences for disease severity between treatments. Anthracnose was more predominant than SERs on the sampled fruits. Orthogonal contrasts showed that there was no significant treatment differences in the efficacies of the two fungicides used for disease control. The single early sprays were just as effective as the double, triple and combination sprays. The single late sprays, one week prior to harvest, were ineffective as they were not significantly different from the untreated controls. The results of this investigation clearly demonstrates the importance of early spray interventions to suppress disease incidences from developing fruits instead of using a late spray just before harvest.

Phytophthora bud rot of oil palm in Colombia

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Bud rot (‘Pudricion del cogollo’, PC) is the most serious disease of oil palm in Colombia and neighbouring countries, causing up to 100% mortality in some areas. Symptoms first appear as necrotic lesions on young, unexpanded spear leaves. Lesions increase in number as the disease develops to cause rotting of all new tissue in the heart area. There is no damage to leaves formed before the infection or to the meristematic area. Early infections can be controlled by surgery of infected tissue, however once it develops, colonisation of the infected tissue by opportunistic microorganisms and insects promote rotting into the meristem, reducing the possibility of recovery of the affected palms. The surgery is complemented with the treatment of the affected and neighbouring palms with a cocktail of fungicide, bactericide and insecticide. This procedure reduces the impact of the disease in different growing areas. Other control measures are being investigated. The causal agent has recently been identified as Phytophthora palmivora. Pathogenicity of field isolates has been confirmed by inoculation of detached very young spear leaflets and of nursery palms. Both assays reveal rapid colonisation of healthy tissue and the development of sporangia as well as the release of zoospores initiating secondary infections. A reliable pathogenicity assay is essential for breeding activities aimed at identifying sources of resistance to this disease. Investigations of pathogen diversity and the disease cycle continue. This disease presents a significant threat to the oil palm industry in Asia and the Pacific.
Investigations into passionfruit short vine life in north-west Australia

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Panama Red passionfruit has potential as a commercial crop in north-west Australia, but is plagued by ‘short vine life’ (SVL), a disorder where vines collapse and die prematurely. SVL has been known in Darwin for many years, and has been quantified in this ACIAR project. Vines with SVL die prematurely, often within a year of planting. The disorder was reported from Coastal Pains, Berrimah and Noonamah in Darwin, Manbulloo in the Northern Territory, and possibly from Kununurra in north-west Western Australia. The problem was not observed on a Darwin farm with less compact soil. It is not caused by Fusarium wilt. Many samples exuded ooze in water. The ooze did not cause wilt in inoculated tomatoes, and was negative in the Ralstonia solanacearum test kit. In contrast, a bacterial isolate from a wilted tomato was positive in the Ralstonia test kit. The bacterium in the SVL ooze was identified by molecular and semi-molecular techniques as Klebsiella. Panama Red seedlings and grafted on QDPI Flavicarpa rootstock succumbed. In contrast, Birdwood Brazilian Flavicarpa as seedlings or as rootstocks showed good longevity. Neither Pythium nor Phytophthora were isolated from any of the SVL passionfruits in the NT. Roots from an affected vine tested negative in both a Pythium and Phytophthora test kit, and no Pythiaceous were isolated on PDA from this sample.

Post-harvest disease control in ‘Arumanis’ mango under sea-freight conditions

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Shelf-life of mangoes is limited primarily by post-harvest diseases, namely anthracnose (caused by Colletotrichum gloeosporioides sensu lato) and stem-end rot (caused by Botryosphaeria spp.). As a result, export by sea-freight is unviable without adequate disease control. A trial was undertaken to evaluate post-harvest treatments in ‘Arumanis’ mangoes that would provide sufficient disease control to allow reliable sea-freight from Lombok, Indonesia to northern ‘south-east Asian’ markets. Fruits were immersed for 2 minutes in either fludioxonil (600 ppm a.i.) or a mixture of azoxystrobin + difenconazole (600ppm + 375ppm a.i.) at ambient temperature (28°C), or in hot water at 58–60°C. Fruits dipped in ambient temperature water were used as a control. Fruits from each treatment were then stored under two conditions; either a) room temperature (25–30°C) for the full assessment period, or b) for two days at room temperature, then for five days in a cold room (15–20°C) before being returned to room temperature again for the remainder of the assessment period. Fruits were assessed 14 days after harvest and the total (anthracnose + stem-end rot) disease incidence recorded. On fruits stored at room temperature, the incidence of disease was 65%, 9%, 23% and 13% for the control, fludioxonil, azoxystrobin + difenconazole and hot water treatments, respectively. On fruits stored for five days in a cold room, the incidence of disease for the same treatments was 22%, 6%, 13% and 4% respectively.

Influence of cyclones on disease incidence and severity in horticultural crops in far north Queensland

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Cyclones bring much needed rain to northern Australia but they can also wreak havoc on farming communities in the region. On 3 February 2011, Category 5 tropical Cyclone Yasi crossed the coast between Innisfail and Cardwell causing devastation and losses estimated at $220 million to banana, papaya, exotic fruits and ornamentals. Gale force winds to 300 km/hr experienced during the cyclone were followed by weeks of heavy rainfall. Much of the cropping in the severely affected zone was either lodged or uprooted. Many plantings that appeared to suffer little or no physical damage later developed diseases predisposed by the severe winds and rain. In papaya, there has been an increase in the incidence of Phytophthora-related diseases, anthracnose and other fruit rots. Bananas that were wind damaged but not destroyed have developed severe yellow Sigatoka and in some cases Erwinia soft-rots. In the exotic fruits such as rambutan, mangosteen and durian, root and leaf diseases and fruit rots are of primary concern and with ornamentals there has been an increase in the incidence of Phytophthora-related diseases and bacterial and fungal leaf spots.
Planning for the future: introducing plant biosecurity activities into schools to increase Australia’s plant health capacity

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Capturing the imagination of school children and developing their enthusiasm for protecting plants from pests is important to ensure Australia’s future capacity in science and plant biosecurity. Many national and international studies have demonstrated that unless children are introduced to science and related disciplines at an early age they are unlikely to pursue careers in these areas. It is also important that once they acquire an interest in science that this interest is nurtured, particularly through the teenage years.

The Cooperative Research Centre for National Plant Biosecurity school education strategy aims to educate the next generation of scientists and science users. By portraying plant biosecurity and science in a positive and exciting manner to students from a young age, it is hoped that more students will be encouraged to pursue science as a career and, in the long-term, fill some of the science, engineering and technology skills gaps.

We have developed a variety of learning activities that are delivered through three key elements—‘Plant Pest Investigation with Lily and Sam’, ‘Plant Pest Investigators’, and ‘Plant Pest Investigations’—that are aimed at primary, primary, and secondary school students respectively. This presentation will outline the various activities we offer, and the feedback from schools to date.

Enrolments are open! Introducing the certificate, diploma and masters in plant biosecurity

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Enrolments for the Postgraduate Certificate, Diploma and Masters in Plant Biosecurity are now open. This postgraduate study in plant biosecurity has been developed specifically for those working in the plant biosecurity sector or for people who wish to pursue a career in plant biosecurity. The individual units are delivered entirely online, so you can study in the comfort of your own home.

Feedback regarding the postgraduate study has been extremely positive with many students commenting that the course content and format is excellent and very relevant and useful to them. If you hold a relevant degree from a recognised university you will be eligible to enrol directly into the Diploma or Masters course. If you do not hold a degree but hold relevant professional experience you will be eligible to enrol in the Graduate Certificate. Individual units are also available for those interested in a specific topic. If you are currently enrolled in another postgraduate course you may be able to complete units from the plant biosecurity program and have them count towards your qualification.

Current students include staff from Commonwealth and state agencies, recent graduates, and internationals. This presentation will provide an overview of the courses, for both prospective students, as well as employers who may wish to provide formal qualifications for their staff.

Increasing diagnostic capacity of plant diseases in Timor Leste using remote diagnostic microscopy


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Plant diseases are a major issue in developing countries such as Timor Leste, due in part to an inherent lack of skills resident in the country to diagnose plant diseases quickly and accurately. This limits the ability of the plant pathologist to rapidly send a diagnosis, together with appropriate advice on control, to the farmer. It also limits the ability of Timor Leste to quickly identify exotic diseases and rapidly initiate strategies to control and limit their spread. To address this issue, Timor Leste has introduced remote diagnostic microscope equipment (RDME) with the help of the Northern Territory Department of Resources, the Cooperative Research Centre for National Plant Biosecurity, Charles Sturt University and AusAID. This equipment will facilitate the quick identification of samples by allowing Timor Leste real-time access to a wider diagnostic network of expertise in Australia and SE Asia and to be part of the emergence of web based diagnostics and the growth of Padil (www.padil.gov.au). RDME, and continuing interaction with rapidly expanding virtual diagnostic communities, will greatly enhance teaching opportunities and knowledge sharing with research institutions, museums and universities. This equipment is now being used successfully to rapidly and accurately identify agronomically important pests and diseases in Timor Leste.

Best practice management framework for Phytophthora dieback in south-west Western Australia

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The introduced plant pathogen Phytophthora cinnamomi is a major threat to the biodiversity of southern Australia. In its 14 years of operation, the Dieback Working Group has identified local government agencies as having a central role in minimising the spread of Phytophthora dieback throughout the many natural and often vulnerable bushland reserves and roadside networks they manage. Furthermore,
LGA’s have a key role in raising awareness of Phytophthora dieback, its impact and management within their community. Given the complexity of the issues involved, managing the spread of Phytophthora dieback has always represented a significant challenge with many LGAs.

The Dieback Working Group has worked closely with LGA’s and allied industries to develop The Phytophthora Dieback Best Practice Management Framework: an integrated web-based management and communication system to aid in the consistent management of the disease (http://www.diebackmanagementsupport.com.au). The Framework provides a set of guidelines, training modules and communication links by which land managers, industry, contractors and community members can (1) access Phytophthora dieback management information and guidelines (2) assess and demonstrate their compliance to best management practices (3) increase Phytophthora dieback management capacity, skills, and knowledge, and (4) foster a culture of joint responsibility, leadership and ongoing quality development. The development of the framework and its roll-out within south-western Australia will be discussed.

Successful establishment of a cooperative research model—biological control of Parkinsonia (Parkinsonia aculeata)

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Parkinsonia, Parkinsonia aculeata L., is a woody shrub, which is classed as a weed of national significance in Australia. It is considered a major threat to both managed and natural ecosystems. Research into the cause of a commonly occurring dieback disorder in Parkinsonia found across much of its native range has identified a range of endemically occurring fungal organisms to be associated with affected plants.

A cooperative research model has been developed to allow regional Landcare groups, government agencies, graziers, mining companies, indigenous wild river rangers and shire weed management officers also to participate in this research program. This standardised model for small-scale trials has enabled these interest groups to establish, monitor and evaluate the performance of a range of potential fungal biological control agents under local conditions. A research kit is a key element of this program and includes resources needed to establish the trial, an instruction manual which outlines the procedures required to select an appropriate trial site, inoculate trees, collect and report data. A series of 11 one day workshops funded by industry and government grants have been delivered in partnership with regional bodies across three states establishing successful collaborations. This cooperative approach has engaged and enabled interest groups to participate in the development of potential solutions for Parkinsonia management their regions.

Papua New Guinea, the last country to succumb to late blight in potato

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An epidemic of late blight caused by Phytophthora infestans swept through the highlands of PNG in early 2003, destroying potato crops and depriving smallholder farmers of an important source of cash. Since then, the popular variety Sequoia cannot be grown without weekly fungicide sprays. A five-year Australian aid project involved evaluation of fungicides, field screening of 59 CIP potato breeding clones for resistance and improving capacity in seed potato production. Twelve of the most suitable of these clones, needing little or no fungicides, are now undergoing further evaluation in farmer participatory trials across the highlands, offering the promise of reviving potatoes as part of the smallholder economy.

Analysis of the P. infestans population has so far found only one genotype in both potato and tomato, different to genotypes from Australia and parts of Asia from which data is available. Current evidence strongly supports a European origin, as the genotype found in PNG is identical to a one that was common in Europe in the 1990s, variously named 2_A1, NL-41 and RF039.
Molecular differences between strains of *Pseudomonas syringae* pv. *actinidiae* isolated from Europe and those isolated from Asia

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*Pseudomonas syringae* pv. *actinidiae* (Psa) is the causal agent of bacterial canker on kiwifruit, which has been reported in Japan, Korea, Italy, France and Portugal. An economically important outbreak of bacterial canker on kiwifruit has been reported in 2009 in Latina, Italy. Using the primers BOXA1R the strains isolated from Europe since 2008 showed a unique pattern which was different from that obtained using DNA from the strains isolated in Asia or in Italy before 2008. Analysis of the DNA sequence of the housekeeping gene cts (gltA) revealed two haplotypes differing by only two base pairs. All the strains were isolated from Europe since 2008 belong to the same haplotype, while all the strains from Asia and those isolated in Italy before 2008 belong to the other haplotype. Other biochemical characteristics such as florescence on different media support the separation of strains of Psa in two different groups. The perfect correlation between the BOX PCR fingerprints, the cts haplotypes and biochemical characteristics suggest that the recent epidemics of bacterial canker in Europe were caused by the same strain which is different from those isolated previously in Asia.

Flagellum-mediated motility and pilus-mediated sessility are important for virulence in *Pseudomonas syringae* pv. *tabaci* 6605

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In phytopathogenic bacteria it is known that 1) surface motility requires flagellum, and 2) surface motility is important for virulence. We have found that flagellar motility is indispensable for complete virulence using flagellin-defective ΔfliC mutant in *Pseudomonas syringae* pv. *tabaci* 6605. However the role of type IV pilus in bacterial virulence is not well understood. In this study, we generated pilus-defective mutant strains, ΔpilA, ΔpilO and ΔfimU and their bacterial characteristics were investigated. The pilA and fimU encode major pilin and putative minor pilin subunit protein, respectively. Whilst the requirement of pilO for pilus biogenesis is known, all ΔpilA, ΔpilO and ΔfimU mutant strains abolished the ability to form biofilm, and reduced surface motility and virulence. Microarray analysis revealed that these pilus-defective mutant strains reduced hrp-related gene expression, whereas ΔfliC mutant activated hrp-related gene expression. Induction of hrp gene expression was greater in colonies grown on solid medium than in a suspension cultures in liquid medium. These results indicate that 1) both flagellum and type IV pilus are important for virulence, and 2) mutations of flagellum- and pilus-related genes inversely affect hrp gene expression.

Acquisition of a pathogenicity island encoding coronafacic acid in *Pectobacterium carotovorum* subsp. *carotovorum* strains causing blackleg on potato

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*Pectobacterium atrosepticum* (Pba) and *Pectobacterium carotovorum* subsp. *carotovorum* (Pcc) are economically important enterobacterial pathogens of potato that cause soft-rot of tubers after harvest. *Pba* is also responsible for blackleg of stems during the growing season. The phytotoxin coronafacic acid (CFA), encoded on a putative pathogenicity island (PAI) called HA12, is essential for development of blackleg by *Pba*.

Recently, surveys to identify black-leg causing organisms have isolated Pcc from disease lesions in plants, suggesting a possible role for Pcc as a second causative agent of blackleg. Here, we describe the discovery of the coronafacic acid biosynthetic cluster in NZEC1, a strain of Pcc capable of causing severe blackleg symptoms. Comparative genomics showed that the DNA sequence and structural organisation of the CFA biosynthetic clusters is highly conserved in *Pba* and Pcc. The CFA cluster is, however, encoded by a unique 98,583-bp PAI, named HA118, which is delineated by 48-bp direct repeats identical to those of HA12 and is inserted within a ph-trNA. HA118 is not present in Pcc strains unable to cause blackleg, suggesting that acquisition of the island via horizontal gene transfer may have been responsible for the evolution of *Pcc* strains to cause blackleg.

In planta excision of a pathogenicity island, HA12, in *Pectobacterium atrosepticum* is mediated by integrase

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HA12 is one of 17 putative horizontally acquired genomic islands (GIs) found on the chromosome of the bacterial phytopathogen *Pectobacterium atrosepticum* (Pba). GIs are unstable regions on the chromosomes of bacteria, often carrying genes useful for rapid adaptation in the environment. During horizontal gene transfer (HGT), GIs excise from the chromosome and form a circular extrachromosomal intermediate that carries a phage integration site (attP). Upon excision the chromosome is repaired, resulting in reconstitution of the chromosomal insertion site (attB). Here, we demonstrate excision of HA12 using quantitative PCR to detect attP and attB. Furthermore, we show the formation of attP and attB is
abolished when a Pba int mutant is grown in planta suggesting that excision is regulated by Int, a tyrosine recombinase family-related integrase. HAI2 encodes phytotoxin coronafacic acid, which is required by Pba for pathogenicity on potato. Thus, acquisition of HAI2 via HGT was likely important in the evolution of Pba as a phytopathogen. We hypothesise that the HAI2 retains the potential for transmission to other related bacteria by HGT.

A novel N-acylhomoserine lactonase AIDH from Ochrobactrum sp. quenches the pathogenicity of bacterial pathogens

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N-acyl homoserine lactones (AHLs) are used in many quorum-sensing systems as signal molecules to regulate interactions between various pathogenic bacteria and their hosts. Quorum quenching by enzymatic inactivation of AHLs has been intensively studied in recent years, and several such enzymes have been reported. We cloned a novel gene termed aidH responsible for AHL degrading from a soil bacterial strain, Ochrobactrum sp. T63. The mutational analyses reveal that aidH is the only gene responsible for degrading AHL signals in strain T63. The predicted amino acid sequence of AidH shares no similarity with any of the known AHL degradases, but exhibits 85% identity to alpha/beta-hydrolase fold from Ochrobactrum anthropi ATCC 49188. By HPLC/MASS analysis, we demonstrate that AidH functions as an AHL-lactonase that hydrolyses the ester bond of the homoserine lactone ring of AHLs. It is also demonstrated in our experiment that AidH did not show substrate specificity on AHL-type molecules. Expression of the aidH gene in Pectobacterium carotovorum subsp. carotovorum Z3-3 and Acidovorax citrulli MH21 abolished their AHL production and dramatically attenuated their pathogenicity on host plants, indicating that this enzyme is able to effectively quench quorum sensing-dependent functions in these bacteria by degrading AHLs.

Genetic and phenotypic diversity of Pseudomonas syringae strains isolated from waterways on three continents

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Strains that produced a fluorescent pigment on King’s B medium and did not produce a cytochrome c oxidase or an arginine dehydrolase and which were identified as Pseudomonas syringae were consistently isolated from headwaters and water streams outside agricultural areas in France, the USA and New Zealand. Based on the phylagenetic analysis of the concatenated cts, gapA, gyrB, and rpoD gene sequences, the 50 different pathovars of P. syringae identified today belong to five clades. A similar phylagenetic analysis of the strains isolated in this study revealed nine clades of P. syringae not previously described. Most of the strains in those new clades induced HR on tobacco, indicating that they are potential plant pathogens. Phylogenetic analysis based on haplotypes of the cts sequences of 323 strains, including 236 strains from water, led to the differentiation of the strains into three ecotypes: water strains, crop strains and ubiquitous strains. Some haplotypes were found at every location and each location had some unique haplotypes.
**Teratosphaeria destructans in Australia: biosecurity threat or elusive native pathogen?**

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Teratosphaeria destructans was first described in 1996 from north Sumatra, Indonesia, where it caused a severe leaf and shoot blight on Eucalyptus grandis in nurseries and young plantations. Since then it has been reported in nurseries and plantations in Vietnam, Thailand and China, with its host range extending to include E. camaldulensis and E. urophylla. Teratosphaeria destructans has also been reported from native E. urophylla in East Timor and was considered a significant biosecurity threat to Australia’s native eucalypt forests and plantations. A study on the population diversity of K. destructans isolates throughout south-east Asia in which 8 gene regions were sequenced (four nuclear genes, one mitochondrial gene and three microsatellite markers) detected very low nucleotide polymorphism. This genetic uniformity is indicative of an introduced population which has subsequently spread throughout Asia via human-mediated movement of germplasm. Surveys of sentinel plantings in northern Australia (Queensland, Northern Territory and Western Australia) revealed a complex of Teratosphaeria spp. among which K. destructans was detected. The same gene regions and markers were sequenced as for the Asian study and the diversity among the K. destructans isolates in Australia was found to be much greater than that in Asia. We believe that K. destructans in native to Australia where is resides asymptomatically within the native vegetation. The disease is only expressed when non-endemic eucalypts are planted. As such the pathogen is a major encumbrance to the establishment of commercial eucalypt plantations in Northern Australia. The disease has not been observed in native ecosystems, but the effect of inoculum build up within plantations on adjacent native eucalypt remnants is not known.

**The pan-genome of Erwinia amylovora provides insights into host specificity and better diagnostic design**

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Erwinia amylovora, the causal agent of fire blight, is a destructive phytopathogenic bacterium of plants in the family Rosaceae. E. amylovora is known not to occur in Australia and is therefore, a major biosecurity threat to the Australian pome fruit industry. Better understanding of the biology of this organism and its interaction with host plants, aids in our preparedness for, and ability to prevent future incursions.

The pan-genome of a bacterial species is composed of a core set of genes present in all strains (core genome), and a dispensable set of genes present in two or more strains and genes unique to single strains (flexible genome). It has been shown in many clinically important bacterial populations that the pan-genome of a species can provide important information on the diversity of a species. In particular, the pan-genome can have wide implications for development of control strategies, diagnostics and greater biological understanding of an organism.

We have identified the pan-genome of E. amylovora using complete genomes of 12 diverse strains of E. amylovora. We will present highlights of this research including an analysis of the flexible genome of E. amylovora which identified new candidates for host specificity including genes involved in secondary metabolite production and toxin biosynthesis, putative effector proteins and plasmids. We will also discuss how the core genome of E. amylovora has been used in a genomics based pipeline for molecular diagnostic target identification.

**Population structure of Ascochyta rabiei in Australia, using the newly developed microsatellite loci markers**

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The genetic structure of the chickpea pathogen, Ascochyta rabiei (teleomorph: Didymella rabiei) in Australia was determined using previously published and newly developed microsatellite markers. A total of 104 isolates collected from chickpea growing regions in Victoria (Kalkee and Kaniva), South Australia (Kingston and Melton) and Western Australia (Northam) were genotyped with the Multiplex-Ready PCR technique. Of the 116 microsatellite markers tested, 62 produced a clear and reproducible amplification product and 22 were polymorphic, with two to four alleles per locus. Haploid gene diversity (H) of 0.095 across all isolates indicated a low genetic diversity within the Australian population, suggesting a recent founder event. The pre-existing microsatellite markers (Geistlinger et al. 2000) identified just 19 haplotypes, however, the newly developed microsatellites (Leo et al. submitted) identified 57 haplotypes among the 104 isolates. All populations were in significant linkage disequilibrium and, coupled with the presence of only one mating type (MAT1-2) it is proposed that A. rabiei is reproducing asexually in Australia. The majority of the genetic variation was observed within populations (91%), compared to among populations (9%). Although relatively low in molecular variation at the microsatellite loci assessed, pathogenicity trials with the same isolates suggested that highly virulent isolates exist, and as evidenced by the 2010 epidemic in northern NSW on the moderately resistant cv. HATTrickTM.

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This raises questions regarding the possible selective adaption of the isolate population towards prevalence of virulent isolates able to overcome the newly adopted moderately resistant varieties around Australia.

Genetic diversity of Guignardia musae on banana based on internal transcribed spacer region of ribosomal DNA


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Freckle disease of banana caused by Guignardia musae is an economically important disease in many banana producing countries. Both Cavendish and non-Cavendish bananas are susceptible to the disease depending on genotypes and geographical locations. Though freckle disease is present in Australia, the pathogen is regulated as a bio-security pest due to the fact that the Australian Cavendish banana genotype appears to be tolerant to the strain(s) of the pathogen found in Australia. In Asia and Oceania, both the Cavendish and non-Cavendish banana genomic groups are highly susceptible. In view of these host range differences between various geographical regions, it is hypothesised that different strains of Guignardia musae may occur in different parts of the world.

The aim of this study is to assess genetic diversity of Guignardia musae worldwide and to determine whether there is more than one strain of Guignardia musae with genotypic variability causing freckle disease on banana.

A global set of freckle disease infected banana tissues including endemics have been collected. The fungal DNA was extracted and compared by means of internal transcribed spacer region nucleotide sequence data. Analysis of sequences generated has shown at least three clades of Guignardia musae based on host genotypes and to some extent geographical locations. This is the first report of a genetic diversity study of Guignardia musae on banana.

Species composition and genetic diversity of Cylindrocarpon species found commonly infecting New Zealand grapevines

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Black foot is an often fatal rot of grapevine trunk bases caused by Cylindrocarpon spp. In a 2005 survey of New Zealand vineyards approximately 170 Cylindrocarpon spp. isolates were recovered from symptomatic plants obtained from eight grape-growing regions throughout the country. Identification of Cylindrocarpon species by morphological features alone was insufficient to confidently differentiate the collected species so molecular methods were employed using recently developed species-specific primers. The results showed that the collection contained 53, 58 and 41 isolates of C. destructans, C. liriodendri and C. macrodidymum, respectively. DNA sequence analysis of 10% of the isolates from each species group confirmed the reliability of the species-specific PCR. In addition, another 14 isolates that were not amplified by the species-specific primers were analysed by DNA sequencing of the β-tubulin region. Similarity with sequences on GenBank identified them as C. pauciseptatum (9), Cylindrocarpon sp. (a new species; 4) and Cylindrocladiella parva (1). The genetic diversity of each species group was investigated using 5 UP-PCR (universally primed polymerase chain reaction) primers which generated information for 66 loci. Each locus was scored for presence or absence of bands and the resultant binomial matrix used to generate a neighbour joining tree. Both intra- and inter-specific diversity within and between vineyards was observed. The implications of genetic diversity will be discussed.
Biosecurity risk of native fungi

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Mitigation of the biosecurity threat of fungal pathogens focuses largely on the risk surrounding the introduction of known pathogenic fungi to new regions, due to the damage that they might cause to exotic crop plants of those regions. In a few cases, risk to native plants are also considered. However, the opposite is rarely treated as a possible biosecurity threat—the impact that native fungi already present in a region might have on newly introduced, disease-free plant species. In this case the pathogen is not moved, but rather the host is shifted so that it comes in contact with potential new pathogens. There is strong evidence that large numbers of native fungi can take advantage of the introduction of new plant species. They can form associations with those new plants, and in some cases evolve new diseases following the introduction of these new hosts. Some examples will be presented, along with a discussion on the biosecurity implications.

Sulfuryl fluoride as a quarantine treatment for timber commodities

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There is a need for quarantine treatments for timber and timber products as an alternative to methyl bromide. Sulfuryl fluoride is examined as a possible candidate. Timber and timber commodities can be host to diverse organisms of quarantine concern. There is some information available to indicate dosage levels for sulfuryl fluoride necessary to kill individual species of fungi, insects and nematodes. Further research on various life stages of different pest organisms on a wider range of timber species, thicknesses and moisture contents as well as length of treatment is needed before a specific level of sulfuryl fluoride can be recommended for use as a quarantine treatment. Too little data exist to be able to consider the use of sulfuryl fluoride against mites, spiders and bacteria or heterogeneous communities of pests in timber commodities. Much higher dosages are needed to kill pests at 15°C than at 30°C. Treatments below 15°C are often not effective. Effective dosages to kill some species of fungi are unrealistically high for commercial applications and would be difficult to maintain in shipping containers or under tarpaulins.

National strategies to enhance Australia’s plant biosecurity system

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Australia’s biosecurity system comprises activities through the continuum of pre-border, border and post-border, and protects plant production industries worth $25 billion per annum. While there is a recognition that Australia has a comprehensive plant biosecurity system characterised by transparency and scientific rigour, it faces an increasing number of challenges, including increasing volumes of trade and movement of people, management of climate variability and conflicting priorities for resourcing. Although many components are in place to support a national plant biosecurity system, as yet there is no coordinated framework to guide investment and development of capacity and capability. There is a need for government agencies and industries to work in partnership to meet future challenges.

Through consultation with stakeholders, these challenges are being met with the development of a National Plant Health Strategy (NPHS) that presents a comprehensive vision for the national plant biosecurity system in 2020. The NPHS, together with sub-strategies addressing plant health diagnostics and surveillance, provide a template for government and industry to build on the strong foundations and improve Australia’s biosecurity system in the next decade.

Biosecurity research and development needs for the AQIS Operational Science Program

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The advent of rapid transport systems has led to significant movement of people and cargo globally. Combined with increasingly intensive agriculture and climate change, globalisation has provided opportunities for exotic plant pests to rapidly expand in distribution and importance. An integrated biosecurity continuum involving risk assessment and monitoring, surveillance and response pre-border, at the border and post-border is essential in managing these risks. Effective biosecurity requires effective partnerships that cover the whole biosecurity continuum from Commonwealth and State Government departments, industries to farmers and communities. However, it is impossible to implement a zero-risk phytosanitary policy because the only no-risk policy is to exclude trade and tourism which of course is untenable. Furthermore, natural pathways will always present a route for entry of exotic pests. As such the best a country can do regarding biosecurity measures is to implement a risk-managed approach and implement controls at pathways designed to
reduce risks to an appropriate level of protection. As plant scientists working in the area of research, diagnostics and extension, everyone at this conference plays an important role in Australia’s biosecurity continuum.

This presentation will summarise the Australian Government’s role in the biosecurity continuum including some key disease interceptions made over the last 5–10 years and research and development needs from a plant biosecurity perspective and how you can help to support the biosecurity continuum.

Development of biosecure packaging for transport of emergency plant pest samples

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There are significant risks involved with movement of diagnostic samples potentially containing emergency plant pests (EPPs) within Australia and internationally. This has recently been recognised by the proposed inclusion of quarantine plant pathogens in the definition of infectious agents in the UN regulations for transport of dangerous goods. In addition, an Australian biosecurity review highlighted the difficulties with packaging and transport of test samples between states as an issue that must be resolved to ensure the development of a successful national diagnostic system for EPPs within Australia. A recent project funded by the Cooperative Research Centre for National Plant Biosecurity has addressed these issues by developing packaging standards that can be used for secure containment and transport of diagnostic samples. Various plant material, cultures and insect samples were packaged in single, double and triple packaging of varying combinations using a range of readily available material purchased from commercial suppliers and supermarkets. The packaging was tested using the IATA Infectious Substances Shipping Guidelines and the successful packaging combinations were then posted or couriered to three laboratories within Australia. Packages were deemed to have failed if the integrity of the package was compromised, or the sample was not maintained in a suitable condition for testing. The best packaging for each sample type was used to develop the recommendations.

Re-establishing area freedom for Globodera rostochiensis in Western Australia—a world first

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Potato cyst nematode (PCN, Globodera rostochiensis) was detected at six sites (total of 15 ha) in the Perth metropolitan region of Western Australia between 1986 and 1989. Immediately, an eradication campaign was established and strict quarantine protocols put in place. State-wide surveillance for PCN has continued to the present day. This detection of PCN resulted in national and international market restrictions on the import of WA potatoes.

Since it is now 21 years since PCN was last detected in WA, data have been collected to provide evidence for State-wide absence of the pest in potato production areas.

Historical records were collated and intensive soil sampling and assessment schemes were carried out to determine, with a high degree of certainty, the current status of PCN in WA. The soil sampling and assessment methodologies used were highly sensitive, providing a 96% statistical likelihood of detecting PCN if present at low levels.

From 2.9 t of soil samples, 27 kg of organic matter was extracted and examined microscopically for PCN cysts. No PCN was detected from any current potato production area. These data supported findings of state-wide PCN testing conducted in all regions from 1986 to 2009 and show that: PCN was successfully eradicated from the sites of the original infestation; PCN did not spread to any other production area of the State; PCN is absent from all potato production areas of WA.

WA was declared free of PCN on 13 September 2010. Negotiations to regain access to markets for WA growers have commenced.
ACIAR research benefits agriculture in Australia and developing countries

The Australian Centre for International Agricultural Research (ACIAR) is an Australian Government agency which provides funding for agricultural research in developing countries and Australia. It is part of Australia’s Aid Program within the Foreign Affairs and Trade Portfolio.

ACIAR’s unique position
Australia has outstanding strengths in agricultural research and shares similar agricultural systems and environments with many of its developing-country partners. This enables ACIAR to fund research and develop partnerships between Australian and developing-country research institutions.

ACIAR’s aim
ACIAR aims to enhance rural household incomes and broader economic growth by investing in research partnerships that encourage agricultural development and capacity building in Australia and our partner countries.

ACIAR’s partnership model and mutual benefits
ACIAR’s partnership model delivers mutual benefits in a range of areas:

- **Improving resource management** (including water use and conservation agriculture). Australian and Vietnamese researchers are working to develop technologies to increase the profitability and sustainability of sandy soils through improved crop and soil management in Vietnam and south-west Australia.

- **Increasing farm incomes.** Mango research in the Philippines and Australia is resulting in more mangoes of better quality getting to markets, which puts more money in farmers’ pockets.

- **Improving biosecurity.** Collaborative work to manage and reduce the threat of avian influenza in neighbouring countries helps protect Australia’s borders from an outbreak.

- **Adapting to change** (including climate change mitigation and adaption). Farmers in Australia and India are working together to make saline-affected, unproductive lands profitable again through seafood production, including prawns and rainbow trout.

ACIAR projects also boost Australian scientific capacity, build international linkages and create significant goodwill.

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Poster abstracts

1 Tolerance to foliar diseases in zucchini, squash, cucumber and pumpkin cultivars in north Queensland

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A key component in integrated foliar disease management of cucurbits is the use of plant genetic resistance. Commercial cucurbit cultivars and new cultivar lines should be screened for resistance to foliar diseases in the regions where they are commercially grown in order to identify cultivars with acceptable low disease levels and high marketable yields. Six field trials were conducted in the dry tropics of north Queensland, to evaluate the reactions to powdery mildew (Podosphaera xanthii), downy mildew (Pseudoperonospora cubensis), and anthracnose (Colletotrichum orbiculare) in a range of cultivars and lines of zucchini (Houdini; CLX29881; 7708; Paydirt; Caroline; Nitro; Amanda; Congo; Crowbar; HMX5702; Calida; Zest; Golden Rod; HMX5713), squash (Sunburst; Delica; Naches; Cochise), cucumber (Camelot; Aladdin; Gremlin; Stonewall; HMX4453; Diamante; Crystal Salad), and pumpkin (Sampson; 183-6; 188-6; Early Jarragrey; Royal Grey; Kens Special 864; Kens Special; Dynamite; TNT).

Crops were grown with fungicide sprays at two research locations, with plantings in June and July, in order to favour conditions for disease initiation and spread. Plants were assessed for disease severity throughout the cropping season and the areas under the disease progression curve were calculated for comparison among cultivars. Additional parameters such as marketable fruit yield, fruit type, earliness, plant architecture, and tolerance to common plant viruses and silvering caused by whiteflies were also recorded. Cultivars with acceptable low disease levels and adequate marketable yields were identified from the collection of each cucurbit species evaluated and can be used in integrated disease management programs.

2 Development of inoculation method for screening of true seedlings of sugarcane against smut

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Sugarcane smut caused by Ustilago scitaminea is one of the most devastating diseases of sugarcane. Two triazole fungicides, propiconazole and triadimefon, have been registered overseas to protect seedcane from infection with sugarcane smut, particularly after hot water treatment. These fungicides were registered under an emergency permit in Australia when smut was found for the first time in Queensland in 2006. A research program was initiated to screen and evaluate a range of fungicides against sugarcane smut. In vitro and field experiments were conducted at BSES Southern Experiment Station, Bundaberg in 2008 and 2009 to screen a range of fungicides. Nine fungicides were tested in vitro at various concentrations for their efficacy in limiting telosporic germination. Azoxystrobin (Amistar®), quinozinate (Quintozone® 750) and didecyl dimethyl ammonium chloride (Steri-max®) completely stopped germination of telosporae at 2.5 mg a.i./L Propiconazole (Tilt®), triadimefon (Bayleton®), cyproconazole (Alto®) and acibenzolar-s-methyl (Bion®) significantly (Ps<0.05) reduced telosporic germination at 50, 100 and 200 mg a.i./L. Two field trials were conducted in 2008 and 2009, where seedcane were dipped in a range of fungicide suspensions for five minutes at ambient temperature prior to planting. No smut was observed over a nine month period after seedcane was treated with cyproconazole at 16 g a.i./100 L, propiconazole at 25 g a.i./100 L and triadimefon 48.5 g a.i./100 L. Strobilurin fungicide, azoxystrobin, was effective and showed <10% smut infection after nine months. The results will lead to important outcomes for managing smut in seedcane in Australia, especially after hot water treatment.

3 Does combining compounds with yeasts reduce Penicillium expansum?

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Detached apple fruit assays were conducted to identify compounds that enhance the biocontrol activity of yeasts against Penicillium expansum (blue mould). Surface sterilised wounded apples were inoculated with yeasts (5.5 x 106 cells/ml) made up in either sterile distilled water (SDW) or one of the following compounds; ammonium molybdate, CaCO3, KCl, Na2CO3, 2-deoxy-D-glucose, glycolchitosan, L-serine and L-aspartic acid. Following drying of the inoculation droplet, wounds were inoculated with P. expansum. When yeasts were combined with CaCl2, CaCO3 or KCl, lesions were smaller than those of the equivalent yeast made up in sterile distilled water (SDW). In investigations of CaCl2, CaCO3 and SDW at differing yeast concentrations most P. expansum lesions failed to develop for all treatments at 105 yeast cells/mL. Lesion incidence was not reduced compared with the pathogen-only control when yeasts were made up in SDW at 106 or 107 cells/mL. Calcium chloride applied with no yeast gave some reduction in disease incidence, but when yeast at 105 or 106 cells/mL were prepared in CaCl2, lesion incidence was reduced to a far greater extent. Calcium carbonate applied with no yeast gave a large reduction in lesion incidence, and addition of yeasts at 106 or 107 cells/mL did not improve this.
4 Biological control of rice bakane disease with powder formulation of antagonistic bacteria

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The potential of antagonistic bacteria from paddy soils at the northern region of Thailand to control rice bakane disease caused by *Fusarium fujikuroi (F. moniliforme)* was studied. The antagonistic bacteria isolates number BAK-016, BAK-088, BAK-102, BAK-117 and BAK-131 which showed the large mycelial growth-inhibition in plate assays and showed the effectiveness in reducing bakane disease incidence in seedbox were selected and developed as t alcum-based powder formulations. Bacterisation of naturally-infected RD6 rice seeds with these powder formulations were tested to determine the effectiveness to control bakane disease in the field trials. The result revealed that naturally-infected RD6 seeds bacterised with isolates BAK-131 and BAK-088 had bakane incidence 8.9% and 9.7%, respectively, comparable to 8.2% of the carbendazim+mancozeb treatment and 10.9% of control treatment. For the other isolates, BAK-102, BAK-016 and BAK-117 had bakane incidence 12.6%, 12.7% and 12.9%, respectively.

5 Preliminary study of antifungal activity of some essential oils against *Fusarium oxysporum* f.sp. *cubense* causing banana wilt disease

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Wilt disease, caused by *Fusarium oxysporum* f.sp. *cubense* (Foc), is one of the most important disease on Banana. Integrated Pest Management (IPM) strategy is promising concept to control this disease. This concept has to be supported with all suitable control techniques that can be utilised compatibly and effectively. Essential oils, that have long been recognised having good fungitoxic compounds, are nominate technologies to complete the control techniques that are available before. The aim of this experiment was to evaluate antifungal activity of essential oils extracted from *Cymbopogon nardus*, *Eugenia aromatica*, *Pogostemon cablin*, and *Vitiveria zizanoides* against Foc. The experiment was conducted in the laboratory of Indonesian Tropical Fruit Research Institute at room temperature in January-April 2008. The result showed that essential oils tested had been able to suppress the growth of Foc’s mycelial. Essential oil extracted from *E. aromatica* provided strongest suppression to the mycelial growth of Foc whether this essential oil existed or eliminated, mainly at volume of 9 and 18 µL. This result indicated that essential oil of *E. aromatica* had good potency to be developed as control agent against wilt disease on banana.

6 Field and pot evidence of biocontrol of Giant Parramatta Grass by crown rot caused by the fungus *Nigrospora oryae*

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Giant Parramatta Grass (*Sporobolus fertilis*) is a serious large grassy pasture weed in northern NSW. In recent years, graziers in some infested regions around Grafton, NSW, have stopped spraying with herbicide because GPG appeared to be declining in pasture. GPG in those areas showed bright orange leaders in the tillers. The aim of this study was to ascertain the extent of the decline and to find if it was due to a pathogen. Frequency of GPG declined at three properties from 88-96% in 2006 to 22-45% in 2009; 25-45% of plants showed the symptoms. Plant density and size were also monitored at four field sites in two properties in early December 2009 and late April 2010. Density showed no change but diameter declined by up to 83%; 32-48% of plants showed the symptoms. The orange leaves were on tillers that were brown colour at the base of the culm and broke off easily. Symptomatic tillers were collected from 86 plants in 2009, surface-sterilised and plated out on V8 agar. Twelve types of microorganism were isolated: ten fungi, bacteria and non-pathogenic nematodes. Of these, the only micro-organism that caused similar symptoms in seedling trials was *Nigrospora oryae*, which was isolated only from the roots and base of the tillers. *N. oryae* is therefore the likely cause of the symptoms observed and appears to be causing a significant decline in GPG in the field, holding promise for biocontrol. This is particularly useful as GPG has developed herbicide resistance in this area.

7 A novel GFP-based approach for screening biocontrol microorganisms in vitro against *Dothistroma septosporum*

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*Dothistroma septosporum* is the causal agent of Dothistroma Needle Blight. A novel green fluorescent protein (GFP)-based screening method was developed to assess microorganisms for potential biocontrol of *Dothistroma*. This method was developed to overcome large differences in growth rate between *Dothistroma* and the potential biocontrol strains, and to assess the effect of dothistromin toxin produced by *Dothistroma* on the strains. The antagonistic activity of fungal strains toward *Dothistroma* was assessed by (i) growth measurements in the presence of dothistromin and (ii) loss of fluorescence from GFP-labeled *Dothistroma*. Regions of *Dothistroma* colonies overgrown by the fungal strains, that exhibited loss of GFP fluorescence, were analysed for RNA expression and growth on selective medium to determine whether the interaction was fungicidal or fungistatic. Results suggested that some *Trichoderma* isolates have the potential to control *Dothistroma in vitro*, via a fungicidal action.
Bacterial strains were tested by inoculating a streak of culture adjacent to the *Dothistroma* colony. The antagonistic activity and type of interaction were assessed with the GFP-labeled *Dothistroma* as described above. Some *Bacillus* strains affected *Dothistroma* growth in *vitro*, via a fungistatic interaction. This GFP-based method represents a novel approach to screening fungi and bacteria for antagonistic activity.

8 Priming for resistance: UV-C radiation as an agent of pathogen resistance

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Plants face many biotic and abiotic challenges in the environment including pathogen challenge and damage due to energetic wavelengths of ultraviolet (UV) light, both of which cause detrimental effects to plants. When *Arabidopsis thaliana* is irradiated with doses of UV-C light between 0 and 1000 J/m², leaves exhibit increasing resistance towards the virulent isolates of the biotrophic oomycete pathogen, *Hyaloperonospora arabidopsidis* (formerly *Hyaloperonospora parasitica*) in a dose-dependent manner. Treatment with UV-C alone does stimulate callose production in the absence of the pathogen; however lignin does not appear to be produced at the dosages used. UV irradiated plants inoculated with *H. arabidopsidis* show a significant reduction in pathogen growth and the presence of hypersensitive lesions. These induced hypersensitive lesions, seen as areas of tightly packed dead cells, are also surrounded by lignin and callose, which is typical of a resistance response. Previous research has strongly suggested that this defence response is linked to DNA damage and repair, both of which are involved after UV-C irradiation. The aim of this study is to investigate other responses that can play a role in the resistance reaction, such as; hydrogen peroxide, callose and lignin to determine their role in UV-C induced resistance towards *H. arabidopsidis*.

9 Efficacy of medicinal plant extracts for the in-vitro control of *Ceratocystis fimbriata*

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*Ceratocystis fimbriata* is the main pathogen that causes mango sudden death in Pakistan. Fungicides are one of the many options being used to manage the disease under field conditions. This may not be sustainable given their costs and other related issues with their use. Medicinal plant extracts may be a good option to manage the disease but little attention has been paid to this option. We undertook a study to determine the efficacy of some medicinal plant extracts for possible suppression of *C. fimbriata* in-vitro. The extracts came from the following five medicinal plants: *Azadiricha indica* L. (Neem), *Curcuma longa* L. (Turmeric), *Acorus calamus* (Sweet flag), *Saussurea lappa* (Kuth) and *Peganum harmala* (Harmal). Small stock solutions of each extract were prepared in acetone and ethanol on the basis of their active ingredients and 100 ppm, 200ppm and 300 ppm concentrations of each extract were added to sterilised molten Malt extract Agar media using micro pipettes, and the media poured into sterilised petri plates. Small plugs of fungal mycelia from an actively growing culture of *C. fimbriata* were placed on the media, the plates wrapped with para film and incubated at 25°C. Growth was observed on petri plates with the Neem extract after just five days while plates with the other four extracts started showing growth only after 10-12 days of incubation. The fungus exhibited minimum growth (1.5 cm) in plates containing 300 ppm concentration of Turmeric and Kuth followed by Harmal (3.5 cm), Sweet flag (3.1 cm) and Neem (7.8 cm) respectively at the same concentrations. The experiment was repeated thrice with similar results. It seems the presence of Neem extracts may actually be enhancing the growth rate of the pathogen while Turmeric and Kuth extracts may be suppressing fungal growth and thus have potential to be used for *C. fimbriata* control. These lab results need to be confirmed under field conditions.

10 Control of soil-borne diseases of vegetables using plant derived volatiles as soil treatments

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Major constraints to vegetable production in Victoria, Australia, are soil-borne diseases such as those caused by *Sclerotinia minor* and *S. sclerotiorum*, root rots (*Fusarium* spp., *Pythium*, *Rhizoctonia* spp.) and clubroot. Preliminary *in vitro* studies previously identified thyme, clove bud and organum as the most effective of 22 essential oils screened against *Fusarium oxysporum, Rhizoctonia solani AG2.1*, *S. minor* and *Pythium* spp. Pot studies were used to confirm the potential of these products as pre-plant soil treatments for disease control. In potting mix inoculated with *R. solani* (AG2-1), broccoli seedling emergence was significantly (P<0.001) higher when treated with the essential oils clove bud, organum or thyme applied as 5% aqueous emulsions (5.0 ml/150cm³) or a mustard and neem blend. Fumafert® (1000kg/ha) compared to untreated controls and the low rate of the standard soil fumigant Basamid® (200kg/ha). Two field trials were subsequently conducted using commercially blended products. Two plant oil products (ECO-V and Vigor® at 50L/ha) showed promise as pre-plant soil treatments by reducing (P<0.001) root rot severity in beans. This level of control was equivalent to that of Basamid® (500kg/ha). This study highlights a need for further field evaluation of plant volatile products to optimise dosage and method of application to improve retention of volatiles in the soil and disease control.
11 Effects of the biocontrol agent
*Pseudomonas fluorescens* 2P24 on microbial community diversity in the melon rhizosphere

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The objective of this study was to investigate the influence of biocontrol agent *Pseudomonas fluorescens* 2P24 on microecosystem in the rhizosphere of melon, and to provide biosafety evaluation for the application of the bioagent. The influence of biocontrol agent 2P24 on microecosystem in melon rhizosphere at different growing stages was investigated by using plate culture and terminal restriction fragment length polymorphism (T-RFLP) analysis. After transplantation, the rhizosphere biomass of bacteria and fungi in the strain 2P24-treated melon seedlings was decreased, while the population of actinomycetes was increased. In the harvest time, the influence of strain 2P24 to bacteria and actinomycetes was not significant, but the fungal population was promoted obviously. Totally 41 TRFs were obtained by T-RFLP analysis, among which the dominant floras of TRF213, TRF240 and TRF513 were not obviously affected, while the floras of TRF61, TRF348 and TRF365 were influenced significantly, which was also validated by the increased biodiversity indices (Shannon-Wiener). The abundance bioinformation on the influence of strain 2P24 to microbial diversity was obtained by the methods combined with plate cultivation and T-RFLP analysis, and the results showed that the biocontrol agent 2P24 did not significantly affected the diversity and dynamics of microbial communities in melon rhizosphere.

12 Effect of chitin and chitosan soil amendments on damping off of radish seedlings

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Chitin and chitosan are known antifungal agents and plant defence elicitors. Chitin increases the populations of total fungi and bacteria that are associated with disease suppression. Chitosan does not enhance total microbial activity and populations of microbial groups, but may elicit defence mechanisms in the plant. The aim of this study was to evaluate chitin, chitosan and liquid chitin as soil amendments, using damping-off in radish as a model system. Four *R. solani* isolates were used: two AG2.1 isolates (R14, R394) and two AG3 isolates (R153 and R422). Twelve treatments of different rates and combinations of chitin, chitosan and liquid chitin were incorporated into infested potting mix at the same time as five radish seeds/pot were planted. There were five replicates (pots) per treatment. Emergence and damping-off was assessed one week after planting. *R. solani* AG3 (153 & 422) did not cause any disease in radish, but AG2.1 (14 & 394) significantly reduced radish emergence. The highest rate of liquid chitin (30 mL) was the only treatment that reduced the impact of AG2.1.
13 Ramu stunt, a quarantine risk for the Australian sugar industry

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The sugarcane disease Ramu stunt first appeared at Ramu Agri Industries Limited in Papua New Guinea during 1985-86. At that time, the causal agent was unknown. The disease is characterised by stunting, various ill-defined leaf symptoms and failure to ratoo. The vector is the sugarcane plant hopper *Eumetopina flavipes*. As the disease has not yet been found in Australia, but the vector occurs in Torres Strait and Cape York, Ramu stunt is a major quarantine disease risk to the Australian sugar industry. Without knowing the cause of the disease and with no reliable assay, accurate diagnosis is impossible. Research has been under way at BSES to determine the causal agent, suspected to be a virus.

RT-PCR cloning experiments have identified a number of clones with homology to known or proposed members of the viral genus *Tenuivirus* and the closely related family *Bunyaviridae*. Sequence data was used to develop a diagnostic test which has been successfully used to screen commercial sugarcane, noble or garden canes (*Saccharum officinarum* and *Eumetopina*). The test will help Ramu Agri-Industries monitor the disease, help the Australian sugar industry prevent or manage any potential incursions and allow safer movement of sugarcane germplasm around the world.

14 New and interesting records of plant pathogenic fungi from south-eastern Australia

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Eight new and unusual records of plant pathogenic fungi from southernmost Australia have been detected in the last few years. These have been from either new diagnostic samples, or from the re-examination of older herbarium material. Several new diseases were found on samples submitted to DPI Victoria, Crop Health Services. The leaf and stem spotting pathogen *Gnomoniopsis idaeicola* was discovered for the first time in Australia; it was isolated from blackberry during routine anthracnose testing. *Colletotrichum dracaenophilum*, a pathogen on lucky bamboo, was detected for the first time in Australia. *Alternaria japonica* was detected for the first time causing leaf spots on bok choy in Australia. The subtropical/tropical fungus *Pityophthora palmivora* was bailed from soil around drying *Pittosporum* shrubs in an inner Melbourne suburb. *Fuscidium convolvularum* on *Convolvulus* was detected for the first time in Australia. Re-examination of herbarium specimens of powdery mildew fungi, the Apiaceae pathogen *Erysiphe heraclei* was found to occur on native species of *Billardiera* and *Sollya* (Pittosporaceae). Powdery mildew fungi on *Fumaria* (Fumariaceae) and *Papaver* (Papaveraceae) were re-identified as *E. aquilegiae*, rather than *E. cruciferarum*.

15 Quarantine plant disease survey training in Papua New Guinea and Solomon Islands

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Plant pathologists from Australia’s Department of Agriculture, Forestry and Fisheries (DAFF) Northern Australia Quarantine Strategy (NAQS), undertake regular plant disease surveys in Australia’s remote north. In recent years, NAQS has participated in activities conducted overseas, organised by the International Capacity Building and Offshore Surveillance Program of DAFF’s Office of the Chief Plant Protection Officer (OCPPO). A series of general plant health survey training workshops have been aimed at quarantine officers and agricultural public servants in PNG and the Solomon Islands. Training focused on the basics of disease symptom recognition, followed by sample and specimen collection and processing techniques necessary to ensure good quality material can be despatched for expert identification. This included preparation of air dried fungal disease herbarium specimens, rapidly desiccated virus and virus-like disease tissue samples and isolation of fungi and bacteria. This work has resulted in one new national record of a disease of key regional quarantine interest plus several other finds of important pathogens in new locations.

16 Bringing disease-free foreign varieties of sugarcane (*Saccharum officinarum*) to the mainstream

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Sugarcane is one of the most important crops in the Philippines. Eighty per cent of the Philippine sugar production is for domestic use, 5% is for reserve stock, 7% is for export to US, and 8% is for the global market. The country allotted 397,991 ha for sugarcane production in 2008. Efforts to increase sugar production through the production of high yielding varieties are being exerted. Aside from local hybridisation, varietal introduction is still an integral part of varietal improvement program in the country. Disease-free foreign varieties were introduced from sugarcane growing countries of the world. All varieties were quarantined and indexed for the presence of exotic pathogens. After more than two years of quarantine, varieties were tested for adaptability to local conditions through multilocation yield and adaptability trials. Varieties that did not surpass the performance of local check varieties were turned-over to the germplasm collection and are now being used as parent materials. Ten promising varieties were selected for commercial release, four of which are now being planted by sugarcane growers.
17 Plant pathogen incursion—surveillance in Queensland

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Biosecurity Queensland is the coordinator and lead agency of biosecurity activity in Queensland through its Plant Biosecurity and Product Integrity Program. It is committed to maintain and demonstrate the favourable plant pest and disease status of Queensland’s horticulture, broadacre and forestry crops. Queensland plant industries contribute significantly to the regional and national economy. Biosecurity Queensland activities aim to mitigate the risks and impacts to the economy, to the environment, and to social amenity associated with plant pests and diseases.

Markets, both domestic and international, are increasingly sensitive to the threat of pests and diseases and will not hesitate to restrict or suspend access to Queensland produce should there be a significant incident, even if the incident occurs in another state. Therefore, Queensland will maintain its commitment to national surveillance and response programs into the future.

In recent times, biosecurity staff have been involved in many important plant pathogen incursions in Australia. This has involved coordination of surveillance to address trace‐forwards and trace‐backs of plant material into and out of Queensland. Surveillance activities have been undertaken for myrtle rust, mango malformation disease, bacterial canker of kiwifruit, angular leaf spot of strawberry, sweet orange scab of citrus. This work involves engagement with the specific industries involved, with stakeholders, with diagnostic scientists within Queensland and nationally and often with public and/or private community organisations. Surveillance can extend from urban backyards, to nurseries, farms, forestry plantations, roadside vegetation and bushland.

18 Development of a multiplex RT-PCR bulk test for the detection and identification of potato spindle tuber viroid

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Potato spindle tuber viroid (PSTVd) is a serious disease of potato, tomato and other solanaceous crops. Since 2001 there have been six reported incursions of PSTVd in tomatoes in Australia. PSTVd was detected in tomato, capsicum and chilli crops in Carnarvon, Western Australia between 2006 and 2008. Eradication of all known infestation has been undertaken by the Department of Agriculture and Food (the Department) in collaboration with industry represented by vegetablesWA since 2006.

Reducing laboratory testing with the development of a RT-PCR bulk test was required to make the necessary comprehensive PSTVd delimitating surveys across the Carnarvon Horticultural Area financially viable and also to verify if eradication had been achieved.

A multiplex reverse transcription-polymerase chain reaction (RT-PCR) was therefore developed using specific primer pair TG21 (F)/CT20(R) and DLH55 (F)/DLH56(R). It was demonstrated that this new RT-PCR PSTVd test can detect one infected plant sample from 500 bulked plant samples, however sensitivity was found to be optimal with 300 bulked plant samples.

During the 2009 growing season close to 50,000 PSTVd host plants were sampled from 155 crops grown on 86 Carnarvon commercial properties and tested for the presence of the viroid. This new RT-PCR bulk test enabled the Department to complete both survey and testing within less than 3 weeks, for a costs of approximately AUD$40,000.

19 New state records of Hemicycliophora species (Nematoda: Hemicycliophoridae) in Australian turf

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Members of the nematode genus Hemicycliophora are sedentary ectoparasites commonly known as sheath nematodes. They are almost cosmopolitan, and have a very wide host range including fruits, vegetables, natives, ornamentals, field crops, weeds and grasses. Of the twenty species recorded from Australia only three (H. arenaria, H. biloculata and H. typica) have previously been recorded on turf. About 3,000 turf samples were received from 1996 to 2008 by Crop Health Services, DPI Knoxfield, Victoria, for the diagnosis of plant-parasitic nematodes causing turf decline. These samples were submitted from Victoria (VIC), South Australia (SA), New South Wales (NSW), Queensland (QLD), Western Australia (WA) and Tasmania (TAS). About 24% of the sample sites contained Hemicycliophora species, with 50% of these above the threshold density of 160 nematodes per 200 ml of soil. New state records of Hemicycliophora identified in this study were, for VIC H. arenaria, H. charlestoni, H. labiata and H. thornei, for SA H. arenaria, H. labiata and H. saueri, for NSW H. iwia, H. labiata, H. thornei and H. typica, for QLD H. brevicauda, H. labiata, H. thornei and H. typica, and for TAS H. arenaria and H. thornei. Hemicycliophora specimens from WA were not identified to species.
20 Banana blood disease detected by pocket diagnostic test

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Blood disease is a devastating and lethal disease of banana, present in parts of Indonesia and absent from Australia. It is caused by the blood disease bacterium (BDB), which has been placed in Ralstonia solanacearum Phylotype IV (Fegan and Prior 2006). Rapid preliminary diagnostics is the key to a successful eradication program should the disease enter Australia.

In June 2010, Australian Department of Agriculture Fisheries and Forestry plant pathologists in collaboration with the Indonesian Tropical Fruit Research Institute (ITFRI), Solok, West Sumatra, Indonesia tested known BDB samples at the ITFRI with Pocket Diagnostic kits for Ralstonia solanacearum manufactured by Forsite Diagnostics Ltd, UK. A weak band indicating a positive result was formed in the test window using the vascular tissue from the skin of a symptomatic banana.


21 Detection and eradication of impatiens necrotic spot virus on ornamental nursery stock in New South Wales

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Australia remains one of the few countries in the world that is free of several important viruses affecting vegetables and ornamentals. In particular, the Tospovirus, Impatiens necrotic spot virus (INSV) is a biosecurity threat for which we have several of its thrips vectors. In February 2010, Spathiphyllum leaves were submitted for pathology diagnostics from a wholesale nursery on the NSW Central Coast. Clinical examination revealed chlorotic ring spots. Tissue was initially tested and found to be negative for Tomato spotted wilt virus using a TSWV ImmunoStrip Test (Agdia Inc, Elkhart, IN). A green band did form at the ‘positive result’ region urging a further test for INSV using a specific test strip from the same manufacturer. A strong purple band forming at the appropriate position, signifying a positive reaction. Total RNA was extracted from tissue and RT-PCR was performed using the primer pair, gL3637 and gL4435c, which amplify a 0.82-kb region of the L gene of tospoviruses. An amplicon of the expected size was sequenced and compared to L gene sequences of INSV in the GenBank database. Australian sequences had a 98% similarity to INSV isolates from China, the Netherlands and Italy. Surveys of the affected nursery and subsequent testing revealed INSV infected begonias, lisianthus and kangaroo paws. All susceptible stock was destroyed. To date, surveys have failed to detect INSV infected plants. To our knowledge this is the first confirmed report of INSV in Australia and the first record on kangaroo paw.

22 The smut fungi of the world and their host plants

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The smut fungi are plant parasitic microfungi. Currently, 1675 species of basidiomycetous smut fungi are recognised, classified into one phylum, 2 subclasses, 4 classes, 10 orders, 25 families and 95 genera. There are further 7 species of ascomycetous smut fungi in 2 genera. The host plants of smut fungi belong to 93 families, mainly angiosperms, non-woody, especially monocots, predominately Poaceae and Cyperaceae. The smut fungi represent 1.67% of the c. 100,000 species of known fungi. Some genera of smut fungi are restricted to a single host plant genus or family, others occur on members of several plant families, either mono- or dicotyledonous, and a few genera on both. Some selected examples are:


Polyphagous smut genera on both mono- and dicots are Urocystis (on 30 families), Entyloma (on 25 families), Thecaphora (16 families), Microbotryum (10 families), Melanotaeniium (7 families), Yelsemia (4 families), Talbotiomyces (on 3 families).
**23 In-vitro and In-planta metabolomic differentiation of X. campestris pathovars**

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*Xanthomonas campestris* is the causal agent of black rot, blight and leaf spot of crucifers. Disease is characterised by marginal leaf chlorosis, vascular blackening, leaf lesions, wilting and necrosis. Such diseases are not only economically important but because these pathovars have multiple hosts, differentiation at the subspecies level is often difficult. Various techniques such PCR, fatty acid analysis and host inoculation have been used to assess the taxonomy of this species at the pathovar level but no method has been universally applied as a robust diagnostic tool. Metabolic profiling using Nuclear Magnetic Resonance (NMR) and Liquid Chromatography-Mass Spectrometry (LCMS) has been used in pathogen detection within clinical settings and may be a useful tool in the taxonomy of plant pathovars and for providing insights into the functional basis of host specificity and pathovar-host interactions in general. The aim of this study was two-fold; to (i) examine the metabolome of three *X. campestris* pathovars *in-vitro* (ii) investigate the host metabolic response to infection with three different *X. campestris* pathovars. Combined LCMS and NMR metabolomic analysis of both cell cultures and leaf tissue from inoculated *Brassica* species has enabled the differentiation of *X. campestris* pathovars from controls and between each other. The metabolomics fingerprints and putative chemical biomarkers responsible for this differentiation will be presented.

**24 Bacterial crown rot, a major threat to Australia’s papaya industry**

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Bacterial crown rot (BCR) also known as bacterial canker or bacterial decline is considered one of the most important diseases affecting papaya (*Carica papaya*). First reported in Java in 1931, this disease which is caused by the bacterium *Erwinia papayae* has spread to many of the major papaya growing countries of the world. Symptoms include angular water-soaked lesions on leaves and petioles causing leaves at the top of the canopy to wilt and die. Firm water-soaked cankers develop on the stem causing the stem to collapse. Small water-soaked lesions which develop on green fruit develop into firm depressed lesions. *E. papayae* has been recovered from seed of infected papaya fruit and was shown to be present in seed after the extraction and air drying process. Research showed that rainfall is the most important weather factor influencing BCR providing conditions necessary for the penetration and distribution of the pathogen. Fifty per cent of Australia’s papaya is grown on the wet tropical coast of far north Queensland which has an average annual rainfall of 3750 mm. Consequently an outbreak of BCR would be devastating for the Australian industry. The Australian Quarantine and Inspection Service (AQIS) now restrict the importation of *Carica papaya* seed from countries where BCR is recorded, with seed being subjected to hot water treatment at 50°C for not less than 20 minutes.

**25 DNA fingerprinting and integron sequence analysis of Xanthomonas translucens infecting cereals**

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Four *Xanthomonas translucens* pathovars have been characterised as causing bacterial leaf streak (BLS) on cereals. Until recently, *X. t. pv. undulosa* (*Xtu*) and *X. t. pv. translucens* (*Xtt*) were regulated pests for *Triticum* and *Hordeum* seed imports into New Zealand. However, *Xtt* was recorded on *Hordeum* and consequently this pathovar was removed from the Import Health Standards for both crops. Overlapping host ranges and the inability of existing diagnostic tools to easily differentiate the four pathovars causing BLS have complicated the accurate identification of pathogenic *xanthomonads* on seed imports. As a result, there remains the possibility of introduction of exotic *X. translucens* strains pathogenic to *Triticum*. In our research we investigated whether an international collection of 18 *X. translucens* isolates infecting barley, wheat and other small grains can be differentiated by DNA sequence analysis of the ubiquitous *Xanthomonas* integron region and by using DNA fingerprinting. We found that integron sequences were identical for almost all strains isolated from *Triticum*. Furthermore, strains isolated from *Hordeum* possessed distinct integron sequences, all of which were different from the integron sequences of strains from *Triticum*. BOX-PCR also showed genetic variation between isolates from *Triticum*, *Hordeum* and other hosts. We discuss the host-specific diversity of *X. translucens* strains and the implications for their detection on seed imports into New Zealand.
26 Common bunt (Tilletia laevis and/or Tilletia triticci) in wheat in Western Australia: effect of soil moisture at seeding, fungicide seed dressings and variety resistance

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Common bunt of wheat can cause catastrophic financial cost for growers as contaminated wheat cannot be delivered to grain receival points. Pot experiments were conducted at Geraldton and Perth, Western Australia in 2009/10 investigating soil-borne and seed-borne common bunt. It was found that: 1) Bunt infection of wheat heads occurred when clean seed was sown into bunt infected soil that was dry until seeding. If soil was wet one to four weeks prior to seeding (simulating rainfall), infection didn’t occur; 2) Clean seed that came into contact with bunt spores and was then sown in clean soil resulted in head infection; 3) A registered seed dressing (difenoconazole/metalaxyl M) was effective in preventing head infection; 4) Of 40 wheat varieties tested only 5 were moderately resistant to common bunt. These results indicate that if common bunt is identified in a paddock, there is a risk of bunt spores surviving in the soil leading to infection of the new wheat crop, particularly in years of minimal summer rain. A one season break with good soil moisture should effectively reduce the soil-borne spore concentration. Regular use of registered seed dressings and growing a moderately resistant variety should manage the risk of common bunt occurring.

27 Molecular tagging of Lr32, a Triticum tauschii-derived recessively governed leaf-rust resistance gene, in bread wheat

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A Triticum tauschii-derived recessively governed leaf-rust resistance gene, Lr32 located on chromosome 3DS was tagged with 3 randomly amplified polymorphic DNA (RAPD) markers. The most tightly linked marker S1234.156 was located at a 2.2cM distance from the Lr32 locus with a flanking marker S124F.156 located at a 6cM distance. On the basis of bulked segregant analysis (BSA) 2 null allele microsatellite markers Xgwm225s and Xwmc529.156 were also found to be linked to the gene Lr32, those could not be mapped. The markers were identified on a segregating F1 population generated from a cross between 'a universal susceptible, Agralocal' and 'Thatcher based NIL of Lr32, ECS135333'. Disease phenotyping was done in controlled environment growth chambers using a virulent distinguishing Indian pathotype, 21R31-1(syn. 104-1) of Puccinia triticina. All the five markers were validated for their specificity to the gene Lr32, against 44 genes of the Australian set of Thatcher based NIL’s of Lr-genes and Donor line C86-6/KSFg. On the basis of validation study the microsatellite Xwmc529 is located on 3DS between 20.6 to 33.0 cM from centromere. Further, in relation to centromere, S1234.156 is located towards the distal end and S124F.156, Xgwm225s and S1142.156 are located towards the proximal end of 3DS from the gene.

28 Marker aided development of NIL of Lr28 in PBW343 background of hexaploid wheat

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PBW343 is a widely grown cultivar of hexaploid wheat in the north-western plains of India. Recently it has shown an increased incidence of leaf rust. Therefore, Lr28 which gives a high degree of resistance (0) has been incorporated into PBW343 using marker aided selection to prolong the cultivation of PBW343 in India. The backcross was developed with HW2037 (HD2329 + Lr28) as male donor parent and PBW343 as female recurrent parent. The movement of the gene was traced by using a dominant coupling phase RAPD marker S421.156 and a null allele SSR marker Xwmc313.156 of Lr28 developed at NPF, India to confirm the homoygosity at the Lr28 locus. To avoid recombinants the segregating population was screened with the predominant pathotype of Puccinia triticina, 121R63-1 (syn. 77-5). While making crosses in F1, BC1F2, BC2F1 and BC2F2 generations the crossed plants were identified by the resistant phenotype and amplification of both the marker fragments to show the heterozygous state of the gene. BC1F2 was selfed to obtain segregating BC2F2 from which six plants homoygous at Lr28 loci were selected. All the six plant families have demonstrated the non-segregation of markers and phenotype among family individuals in the BC2F2 generation. These were pooled for field analysis in BC2F2. Use of molecular markers has greatly reduced the number of individuals requiring evaluation in every generation.

29 Factors associated with take-all in New Zealand wheat crops

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No wheat cultivars are resistant to the root disease take-all, and fungicides have limited effect, so disease control relies on minimising primary infection and disease epidemic development. Use of molecular methods to quantify inoculum of the take-all pathogen Goeumannomyces graminis var. tritici (Ggt) has improved our ability to identify the factors associated with this disease. The most important
factor in take-all severity is inoculum concentration, which is strongly influenced by crop rotation. Inoculum builds up rapidly in a first wheat crop, but can also diminish equally quickly during a break crop. Length and type of break crop, along with the presence of wheat volunteers or grass weeds and use of herbicides affect the processes of inoculum decline or increase, during a break from wheat. Factors other than pre-sowing inoculum concentration can influence the development of damaging take-all. Some growing seasons are more conducive to disease than others. Physical and chemical soil factors can also affect disease. In addition, soils can become suppressive to take-all with continuous wheat cropping, and there is evidence that this process can begin as early as a third wheat crop in a sequence.

30 Colonisation of maize by Gibberella zeae

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Gibberella zeae (Fusarium graminearum) is the cause of Gibberella stalk and cob rot in maize and Fusarium head blight (FHB) in wheat and barley. Both diseases occur on the Liverpool Plains region in northern NSW, and there are critical links in the epidemiology of the two diseases. Perithecia of G. zeae are produced on infested maize residues, and are an important source of ascospores for FHB infection. There is however, little information on the timing, location and extent of infection of stalks of maize plants by G. zeae. Consequently, leaf sheath and node samples were taken from plants from a centre-pivot irrigated maize crop sown directly into durum wheat residues with abundant perithecia, in the southern Liverpool Plains. Plants were sampled at the seedling, silking and physiological maturity stages. The fungus was recovered from each stage of the crops development, with 97% of plants infected by physiological maturity. Infection was presumed to have occurred from ascospore deposition into the leaf axial. The early colonisation of maize plants by G. zeae gives the pathogen a continuing advantage over saprophytic colonisers following the onset of senescence. The reservoir of hyphal inoculum in the stalk tissues enables the formation of abundant perithecia. In this trial perithecial production was observed on slashed residues within 8 weeks of harvest.

31 Quantitative trait loci for adult plant resistance to Stagonospora nodorum in wheat

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Stagonospora nodorum is a major fungal pathogen of wheat in Western Australia and other parts of the world. The aim of this study was to phenotype a doubled haploid (DH) mapping population of spring wheat and identify quantitative trait loci for resistance to S. nodorum expressed in adult plants under field conditions.

An F1 derived DH population of 235 individuals was constructed from a cross between spring wheat cultivars EGA Blanco (resistant) and Milllewa (susceptible). The population was assessed for flag leaf resistance and relative grain weights (RGW) in the field in 2007 and 2008. To overcome the effects of maturity on disease expression, each line was individually inoculated at late booting and flag leaves rated at a specific thermal time. Fungicide protected and inoculated plots were used to measure RGW. The population showed a continuous distribution and transgressive segregation for both traits. There was a moderate correlation between years for flag leaf assessments (r = 0.4) and a moderate correlation between the flag leaf assessment and RGW in 2008 (r = -0.5).

Genetic analysis showed regions on chromosomes 1B and 5B affecting both flag leaf infection and relative grain weight with the resistance allele coming from EGA Blanco.
33 Genetic analysis of non-SBL yellow spot resistance in a mapping population of wheat

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Yellow spot (YS) [syn. tan spot], caused by Pyrenophora tritici-repentis (Ptr), is an important foliar disease of wheat. Relatively few yellow spot resistance genes have been identified and mapped in Australian germplasm and a significant opportunity exists to enhance expression of YS resistance through identification of resistance factors other than tsn1 on chromosome SBL.

In this study a double haploid mapping population fixed for tsn1 locus was assessed at seedling, tillering and adult plant stages for yellow spot resistance in 2009 and 2010. Parent Calingiri was moderately susceptible to the disease while parent Wyalkatchem was moderately resistant. The population showed a continuous distribution and transgressive segregation at all growth stages. However, there was an influence of growth stage on disease expression at the adult stage (r = 0.7) in 2009. In 2010 this effect was overcome by inoculating individual plots at a similar growth stage and assessing disease at a specific thermal time [data awaited]. Correlations between years and various growth stages were moderate (r = 0.5 to 0.6).

Genetic analysis of 2009 results showed a region on chromosome 2A affected symptom severity at the seedling, tillering and adult plant stages, with the resistance allele coming from Wyalkatchem.

34 Isolation of microRNAs from wheat (Triticum aestivum L.) challenged by Puccinia striiformis f. sp. tritici

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MicroRNAs (miRNAs) are small, non-coding RNAs that play vital roles in the fine regulation of gene expression by targeting the corresponding genes at the transcriptional level. Despite spawning an explosive new field of research since their relatively recent discovery, there is still much that remains unknown regarding the role of miRNAs in key physiological processes such as biotic stress in plants. We are interested in exploring miRNA in wheat (Triticum aestivum L.) challenged by Puccinia striiformis f. sp. tritici (PST). Three treatment groups were established, consisting of the compatible and incompatible interactions, together with a mock inoculated group. Three sets of total RNA isolated from leaves at 12, 18, and 24 hours post inoculation were pooled respectively and were directly subjected to solexa pyrosequencing. A total of 1,566,579 unique sequences, were generated in the incompatible interaction, compared to 1,546,589 in the compatible interaction and 1,417,838 in the mock treated plants, ranging in size from 18-26 nt. Northern blot analyses indicated that several miRNAs were up- or down-regulated in both of the compatible and incompatible interactions between wheat and PST. We will present the miRNAs that are involved in resistance and our efforts to characterise the pathways these miRNAs regulate.

35 Identification of the gene locus Lr34/Yr18/pm38 in Chinese wheat cultivars conferring adult plant resistance against stripe rust

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Stripe rust, caused by Puccinia striiformis f. sp. tritici (PST), causes high yield losses on wheat in China annually. Adult plant resistance (APR), expressed at later stages of plant growth, is durable and thus useful for control of stripe rust. The gene locus Lr34/Yr18/pm38, confering APR to leaf rust, stripe rust, and powdery mildew, is present in a large number of wheat cultivars. To verify the distribution of this locus among Chinese cultivars, we used a new set of Gene-specific markers (cssf5) for unambiguous identification of Lr34/Yr18/pm38 in a variety of wheat genotypes. A total of 564 entries, including 533 wheat cultivars and advanced lines, together with a core collection of 31 lines which were widely used historical varieties, were evaluated for stripe rust resistance. Lines were evaluated at the seedling stage in the greenhouse with pathotypes CYR32 and CYR33, at the adult stage in the field with eight mixed races at Yangling and in the field under natural infections at Tianshui, during the growing seasons of 2008 to 2009. The results showed the Lr34/Yr18/pm38 gene locus maintained moderate resistance to the major prevalent Chinese stripe rust races at the adult stage. After screening using cssf5, the proportion of the Lr34/Yr18/pm38 gene among the cultivars and advanced lines is 2.44%, while 7 of 31 (22.58%) in the core collection contain this Lr34/Yr18/pm38 locus. The fact that the ratio of wheat genotypes carrying Lr34/Yr18/pm38 in the core collection is much greater than in the cultivars and advanced lines, implies that the gene locus has been widely used previously.
36 TaERG3, an elicitor responsive gene in wheat implicated in defence response against stripe rust pathogen infection and abiotic stresses

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Plants protect themselves against pathogen attack by launching both localised and systemic defense responses. The elicitor-mediated signal transduction pathways play a very important role in activating plant defense responses. Here we isolated a novel elicitor responsive gene, designated as TaERG3, from wheat leaves infected by Puccinia striiformis Westend. f. sp. tritici Eriks. using in silico cloning and reverse transcription PCR (RT-PCR) approaches. TaERG3, 481bp in length, was predicted to encode a 144-amino-acid protein, with the molecular mass of 15.68 kDa and isoelectric point (pl) of 3.93. Analyses of the deduced amino acid sequences of TaERG3 using InterProScan and SMART revealed the presence of an N-terminal calcium-dependent phospholipid-binding module (C2 domain, 5 to 103). TaERG3 gene was successfully expressed in the E. coli BL21 strain, with recombinant protein obtained in fusion with His-tag, followed by chromatographic purification using a His-Trap approach. Quantitative real-time PCR (qRT-PCR) analyses revealed that the transcription level of TaERG3 was rapidly and dramatically induced in the incompatible and compatible interactions, as well as by exogenously applied abscisic acid (ABA). The other three molecules, including methyl jasmonate (MeJA), ethylene (ET), and salicylic acid (SA) did not significantly affect TaERG3 expression. In addition, expression of TaERG3 transcripts was also induced by environmental stimuli, including low temperature, high salinity. Finally, functional assessments mediated by barley Stripe Mosaic Virus-Virus Induced Gene Silencing (BSMV-VIGS) revealed that wheat plants with the knocked down TaERG3 gene produced a slight amount of sporulation around the necrosis spots. These results imply that TaERG3 gene is involved in the wheat defense response against stripe rust and environmental stresses which induce an ABA-dependent signal transduction pathway.

37 A stochastic model for predicting the maximum yield loss due to panicle blast disease of rice

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Infections by rice panicle blast fungus occur on nodes, internodes, rachis branches and grains of panicles. The levels of damage due to infection can vary depending on locations of infection on the panicle. Considering the locations of infection, we developed a stochastic model for predicting damage caused by rice panicle blast. Assuming that multiple infections occur randomly on any segment between nodes on the panicle, the probability of an infection on a segment is proportional to the length of the segment. When a certain number of multiple infections occur on a panicle, the model predicts the probability of the relative frequency of panicles having a certain number of damaged grains and the proportion of damaged grains in the panicles. Using 30 panicles of the rice cultivar Chucheong harvested from a rice field in 2008, the damage response to multiple infections predicted by the model was evaluated. A simulation of the damage response indicated that the damage response varies depending on the panicles and the variation is due to the differences in the number and the length of segments as well the number of grains in individual panicles. The proportion of damaged grains in a panicle sample increased nonlinearly, showing a rapid increase initially and then asymptotically approaching 100% as the number of infections increased.

38 Characterisation of stripe rust resistance in Triticum aestivum ssp. spelta genotypes

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Spelt (Triticum aestivum subsp. spelta) is a hexaploid wheat that was once commonly cultivated in Europe but was progressively replaced with higher yielding free threshing bread wheats. There has been a resurgence in interest in spelt wheats arising from demand for organic products and the reported health benefits of spelt flour. Since spelt wheat has the same genomic constitution (2n=6x=42; AABBDD) as bread wheat, resistance genes from spelt can be conveniently introgressed into bread wheat. In Australia, spelt is mainly produced for export and there is considerable scope for expansion in area and production. However rust diseases, such as stripe rust (Puccinia striiformis f.sp. tritici, Pst), are a potential limitation to the spelt industry. In order to determine the genetic diversity for resistance to Pst, twenty-five lines were evaluated at the seedling stage using seven predominant stripe rust pathotypes. The genes Yr5 and Yr10 were postulated in some of these lines, and the designations confirmed using molecular markers. High levels of seedling resistance were observed in 7 lines, whereas 9 lines displayed high levels of adult plant resistance (APR) in field nurseries. Molecular marker analysis will be used to identify APR genes Yr18, Yr29, Yr30. The inheritance of stripe rust resistance was studied in crosses with the susceptible wheat cultivar Avocet S, as well as crosses between resistant...
spelt lines. Initial segregation analysis indicated resistance to be associated with single, dominant genes with at least one gene in common.

39 Isolation of differentially expressed genes during compatible interaction between wheat and *Puccinia striiformis*

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The rust fungi, *Puccinia striiformis* (Pst), is a destructive pathogen on wheat, depending on living host tissue for growth. To establish compatibility with their host, Pst forms special infection structures, through which they obtain their nutrients. Although various approaches were used for analysing the infection process, little is known about the differentially expressed profiles during the infection process. Here we constructed a suppression subtractive hybridisation cDNA-library with total RNA, extracted from susceptible infected and mock inoculated wheat seedling leaves, harvested at 36, 72 and 120 hour post inoculation. A total of 1707 ESTs with high quality were obtained and clustered into 787 non-redundant unigenes. The BLASTx program was used to screen homologous genes of the unigenes against the non-redundant protein database in GenBank. The functional classification of all ESTs was established based on the database entry giving the best E-value using the Bevan’s classification categories. Of the 787 unigenes, 134 (17.0%) were similar to genes encoding proteins with unknown functions and 262 (33.4%) did not have significant homology to any sequence in the database. Almost all of the 388 remaining annotated unigenes were probably of plant origin and only three were homologous to pathogen sequences. The quantitative real-time PCR (qRT-PCR) analysis determined the transcription profiles of twelve genes and their involvement in the wheat-Pst interaction.

40 Papilla and cell wall related non-host resistance renders *Uromyces fabae* penetration failure in wheat

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Non-host resistance (NHR) confers plant species immunity against the majority of would-be pathogens. Due to its robust and durable nature, exploiting NHR is considered a promising strategy for long-term protection of crops against potentially devastating diseases such as rusts. Here, we report a study on the basis of NHR in wheat against the broad bean rust pathogen, *Uromyces fabae* (*Uf*). In the wheat-*Uf* interaction, microscopic observations showed that the majority of colonies were arrested by the thickening of plant cell wall after the formation of haustorial mother cells (HMC) and only 2% of the investigated infection units could form haustoria in plant cells. The results of cytological analysis confirmed that attempted penetration of *Uf* induced the marked formation of papillae subtending HMC in plant cells. Histochemical experiments demonstrated that H$_2$O$_2$ accumulated in localised plant cell walls, papillae and encased haustoria, however O$_2$ accumulation was not detected. Transcriptome analysis indicated that pathogenesis-related (PR) proteins, were notably up-regulated with maximum induction occurring at 12-48 hours post inoculation (hai). Genes involved in ROX-scavenging mechanisms were also induced. In conclusion, our study revealed the histochemical and molecular bases of NHR in wheat against the *Uf* non-pathogen, and highlighted the significance of papilla production in the prehaustorial NHR. Our study may lead to an improved understanding and potential utilisation of NHR in wheat against rust fungi pathogenic to other crops.
41 Monitoring fungicide resistance in cucurbit powdery mildew populations in north Queensland

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Powdery mildew (Podosphaera xanthii) is a regular problem on cucurbits in the dry tropics of north Queensland. Growers rely on regular use of fungicide sprays to manage the disease. Sometimes even repeated sprays only offer limited control leading in some cases to crop failure. When this happens, it becomes important to monitor if pathogen strains are becoming resistant to specific fungicides in use. Loss of sensitivity by P. xanthii to Spiniflo®, Nimrod®, Amistar®, and Bayfidan® was monitored in pathogen populations across several cucumber crops in the Burdekin Delta region of north Queensland using a field bioassay where seedlings were sprayed with each of the 4 fungicides and exposed for a few hours to natural infection in target fields before observing for disease development under controlled conditions. Unsprayed seedlings served as controls. Loss of sensitivity was determined by comparing disease severity levels in the treated seedlings with the untreated controls. The 2008/2009 crop monitoring results suggested that resistance to the fungicides in use was likely with variable levels among different cucumber species. This was confirmed during the following season. In general, resistance was more prevalent in late season crops than in early crops mainly because of the heavy build up of inoculum as seen in the untreated controls. In some fields, resistance could be detected even when the grower had not used any fungicides suggesting extensive movement of spores across fields in the same region. This suggests that only an area-wide program for managing fungicide resistance could be effective. Seasonal monitoring for resistance is useful in making adjustments to cropping practices that rely on integrated approaches to delay resistance development.

42 Durian dieback epidemic in Champasak Province, LAO PDR

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A dieback disease in durian trees was commonly observed during a limited survey in Bajeng District, Champasak Province, southern Lao PDR, in May 2009. Gummosis and canker symptoms typical of Phytophthora palmivora infection were observed on the trunks of some trees. Soil samples were collected from under the drip line of five diseased trees, as well as samples of roots and canker tissue, if present. Samples were bailed for Phytophthora using rose petals, and cultures of a Phytophthora species were recovered from some samples and identified morphologically as P. palmivora. In May 2010 three workshops were held for farmers and local staff to promote IDM strategies for the disease. A more intensive survey revealed that most trees on farms had symptoms of dieback, with many severely affected. Some farmers had lost all their trees. The farmers reported first seeing dieback symptoms in 2003. Fifty trees with dieback symptoms were selected on an ad hoc basis from several farms in each of two villages, and injected with phosphonate to demonstrate efficacy. Injecting was slow presumably because of the very dry conditions. A small field trial with 40 young trees using an RCB design was also established at the local field station to demonstrate efficacy. Many of the trees had symptoms of dieback. The height of all trees was measured. In addition each was photographed and notes made on symptom severity. Disease severity and tree height will be assessed in January 2011 after the wet season.

43 Aphelenchoides fragariae—a foliar nematode on strawberries in south-east Queensland

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The leaf and bud nematode, Aphelenchoides fragariae, was detected on strawberry plants, identified as having abnormal growth by a fruit grower on the Sunshine Coast in QLD, in July 2010. The plants had been received from a runner grower and planted in March/April. By early August, the nematode had been detected at several other properties where symptoms had appeared. Infection rates in fields on one property were estimated to range from 10-40%. This severely impacted the yield of this high value crop, as heavily infected plants do not produce fruit.

Symptoms include stunting, a tight aggregation of crowns (some with a necrotic apical tip) and stunted petioles and flower stalks. Flowers on short stalks commonly had aborted or partly aborted floral parts. Distortion and chlorosis or bronzing of newly emerged leaves was also seen.

This is the first known record on strawberries in Queensland, with only two other previous doubtful records on strawberries Australia wide. It has previously been detected on a range of hosts (mainly ornamentals) in Queensland.

Work is continuing on the etiology of the disease and potential control measures for runner and fruit growers.
44 Genetic diversity and pathogenic variability among isolates of *Ralstonia solanacearum* from white potato-growing areas in northern Mindanao

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*Ralstonia solanacearum* causing bacterial wilt is one of the most important and widely spread bacterial disease of solanaceous crops in the tropics, sub tropics and warm temperate regions of the world. It is traditionally classified into five races based on differences in host range and into five biovars based on biochemical properties. Potato plants exhibiting symptoms of bacterial wilt were collected from different areas of Northern Mindanao, Philippines. Pure cultures of bacteria were isolated and grown in TZZ medium. *Ralstonia solanacearum* colonies are large, elevated, fluidal and either entirely white or with a pale red center. A PCR-based method was used to confirm the identity of the bacteria. All isolates were tested using the primer pair RALSF 5’-GCTAAAGGACATTGCTGGC-3’ and RALSR 5’-TTCATAGATCCAGGCATC-3’, designed using cytochrome c1 signal peptide sequences specific to *R. solanacearum*, and results yielded a product of 932 bp. All isolates belonged to biovar 3 based on their biochemical properties such as ability to utilise sugar and alcohol, but they differed in terms of aggressiveness when inoculated onto tomato cultivar Yellow Plum.

45 Plant health products and fungicides increase Brassica stem canker suppression

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Brassica stem canker is a disease complex caused by several pathogens including *Leptosphaeria maculans* (the cause of blackleg) and 3 anastomosis groups of *Rhizoctonia solani; AG 2.1, 2.2 and 4.

Most severe in winter plantings for spring harvest, the complex occurs in cauliflower, broccoli, cabbage and Brussels sprout. Crop losses up to 80% from complete stalk collapse in cauliflowers in the Northern Adelaide Plains of South Australia were first noted in 2000. Evaluation of over 15 fungicides applied as root drenches prior to or after transplanting of seedlings showed only disease suppression was achieved. Therefore alternatives to traditional fungicides for suppression of Brassica stem canker were evaluated in greenhouse trials. Trichosferil®, Bioforce®, Mycotea® and Companion® claim to alleviate plant stress or improve fungal defence, plant strength, nutrition or root mass. These products were applied as a seedling root drench to 6 week old cauliflower cultivar Donner, either alone or in combination with the fungicide Amistar®. The seedlings were planted into artificially inoculated growing media and disease severity assessed every 14 days until harvest. The Relative Area Under a Disease Progression Curve (RAUDPC) was calculated for each treatment, enabling comparison between products of Brassica stem canker suppression. The trials demonstrated that these plant health products applied in combination with Amistar as a soil drench improved control of Brassica stem canker compared to any of the products used alone. Such products may assist plants to resist disease sufficiently to allow a harvestable age and quality to be achieved.

46 Sensitivity of *Monilinia* species of stonefruit to propiconazole, iprodione and fludioxonil fungicides

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Control of brown rot of stonefruit, caused by *Monilinia fructicola* and *M. laxa*, relies heavily on well-timed application of dicarboximide and triazole fungicides during key crop growth stages. Fludioxonil, a new registered fungicide for use as a post-harvest dip, will provide an additional control option. However, the comparative sensitivity of *Monilinia* spp. to these fungicides needs to be determined. Twenty *Monilinia* isolates were screened against propiconazole, iprodione, and fludioxonil, which belong to the triazole, dicarboximide and phenylpyrrole chemical groups respectively. The isolates were previously cultured from peach, nectarine and plum that had been collected from Victoria and South Australia. Potato dextrose agar was amended with each of these fungicides at concentrations from 0 to 1.62 ug/ml. A five mm mycelial plug of each isolate was placed in the centre of each agar plate. Each isolate was tested in duplicate. The diameters of the colonies that developed were measured after incubation for five to six days at 21°C in darkness. The 50% effective concentrations (EC_{50}) for the majority of the isolates were 0.012-0.034, 0.04-0.26 and 0.0025-0.007 ug/ml for propiconazole, iprodione, and fludioxonil respectively. The data suggest the isolates were sensitive to both propiconazole and fludioxonil with low EC_{50} values, whilst the isolates were sensitive to iprodione at a higher and wider concentration range.

47 Development of specific PCR primers for the detection of the postharvest pathogen *Cadophora luteo-olivacea*

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In recent years a postharvest disease of kiwifruit caused by *Cadophora luteo-olivacea*, characterised by a pitting of the skin appearing after 3 or more months of storage, has been reported in most Italian packhouses. In all experiments, *C. luteo-olivacea* was identified based on morphology and sequencing of the ribosomal region ITS1-5.8S-ITS2. Pathogenicity tests show that *C. luteo-olivacea* was pathogenic on apple, pear, and kiwifruit stored at 4°C for 90 days. There is a need for a sensitive, reliable and rapid diagnostic method for identification of the fungus; a PCR-based assay was developed. Variation within the internal
transcribed spacer region of the rDNA was used to characterise the *C. luteo-olivacea* strains and to design specific primers within the ITS region.

48 Resistance to exotic sunflower pathogens available in public germplasm

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Although sunflower (*Helianthus annuus*) has been grown in Australia for over a century, many significant global pathogens remain absent due to effective quarantine measures. Some of these exotic pathogens include downy mildew (*Plasmopara halstedii*), Phomopsis stemanker (**Diaporthe helianthi**) , broomrape (**Orobanche cumana**) and sunflower mosaic virus. The U.S. Department of Agriculture (USDA-ARS) Sunflower Research Unit is one of the few public research groups in the world whose mission is to develop and distribute sunflower germplasm with disease resistance. Over the past thirty years, more than 200 germplasms have been released to the public, with more than 25% selected primarily for disease resistance. Some releases, such as TX16R, possess multiple pathogen resistance (resistant to all known races of *P. halstedii* and *Puccinia helianthi* plus sunflower mosaic virus). Other releases, such as RHA 468, target individual pathogens, but have been incorporated into elite germplasm containing modern agronomic traits including high oleic acid content and resistance to imidazoloinone herbicides. The USDA-ARS also maintains an extensive germplasm collection of cultivated sunflower and 51 wild *Helianthus* species. Through extensive screening for disease resistance in greenhouse and/or field environments, sources within this collection have been identified with resistance to many diseases. In keeping with the mission of the USDA-ARS, information regarding resistance in germplasm is available online (http://www.ars-grin.gov/cgi-bin/npgs/html/crop.pl?79), and source material is distributed free of charge. To preemptively combat exotic, high risk sunflower pathogens, Australian plant breeders can avail themselves of public germplasm developed with disease resistance, and often with an elite agronomic background.

49 Implementing pest management strategies in Vietnamese temperate fruit crops


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Temperate fruits are grown in north-western Vietnam. Farmers have various ethnic backgrounds, speak a number of languages and often have low levels of literacy. Since the 1980s various agencies have collaborated to introduce improved peach, plum and persimmon germplasm. Despite initial improvements, production declined sharply after 10-15 years. This was due to a lack of crop husbandry knowledge including very few crop protection skills. Since 2002, ACIAR have facilitated the development of crop protection programs for Vietnamese stone fruit and Persimmon industries. Pest and disease management in Vietnamese upland crops is extremely poor. Diseases are generally uncontrolled and yield is lost as a result of diseases such as peach leaf curl (peaches) and Cercospora leaf spot (persimmons). Fruit is often harvested green and hard to avoid diseases such as stone fruit brown rot. In many cases diseased fruit is accepted as the norm. Surveys examined the pests and diseases (types, timing and severity) in plums, peaches and persimmons across three provinces. Surveys also defined current agronomic practices, attitudes and the local availability of pesticides. This information has been used to develop a locally-relevant pest management strategy. Workshops and manuals target two groups, District Extension staff and Farmers. Extension to farmers is highly visual and participatory, while extension staff receive more technical detail. Vietnam has a structured extension network and more effective pest management is now being undertaken as this knowledge spreads through villages.

50 Mechanism study of *Bacillus cereus* colonisation on plant

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Plant microecology is a complex system with all members interrelated. Bacteria from this system which have plant growth-promoting and bio-control activity of plant diseases have been used to develop biopesticides and/or biofertilisers. *Bacillus cereus* 905 (formerly *B. cereus* A-47) were isolated from wheat by our lab and showed effective function in promoting crop growth and controlling diseases. Successful colonisation on/around the host plant is required for effective function. Biological assays showed that attenuation of the chemotaxis-encoding gene cheA or the flagellin-encoding gene flaA reduced bacterial populations in the rhizosphere. These results indicate that cheA and flaA play an important role in colonisation of *B. cereus* on plant.

Superoxide dismutases (SODs) play an essential role in the stress response of microbes, plants, animals and human beings. In our study, two MnSOD encoding genes were identified in *B. cereus* 905. Attenuation of either or both of the genes resulted in reduced populations of *B. cereus* 905 in the wheat rhizosphere. and less survival on minimal media M9 supplemented with glucose, succinate or myoinositol. These results indicate that SOD is essential for *B. cereus* 905 to colonise in the wheat rhizosphere, possibly because of the disturbed ability in nutrition utilisation of *B. cereus* 905.
51 Isolation and application of a Bacillus subtilis strain to control gray mold on tomato and powdery mildew on cucumber
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Gray mold and powdery mildew are important diseases on tomato and cucumber respectively causing a great damage in China. The control of both diseases primarily depends on the application of chemical pesticides. However, it becomes a popular and important problem that many chemicals show the potential toxic effect on humans, wildlife, foods, pathogen resistance and environment. So, it is a hot research point nowadays to find and use natural product to control these diseases. Microbial fungicides show such a more potential efficacy of control on plant diseases in greenhouse that the studies thereof become more popular in China. In this study, a bacterial isolate Bacillus subtilis BAB-1 were screened against the pathogen Botrytis cinerea by dual culture and showed a significant efficacy to control gray mold on tomato in pot test. A preparation, 5 \times 108 cfu/ml spores AS, was made with spores of B. subtilis BAB-1 and applied in greenhouse. Naturally infested, the tomato and cucumber at flowering stage were sprayed 4 times (interval 7 days) with 50-fold diluted solution of this preparation. 45 days after first spraying, the diseases were rated. This experiment was designed randomly and conducted in two years, 4 replicates for each year. The treatment could significantly reduced both diseases at \( p = 0.05 \) with a control efficacy 81.6%–93.7% on gray mold of tomato and 81.1%–98.3% on powdery mildew of cucumber. This study will provide a new and environment-friendly fungicide to control both diseases in China.

52 Value of resistance and fungicides for control of mixed infections of powdery mildew and leaf rust on barley
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The foliar diseases powdery mildew and leaf rust are a severe limitation to the yield and quality of malting barley on the south coast of Western Australia (WA). A 2009 field trial at Gibson, in the south-east of the WA agricultural region, investigated the value of seed and foliar fungicides (applied at early stem elongation to half head emergence) and variety resistance, in minimising disease impact on grain yield and quality of malting barley. Powdery mildew severity in the susceptible (S) varieties, Baudin and Vlamingh showed a significant response to fungicide treatments, whereas Baudin (S), Buloke (S) and Vlamingh (MS) all required fungicide control for leaf rust. Significant yield responses to fungicide applications occurred in Baudin, Vlamingh and WABAR2315. The varieties Baudin and Vlamingh which are susceptible to both diseases showed the largest yield response and in these varieties the full control treatment provided further yield improvement over one or two fungicide sprays. The grain quality measures, percentage screenings, protein and hectolitre weight were all improved in Baudin. In the other varieties these measures were not all improved by fungicide application. This study demonstrates that integrated disease management options are available to barley growers in south Western Australia with variety selection matched with the appropriate fungicide package to maximise yield and grain quality.

53 Pseudocercospora spp. associated with fruit rots of Actinidia chinensis ‘Hort16A’ in Korea and Japan
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Fruit rots of the yellow-fleshed kiwifruit Actinidia chinensis ‘Hort16A’ have caused significant loss of production in Japan and South Korea since 2006. The symptoms on fruit from both countries are similar and appear before harvest. These symptoms include characteristic depressions on the surface of fruit that later develop into distinctive black or dark brown sclerotic lesions with discoloured fruit flesh immediately beneath the lesion. Some fruit fall to the ground prematurely. Rots also develop in fruit during storage. The most common fungi isolated from fruit rot symptoms were Pseudocercospora spp. Pathogenicity tests indicate that Pseudocercospora isolates are capable of causing these fruit rot symptoms. A phylogenetic study of 40 isolates from Japan and Korea suggests that there are at least two different Pseudocercospora species that cause the disease.

54 Genetic diversity among oil palm (Elaeis guineensis) progenies in a field trial in Solomon Islands
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Oil palm (Elaeis guineensis) is a perennial crop of great economic importance to many countries in tropical Asia/Oceania, providing export revenue. Unfortunately basal stem rot (BSR) caused by the white rot fungus Ganoderma boninense poses a major threat to the oil palm industry, and hence to farmers’ livelihoods. The only long-term control for this disease is through implementation of improved cultural practices and the use of more resistant planting material. In this ACIAR funded project we have a collection of 26 parental lines (of Delli, Avros, Avros-Ghana and Ghana origins) which were used to produce progenies for a field trial in Solomon Islands. To ascertain the level of genetic diversity present in our palm population we used simple sequence repeat (SSR) markers (Billotte et al., 2005) on a collection of 100 progenies representing 20 families and their parental lines. A total of 93 alleles were generated. Cluster analysis revealed associations among progenies which were in close agreement with the
pedigree data. Despite a narrow genetic origin of the Deli line, SSR markers revealed genetic diversity of the Deli parents, as well as genetic diversity within and between families.

55  Symptom development of two banana cultivars infected with bugtok and moko strains of *Ralstonia solanacearum* Race 2

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We conducted cross-inoculation experiments under field conditions to better understand the relationship of our endemic bugtok strain with the moko strain of *Ralstonia solanacearum* Race 2. Symptom expression was affected by the age of the plant, cultivar, mode of transmission and strain. Both ‘Cardaba’ and ‘Cavendish’ cultivars developed wilt or moko symptoms when inoculated with either moko or bugtok strains. ‘Cardaba’ had the ability to recover from wilting when inoculated at 3 and 6 months after transplanting (AT). Late inoculation at 9 months AT of ‘Cardaba’ resulted in very slow increase in wilt incidence over time but reached almost 100% at maturity. A high incidence of wilt occurred in ‘Cavendish’ 2-3 weeks after inoculation especially when the bugtok strain was used. All plants that survived showed fruit pulp discoloration or bugtok symptoms. The ‘Cardaba’ fruits had a higher number of fingers discolored per bunch. Inoculation at inflorescence stage did not result in wilt symptom. Fruit pulp discoloration in both cultivars resulted when bacteria were sprayed on male or female flowers and when bacteria were injected at the base of the flower bud before emergence. ‘Cardaba’ had higher bugtok symptoms than ‘Cavendish’ while the bugtok strain caused higher fruit pulp discoloration than the moko strain across both cultivars.

56  Molecular analysis of the mode of phosphite action in *Arabidopsis thaliana*

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Phosphite (H₃PO₃) is a phosphate analog widely used to protect plants from oomycete pathogens such as *Phytophthora* and *Pythium*. *Phytophthora* species are prominent pathogens in agriculture, e.g. *Phytophthora infestans* causing potato late blight. *Phytophthora cinnamomi* has devastating effects on native ecosystems with over 4000 plant species at risk in Western Australia alone. Phosphite is a well-known protectant of plants and exhibits a complex mode of action. It directly inhibits the pathogen’s growth by interference with its phosphate-dependent metabolism. At the same time it also inhibits the plant’s phosphate starvation response, e.g. the up-regulation of high-affinity phosphate transporters, and thus has constrictive effects on plant growth under low phosphate supply. In addition to these direct effects, phosphite also induces the plant’s defence responses with increased expression of defence genes. However, the underlying mechanism of this indirect effect is not understood. We have started to characterise the impact of phosphite on plant defence responses by analyses of transgenic plants, metabolic pathways and the natural genetic variation in the plant *Arabidopsis thaliana*.

57  Chitinase production from *Trichoderma harzianum* Th-30 and its antagonistic activity against *Botrytis cinerea* of tomato

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To improve the production of chitinase by *Trichoderma harzianum*, growth medium and culture conditions for *T. harzianum* Th-30 were examined using single factor and orthogonal tests. The results indicated that the optimal medium for inducing chitinase contained 7.0 g/L chitin, 2.0 g/L peptone, 50mL/L nutrient salt, 1.0mL/L trace elements salt solution. The optimum culture conditions for inducing chitinase were as follows: 50mL medium filled in a 250mL flask with 8% inoculation quantity of the culture, initial pH 5.5, 28°C, incubating for 96 hours. The *T. harzianum* Th-30 chitinase extract could significantly antagonise *Botrytis cinerea*. A 2-fold extract dilution led to an inhibition of *B. cinerea* hyphal growth of 67. 6-71. 3%. The generation and germination of *B. cinerea* spores eas inhibited by 81.0% and 81.4% respectively.

58  Management strategies for root rot of continental parsley

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Root rot of parsley is a disease complex, which causes up to 100% yield loss in Victoria and Queensland, Australia. The disease symptoms, including damping off, root lesions and root rot, have been associated with *Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Phoma* spp. and *Rhizoctonia* spp. Aboveground, the disease occurs as irregular patches of foliage chlorosis or completely collapsed plants. Control strategies for parsley root rot were evaluated in a field trial in sandy soil in Victoria, Australia in winter 2010. The control methods included applications of metalaxyl, ferric citrate, the biological control agent *Pythium oligandrum* or garden mulch. In untreated control plots, 88% of systematically sampled plants exhibited disease symptoms on their roots and foliages before the first harvest of foliage, 140 days after sowing. Biomass of plants with collar or tap root rots or a combination of both symptoms was 43% lower than the biomass of healthy plants. Lesions on the upper or lower tap root did not affect plant biomass. Applications of ferric citrate, garden mulch or metalaxyl increased biomass by 2.18, 1.68 and 1.24 t/ha, respectively, when compared with the untreated control. The results demonstrate that treatments, such as garden mulch and ferric citrate, which
improve soil conditions, may be used to reduce yield loss caused by the root rot complex.

59 Management of Botryosphaeria canker of grapevines

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In Australia eight species of Botryosphaeriaceae contribute to the grapevine trunk disease complex known as ‘bot’ canker. Protection of pruning wounds is the most effective means of preventing grapevine trunk diseases. Field trials were established in the Hunter Valley, NSW and in the Barossa Valley, SA to assess FolicurTM, NustarTM, ShirlanTM, BavistinTM, SwitchTM, TopasTM, RovralTM, MyclossTM, DomarkTM, BacSealTM, GarrisonTM, VinevaxTM and ATCS tree wound dressing as potential pruning wound protectants. One-year old canes were pruned to two buds and treatments were applied to 10 pruning wounds on each vine, after which, wounds were inoculated with 500-1000 spores of Diplodia seriata or D. mutila. Canes were assessed for the presence or absence of the inoculated fungus after 12 months. Efficacy based on mean per cent disease control (MPDC) was calculated as the reduction in mean per cent recovery (MPR) of the fungus from treated canes as a proportion of the inoculated control. In the Hunter Valley, Garrison, Bavistin, Folicur, Rovral, Shirlan, Switch and Vinevax significantly reduced the MPR of D. seriata. However, the best control was obtained when products were applied at rates exceeding the manufacturer’s recommendations. In the Barossa Valley, ATCS tree wound dressing, Bacseal, Bavistin, Folicur, Garrison, Nustar, Shirlan and Switch provided between 32-65% control of D. mutila when applied at label rates or in accordance with manufacturer’s recommendations. Conducted over two consecutive seasons from 2008 through 2010, this study aimed to develop effective treatments for immediate and long-lasting protection of pruning wounds.

60 Control of Cercospora leaf blight on carrots

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Cercospora leaf blight is one of the most important foliar diseases of carrots. The infected carrot tops break off easily during mechanical harvesting and hence may cause substantial yield losses as affected plants are left in the ground. In Tasmanian trials in commercial crops, azoxystrobin, iprodione, tebuconazole and copper sulphate possessed leaf blight control efficacy. Azoxystrobin was the most effective fungicide treatment, reducing leaf blight by 87% compared to the untreated control. Azoxystrobin applied at the lowest rate of 75 g ai/ha gave equivalent disease control as the higher rates (150 and 250 g ai/ha). Iprodione was the second most effective fungicide, reducing leaf blight by 69% compared to the untreated control. Tebuconazole at 129, 258 and 430 g ai/ha provided equivalent control to copper sulphate at 213 g ai/ha. Yield increases were only recorded in plots treated with azoxystrobin and iprodione. Azoxystrobin applied early, just before the onset of leaf blight infections, resulted in significantly higher shoot biomass and carrot yield than late applications after onset of leaf infections. The application of non-residual soft products such as sulphur, oils and potassium bicarbonate provided little or no disease control.

61 Powdery mildew disease management in carrot crops in Australia

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Powdery mildew caused by Erysiphe heraclei was first recorded on carrots in Australia in 2007 and since then outbreaks have occurred in different carrot varieties grown for juicing, slicing and the fresh market. Field trials were conducted in commercial crops at the onset of infection to test the efficacy of available products for the protection of new foliage and lowering disease severity. The products were the fungicides (azoxystrobin, boscalid, bupirimate, difenoconazole, pyraclostrobin, tebuconazole and triadimenol) and non-residual soft products (botanical oil, paraffinic oil, vegetable oil, potassium bicarbonate, sulphur, sulphur dioxide plus benzoic acid and Streptomycetes lydicus). Azoxystrobin, pyraclostrobin and tebuconazole were more effective in reducing disease severity on new leaves compared to boscalid, bupirimate, difenoconazole and triadimenol. Azoxystrobin applied at a lower rate of 75 g ai/ha gave a similar level of disease control as the current recommended rate of 250 g ai/ha. Among the soft products, only sulphur, applied at 0.2% w/v was highly effective. All the oils applied on their own had little or no effect on the disease. Screening of six carrot varieties in the field and in the glasshouse showed there were differences in their susceptibility to powdery mildew.

62 New fungicide options for white blister disease control in broccoli

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White blister, caused by Albugo candida, has been a major foliar disease of broccoli crops in Tasmania and Victoria since 2003. The disease can affect all stages of plant growth, but the greatest impact is on infected flower heads, resulting in substantial yield losses and higher sorting costs. There are very few fungicides available for commercial use. Field trials were conducted in commercial crops in 2004-2010 to screen for effective fungicide and non-fungicide products for white blister control. The most effective fungicides for white blister control were Amistar® (azoxystrobin), Cabrio® (pyraclostrobin), Ridomil Gold Plus® (metalaxyl-M plus copper hydroxide) and Ridomil Gold MZ® (metalaxyl-M plus mancozeb). A spray mixture of Amistar® with either Bion® (acidibenzolar-s-methyl, a plant resistance activator) or
Polyram® (metiram, a protectant fungicide), enhanced disease control on leaves and heads compared to Amistar® alone. Aero®, based on metiram plus pyraclostrobin, and a new fungicide NUL 1955 also showed good activity for white blister control. Copper fungicides were effective in reducing head infections, but were less effective than the systemic fungicides in preventing leaf infection. Other fungicides such as mancozeb, chlorothalonil, boscalid, phosphorous acid, propamocarb and two new fungicides NUL 2111 and NUL 1935 provided little or no disease control. Non-fungicides such as Streptomyces lydicus and Zoeli® (food grade anti-fungal product) also had no effect.

63 Optimising fungicide combinations for control of all major foliar potato diseases

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Early blight (Alternaria solani), late blight (Phytophthora infestans) and white mould (Sclerotinia sclerotiorum) are the major foliar diseases of Australian potato crops. Disease control requires growers to apply the right combination of fungicides at the appropriate crop stage, so achieving maximum protection and yield. Selecting a robust fungicide program containing products with different modes of action can help minimise the risk of resistance development in the new single-site fungicides. Spray programs that incorporate single and multiple site fungicides were assessed in commercial crops for their impact on diseases and yield. Boscalid (Filan®), difenoconazole, metiram (Polyram®), metiram + pyraclostrobin (Aero®) and fluazinam (Shirlan®) were compared against other industry standards and an untreated control. Filan, Polyram, Aero and difenoconazole were very effective in controlling early blight, while Aero, Polyram and Shirlan were effective for late blight control. Filan and Shirlan also control white mould. In trials conducted over two years, a spray program of Filan mixed with Polyram followed by Aero was shown to increase the proportion of large sized tubers by up to 34% and increase marketable yield by up to 19%, compared to the untreated control. The results of this research led to the introduction of a commercial disease management program known as the PowerYield Program for Australian potato growers. This program provides the right fungicide combination at the appropriate crop stage. It ensures optimum levels of disease control through the introduction of new chemistry, while also aiming to prevent disease resistance.

64 The development of an integrated disease management strategy for onion white rot control

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White rot is a major disease of onions (Allium cepa) and bunching onions (Allium fistulosum) in Australia. White rot is caused by Sclerotium cepivorum, a soil-borne fungus that produces sclerotia that can lie dormant in soil for many years until stimulated by sulphur-based compounds emitted by roots of Allium plants. In northern Tasmania, 80% of land used for growing onions is affected by white rot. Control strategies that included late planting to reduce crop susceptibility, the use of biostimulants before planting, formulating a granular fungicide for application at sowing, and late fungicide spray applications were developed to combat the disease. Before planting, biostimulants based on synthetic or naturally occurring diallyl disulfide can be applied into soil to trick the white rot sclerotia into germinating. In the absence of host plants to infect, the fungus dies out, hence reducing the inoculum level. With furrow applications at sowing, tebuconazole delivered in a fine granulated carrier was shown to extend the period of early plant protection for up to 120 days compared to liquid sprays of tebuconazole. Up to two soil spray applications with triadimenol after crop establishment were shown to provide late plant protection and reduce disease severity on affected bulbs.

65 Nitrogen affects lettuce susceptibility to downy mildew (Bremia lactucae)

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Downy mildew, caused by the oomycete Bremia lactucae, is the most important disease of lettuce (Lactuca sativa). Nitrogen is essential for plant growth and may influence the severity of disease. Trials were undertaken as part of a national collaborative project to assess incidence and severity of downy mildew infection on four lettuce varieties (cv. Constanza, Fortune, Boomerang and Lily) treated with various forms and rates of nitrogen fertiliser. B. lactucae was isolated from field infected lettuce and inoculated (105 spores/ml) onto seedlings grown in a controlled environment growth room at 14°C under a 12 hr light/dark cycle. Fifteen replicate plants were watered every 3 days with a form of nitrogen (ammonium nitrate, calcium nitrate or potassium nitrate) or water at various rates (0, 2, 10, 50 mM). Plants were assessed for disease incidence, disease severity and fresh weight. Symptoms appeared 7-13 days after inoculation. Ammonium nitrate contributed to high disease incidence and severity at all rates which significantly reduced fresh weight. The highest rate of potassium nitrate increased disease incidence for the most susceptible variety Constanza. In comparison, calcium nitrate did not significantly affect plant susceptibility to downy mildew. In all treatments, high rates of nitrogen depressed growth. The source of nitrogen is
perhaps more important than the rate of nitrogen applied in regard to susceptibility of the plant to disease.

### 66 The influence of variety and nitrogen fertiliser on susceptibility of lettuce to anthracnose (Microdochium panattonianum)

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Anthracnose is a common disease of lettuce (Lactuca sativa) caused by the fungus Microdochium panattonianum. The pathogen survives in debris, and microsclerotia can survive in soil for up to four years. Control of the disease is largely reliant on fungicide usage as resistant cultivars are few. Lettuce production requires applications of nitrogen, potassium and calcium for good growth and head development. Varietal susceptibility and the influence of nitrogen on the incidence of anthracnose were investigated in controlled environment trials. Twenty-one lettuce varieties were inoculated with M. panattonianum isolated from field infected lettuce and grown at 14°C under a 12 hr light/dark cycle. Typical anthracnose symptoms appeared 8 days after inoculation. Symptoms were observed on all varieties tested with varying severity, with the most susceptible being Explore. Four varieties (cv. Kong, Explore, Seagull and Alpinas) of varying susceptibility were selected to investigate the effect of three forms of nitrogen (ammonium nitrate, calcium nitrate or potassium nitrate) at various rates (0, 2, 10, 50 mM). High rates of nitrogen did not increase the incidence or severity of anthracnose. In general, disease was observed when optimal plant growth conditions occurred at 10 mM of all sources of nitrogen tested. High rates of calcium nitrate reduced the incidence of anthracnose, possibly by strengthening cell walls.

### 67 Introgression of resistance to Pratylenchus from wild Cicer species into Australian chickpea cultivars

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Chickpea (Cicer arietinum L.) is a major pulse crop worldwide and is commonly grown in rotation with wheat in the Australian northern grains region. The root-lesion nematodes (RLN) Pratylenchus thornei and P. neglectus cause yield losses of up to 20% and 50% in intolerant chickpea and wheat respectively thus reducing the rotational benefits in a winter cropping regime. Our previous assessments of chickpea germplasm identified seven wild Cicer accessions resistant to Pratylenchus. These accessions were crossed with the commercial chickpea cultivars Jimbour and Howzat and 132 F1 progeny evaluated for resistance to P. thornei and P. neglectus. The wild Cicer accessions ILWC 245, ILWC 246 (C. echinospernum) and ILWC 123, ILWC 140 (C. reticulatum) and 37% of their F1 progeny were significantly more (P<0.05) resistant to P. thornei than all commercial chickpea cultivars, with 12 F1 lines significantly more resistant than moderately resistant wheat cultivar QT8343. All wild Cicer accessions and 43% of F1 progeny had resistance to P. neglectus equal to or better than moderately resistant chickpea cultivar Villalta. Currently 118 derivatives from wild Cicer accessions are undergoing further development to combine resistance to RLN and the fungal diseases Ascochyta blight and Phytophthora root rot to produce multiple disease resistant chickpea cultivars that will provide improved rotational benefits and economic gains in winter crop sequences.

### 68 In vitro antifungal activity of volatiles from biofumigant brassicas against soil-borne pathogens of vegetables

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A laboratory method was developed to assess the antifungal potential of new biofumigant Brassica cultivars for control of four major soil-borne pathogens of vegetables (Sclerotinia minor, Rhizoctonia solani, Fusarium oxysporum and Pythium dissotocum). Different quantities of freeze-dried shoot and root tissue of ten Brassica species and cultivars were compared for their ability to reduce the survival of mycelium of the four pathogens in vapour exposure bioassays conducted in-vitro. Analysis of glucosinolate (GSL) content showed that the Brassica tissues which were the most antifungal in the bioassays had high levels of sinigrin (2-propenyl GSL). Sinigrin is hydrolysed to the volatile compound 2-propenyl isothiocyanate (ITC) upon tissue disruption and the Brassica tissues with the highest levels of sinigrin were the most effective in suppressing or killing mycelium of the four pathogens. Shoot tissues were more effective than root tissues and contained several fold higher concentrations of sinigrin. A dose-response relationship was demonstrated with greater quantities of Brassica tissue increasing the biocidal activity. The results will be discussed in relation to selection and field evaluation of new Brassica biofumigant crops for ITC-based soil biofumigation in vegetable production.

### 69 The effect of temperature and vapor pressure deficit on in vitro germination of Podosphaera fusca

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Powdery mildew (caused by Podosphaera fusca (Fr.) S. Blumer & N. Shishkoff) is a common and often serious disease of cucurbits worldwide. While disease forecasting systems have been developed for other powdery mildews, none exist for cucurbits. As detailed epidemiological studies of this disease on cucurbits in Australia are also lacking, this study aimed to obtain quantitative data on the effects of temperature and vapour pressure deficit (VPD) on in vitro conidial germination. Effect of temperature and VPD on
conidial germination was studied at seven temperatures and 16 different VPD levels using a detached leaf disc technique. Cucumber (cv. Crystal salad) leaf discs were inoculated with P. fusca using a spore settling tower and incubated in humidity and temperature-controlled chambers. Conidial germination was observed at four incubation times. P. fusca germination was observed at all tested temperatures except at 35°C (all incubation times). The highest germination rates were recorded at 28°C, but decreased at ≤19°C or ≥31°C. P. fusca germination on cucurbit leaf discs was favourable at the lowest VPD (0.03KPa) at which conditions were nearing saturation, but drastically dropped when the VPD increased to 0.10KPa.

70 Cherelle wilt phenomenon on hybrid cocoa clones in Papua New Guinea

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The etiology of cocoa cherelle wilt phenomenon is still a mystery. Suggested causes are insufficient pollination and pod abortion resulting from the presence of too many potential pods. The objective of this study was to investigate whether pathogens were involved in the condition. Cherelles of six hybrid clones, (73-14/1, 24-9/1, 33-15/1, 16-3-2, 16-2-3 and 36-3/1) were tagged at approximately 1 cm length and observed throughout the pod developmental stages until ripening 5 to 6 months after pollination. There were ten cocoa plants per clone except for clones 16-3-2 (3 trees) and 16-2-3 (7 trees) and 5 cherelles per tree were tagged monthly. A total of 2154 cherelles were tagged and monitored daily over a 13 month period from November to December of the following year. Records of possible causes of wilt were kept and attempts made to isolate pathogens. Data collected showed that most cherelles wilted within the first month of development. Preliminary results showed that cherelle length (cm) is directly proportional to age. A low percentage of cherelles were lost to Phytophthora palmivora. However, larger proportions were lost to unknown causes with only a few ripening. The pathogen Colletotrichum gloeosporioides was commonly isolated from wilted cherelles.

71 Periwinkle petals, suitable bait for quantifying Phytophthora palmivora from cocoa soils in Papua New Guinea

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Phytophthora palmivora causes pod rot, stem canker, chupon blight and seedling blight of cocoa in Papua New Guinea (PNG). Although P. palmivora is not a good soil competitor, it can survive as resting spores and re-infest when conditions are conducive. Four Integrated Pest and Disease Management (IPDM) options tested at the PNG Cocoa Coconut Institute (PNG CCI) showed that greater inputs with timely application led to higher yields. Due to the incursion of the notorious Asian cocoa pod borer, all pods, pod husks and cocoa placentas are usually buried to destroy larvae and pupa of Conomorpha cramarella. Preliminary results showed that burial also reduced P. palmivora infestations as a result of inoculum burial.

A method for quantifying P. palmivora soil inocula was needed to assess IPDM treatments. Four different bait were tested: red hibiscus (Hibiscus coccineus) petals, purple periwinkle (Vinca minor) petals, watercress (Nasturtium officinale) leaves and kangkong (Ipomoea aquatica) leaves. Soil samples were taken from beneath cocoa trees and from a non-cocoa site. Plastic cups were a third-filled with soil then distilled water added to fill the cups. Baits were floated on the water and discolored baits removed as they developed using sterile forceps; baits were mounted on a microscope slide and viewed under a light microscope for the presence of P. palmivora sporangia. Results showed that periwinkle (V. minor) petals were the best bait for P. palmivora under cocoa. Periwinkle petals are in abundance at the CCI headquarters; periwinkle petals will be used as a cheap and reliable bait to test nursery soils before cocoa propagation. Most importantly the bait will now be used to quantify P. palmivora in IPDM treatment soils to provide a better understanding of disease etiology and pathogen management options. The most suitable management practices will then be adopted to minimise pathogen populations and to increase cocoa yields.

72 Biological control with actinomycetes endophytic in cucumber

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Endophytic actinomycetes were isolated from cucumber seedlings cultivated on soils of several agricultural fields at Okayama, Japan. Three candidates (A12, A16, and A19) were selected among 40 isolates through in vivo assay with Colletotrichum orbiculare (104T). They scarcely inhibited the growth of 104T on PDA medium, but prevented lesion formation on the leaves, suggesting an indirect effect of the three isolates. We used A12 for the following experiments. Brassica campestris (Komatsuna) also became resistant to C. higginsianum by treatment with A12, which significantly inhibited the infection but not the germination and appressorial formation by C. higginsianum, suggesting that A12 blocks the infection process. The lesion area was also decreased significantly on the water-treated cotyledon of the seedling where another cotyledon was pretreated with A12 for 1 day. The results indicate that A12 induces or primes the host resistance. A similar result was obtained with Arabidopsis thaliana-C. higginsianum combination. Furthermore our preliminary analysis showed that living A12 evoked the transcriptional activation of several defence-related genes by 3 h after treatment. Taken together with previous data, A12 seems to activate ISR and to be available to protect broad-leaf plant species from their pathogens without direct antifungal activity.
73 **Rotations for managing Fusarium wilt**

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Fusarium wilt of cotton, caused by *Fusarium oxysporum* f.sp. *vasinfectum*, remains an economic constraint to cotton production in infected fields. The pathogen remains indefinitely in the soil, surviving as spores, saprophytically on organic matter or on alternative hosts. This may suggest that using rotations as a management tool could be limited; however data from a recent field trial suggests that some rotation options are better than others. Results showed fallow rotations with sorghum or maize can increase plant survival and reduce disease levels compared to a cotton-fallow-cotton rotation or three years of continuous cotton. Managing crop residues after harvest may also influence disease levels, although in this trial there was no significant difference between maize residues retained on the surface or incorporated into the soil, nor where sorghum residues were retained or incorporated.

74 **Effects of carriers and pesticide adjuvants on Clonostachys rosea 67-1 and plant growth**

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Plant spray and seed-treatments are effective, practical ways to control many fungal diseases, including soybean *Sclerotinia* stem rot, wheat *Rhizoctonia* sharp eyespot and tomato *Botrytis* grey mold. Thirty kinds of carriers and pesticide adjuvants were tested for development of seed-coating and wettable powder formulations of *Clonostachys rosea* (syn. *Gliocladium roseum*) 67-1, a potential biocontrol agent for plant fungal pathogens. Significant differences occurred in respect of spore germination and hyphal growth on agar or sterile sand plates amended with the different products. Addition of 0.1% calcium lignosulfonate promoted 67-1 growth. 0.5-1% CMC, CMC-Na, 1% polyvinyl alcohol, xanthan gum and 5% dextrin were acceptable adjuvants for 67-1 biopesticide production. 1% humic acid and chitin should be avoided. 10% starch, diatomite and calcium carbonate were good candidates as fungal carriers. The effects of the adjuvants on seed germination and growth of soybean, wheat, and tomato were determined as well. All the plants grew well in sands amended with 0.5-1% polyvinyl alcohol, CMC, CMC-Na and 0.1% calcium lignosulfonate. However, some of the materials displayed different effects on each plant species. 0.5-1% xanthan gum was good for both wheat and soybean; 5% humic acid was beneficial for tomato growth. Calcium carbonate was a good carrier for tomato and soybean growth but not for wheat, and could be substituted by vermiculite, diatomite or peat. The study provided useful information for the development of *C. rosea* as a biopesticide.

75 **Survival and pathogenicity of Sclerotia rolfsii in submerged soils**

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During disease surveys conducted in cropping districts of Cambodia, *Sclerotia rolfsii* was identified from various hosts such as longbean, tomato and mung bean. An investigation was undertaken to generate information on the effects of soil flooding on *Sclerotia Rolfsii* under glasshouse conditions. The tomato variety Neang Tom which was released by the Cambodian Agricultural Research and Development Institute (CARDI) was selected as the host for study. Loamy soil in which *S. Rolfsii* was known to be absent the previous year was dried for 3 days in the glasshouse prior to submersion in water. *Sclerotia of S. Rolfsii* were generated in the laboratory and ten sclerotia were wrapped in netting. The glasshouse trial was conducted with four replications, with each replicate consisting of four pots and each pot containing four bags of sclerotia buried to 2cm in soil. Flooding was simulated by maintaining water levels 10cm above the soil surface. The net cloths were collected at two-weekly intervals from 0 to 8 weeks and sclerotia were inoculated onto culture media following surface sterilisation. The results indicated a gradual decrease in the germination of sclerotia on culture media over the eight week period. In addition disease levels on the tomato host displayed a similar decrease. This may provide a suitable method for adoption by farmers for the maintenance of disease free nursery soil.
76 Characterisation of citrus tristeza clustrovirus isolates from Thailand using restriction analysis of their coat protein gene

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Citrus tristeza virus (CTV) exists in citrus as a large number of distinct strains differing in biological characters and with different distributions in citrus producing. The control strategies such as mild strains cross protection, aimed at controlling severe variants of the pathogen, require procedures to identify virus strains accurately and reliably. For better understanding of the structure of CTV population and relationship between molecular and biological characterisation, 25 CTV samples collected from four provinces in Thailand were studied, using biological indexing, P25/HinI I restriction fragment length polymorphism (RFLP). The mixture of severe stem pitting isolates was found to be dominant in the field. CTV isolates with P25/HinI I RFLP groups I, IV and V were the main cause of epidemics, and most CTV isolates were found to be mixture of mild and severe strains. More accurate identification of strain mixtures in the field and better understanding of the biological traits of the isolates may be achieved by applying the molecular detection methods simultaneously.

77 Development of Bacillus subtilis endospore-forming products for ginger wilt control in Thailand

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Product development of Bacillus subtilis (Bs; tobacco root soil isolate no.4) to control Ralstonia solanacearum (causal agent of ginger wilt) was investigated. The study objective was to achieve high endospore concentrations and prolonged shelf life of Bs products. Twenty-one combinations of media formulation, shaking performance and carrier materials (skim milk, corn flour and talcum) were tested. The results showed that the highest endospores concentrations were produced in N3 and FFS1 media (N3: Peptone 15 g/l, yeast extract 3 g/l, NaCl 6 g/l, distilled water 1,000 ml; FFS1: fish extract 10 mL/L, soybean meal 10 g/L, distilled water 1,000 mL) with 3.10 x 10⁷ and 2.1 x 10⁷ cfu/mL forming respectively. Incubating Bs on a shaker at 150 and 200 rpm led to the highest endospore production. Endospore survival in liquid (FFS1) product with/without added skim milk after 5 months was 3.3 x 10⁷ and 8.3 x 10⁶ cfu/mL, respectively. Endospore concentrations in corn flour and talcum (wettable powder) products, after 7 months storage decreased to 10⁵ cfu/mL while Bs endospores did not survive after 7 months when produced from PSA media in a formulation incorporating the addition of talcum.

78 Development of decision-support tools for the management of brown rot of stonefruits

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Brown rot caused by Monilinia fructicola and M. laxa is a damaging disease of stonefruit in Australia. Crop losses due to blossom blight and fruit rots often occur despite fungicial sprays applied by growers. A further 5-20% of the crop develops postharvest rots.

Infection can be controlled with well-timed, effective fungicides; however, growers lack access to site-specific infection risk assessment tools to support rational spray timing. In addition, brown rot infections are typically quiescent before harvest. The entire supply chain would benefit greatly from a tool to predict rot levels likely to develop after harvest.

Eleven field sites were established in the Murray and Goulburn Valleys. Weather stations located at each orchard provided site specific data for an infection risk model and growers were notified within 12 hrs of infection conditions occurring. Disease was assessed after harvest to evaluate the success of spraying by the growers according to the predicted rot risk. Well timed fungicides, targeting infection risk events, suppressed infections and growers demonstrated continuous improvement in rot control over 2 to 4 seasons. Moist incubating samples of fruit collected close to harvest estimated the risk of rots developing during storage, transport and marketing, and identified high risk batches of fruit.
79 Effects of cover crops and green manures on disease, yield, soil and profit on vegetable farms

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Rotation with cover crops used for green manuring has been promoted as a management option for controlling soil-borne diseases and enhancing soil quality, yield and farm profitability. Long-term trials on vegetable farms in Victoria, Australia, investigated the effects of green manures of several autumn-winter grown cover crops including legume, Brassica biofumigant and grass/cereal, on soil-borne diseases, soil, yield and profitability. Results from the first year (one crop cycle) indicated that cover cropping and green manures can provide a range of benefits in vegetable production including weed and pathogen suppression and improvements in yield and soil quality. For example, green manures of faba beans and Mustclean (B. juncea) reduced the severity of root infections on green bean plants compared to a fallow control in alluvial silty soil. Green manure of Caliente 199 (B. juncea) increased soil organic matter and bean yield in alluvial soil and soil nitrogen and fresh weight of spring onion plants in sandy soil. Green manure of BQ Mulch (B. napus/B. campestris) reduced the populations of S. minor sclerotia and this reduced lettuce drop incidence in sandy soil. The potential benefits of winter cover crops and green manuring for controlling soil-borne diseases and developing sustainable systems for vegetable production will be discussed.

80 First record of powdery mildew of carrots in Australia

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Powdery mildew has been found on carrot crops in three states of Australia. The disease was first reported from the Murrumbidgee Irrigation Area of New South Wales in 2007. It was subsequently found in Tasmania and South Australia in 2008. While powdery mildew is commonly found in parsnip crops, it had not previously been recorded on carrots in Australia. No other states have yet confirmed the disease on carrots. The causal agent is Erysiphe heraclei, the same fungus that affects other members of the Apiaceae family. Host infection studies have indicated that this form of E. heraclei does not infect parsnip, parsley or other members of the Apiaceae, indicating that it is specific to carrots. It is more severe in dry, mild conditions encountered in spring or late summer to autumn depending on the state. Alternative hosts have not been found; therefore it appears that continuous carrots and volunteers are the most likely method of survival from season to season. Rain and overhead irrigation can reduce disease levels. Furrow irrigation favours the disease as does insufficient overhead irrigation. Severity varies with variety.

81 Selection of plant endophytic bacteria from Kepok Kuning (ABB) cultivar for biological control of Fusarium wilt and blood disease of banana

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Banana is one of Indonesia’s main fruit commodities. The two diseases encountered in the cultivation of banana are Fusarium wilt and blood disease. Fusarium wilt disease is caused by Fusarium oxysporum f.sp. cubense (Foc) and blood disease is caused by blood disease bacteria (BDB).

Until now, control of Fusarium wilt and blood disease of banana is very difficult. Biological control is one alternative to control those diseases. The purpose of this study was to obtain endophytic bacteria from healthy? banana plant tissue that were antagonistic to Foc and BDB. From 500 strains of endophytic bacteria isolated from healthy Kepok Kuning (ABB) cultivar, 32 strains inhibited the growth of Foc, 27 strains inhibited the growth of BDB. Of these, only 10 isolates inhibited the growth of both Foc and BDB in vitro. PCR with universal primers 16S showed that the endophytic bacteria could be detected in plantlet tissues of Kepok Kuning (ABB) cultivar. This suggested that the endophytic bacteria were able to grow and develop in the plantlet tissue of Kepok Kuning (ABB) cultivar.

82 Susceptibility of green manure crops to Sclerotinia

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Cover crops used as break crops in vegetable production must be fit for the cropping system and poor host or non-hosts to pests and diseases. Cover crops used as green manures to control soil-borne pathogens such as biofumigation crops must also produce high levels of biomass and be poor or non-host to the target pathogen(s). This study investigated the susceptibility of new Brassica biofumigant and other cover/green manure crops to S. minor and S. sclerotiorum infection. In pot trials, seedlings of legume and Brassica cover crops were highly susceptible to S. minor and S. sclerotiorum when grown in pots containing soil inoculated with mycelium but cereal and grasses were poor or non-hosts to Sclerotinia. However, when pulverised tissue of field grown plants was added to S. minor infested pot soil as a green manure, oats increased the mortality of germinating green beans compared to the inoculated control. Brassica treatments had lower green bean mortality than the inoculated control indicating a biofumigation effect. In the field, Sclerotinia incidence was assessed at two farms where Sclerotinia was endemic but Sclerotinia incidence was very low and did not affect biomass production. The factors
83 Morphological and molecular identification of seed-borne Fusarium of cabbage seeds and its pathogenicity

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In this study, the detection of seed-borne Fusarium species and subsequent pathogenicity tests were carried out. Seeds of twenty cabbage varieties from China were examined for seed-borne Fusarium spp. by washing tests and PDA plate methods. Fusarium spp. were isolated from seeds of cvs. Chungan No.4.5 and Hongmu, which were named as Fusarium-CG and Fusarium-HM, respectively. Fusarium-CG and Fusarium-HM were identified as Fusarium oxysporum on the basis of morphological characters and molecular identification. The two isolates were tested for their effect on seed germination and for their pathogenicity. After dipping into different concentration of spores suspension, the germination energy, percentage germination, germination index and vigour index of cabbage seeds decreased, and the vigour index significantly decreased when the concentration was 106 spores/ml. Both Fusarium-CG and Fusarium-HM could cause disease, and the symptom on leaves of cabbage seedlings was similar to that of cabbage Fusarium wilt in the field. The incidence of disease on leaves of resistant cabbage seedlings was significantly lower than that of susceptible cabbage seedlings. This is the first report in China that cabbage seeds can carry pathogenic strains of Fusarium oxysporum.

84 A volatile substance from Talaromyces sp. promotes plant growth and suppresses the development of diseases on several plants

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Talaromyces sp. promoting plant growth was isolated from an agricultural field at Okayama Pref., Japan. A strain FS2 was identified as T. wortmannii based on ITS1 sequence and morphology. FS2 enhanced seed germination, root elongation and leaf growth of Brassica. The leaf growth was also accelerated in the same sealed chamber where FS2 was cultured on PDA medium separated from seedlings, suggesting effective volatile compound(s). GC-MS analysis showed that FS2 emitted at least seven terpenoids, of which a volatile was identified as b-caryophyllene. The compound alone promoted the growth of Brassica, Cucurbitaceae, Nicotiana and so on. It also accelerated root development of Brassica tested. Furthermore b-caryophyllene increased the yield of cucumber fruits. Interestingly, we found that b-caryophyllene conditioned Brassicae, Cucurbitaceae, Nicotiana benthamiana and Arabidopsis thaliana to be resistant to respective diseases caused by Colletotrichum higginsianum, C. lagenarium or Botrytis cinerea. Preliminary microarray analysis showed that b-caryophyllene induced the expression of genes such as GSTtau1, PAD3, MYB15 and so on. Based on these findings, we discuss the availability of Talaromyces sp. and b-caryophyllene on cultivation.

85 Identification and evaluation of upland rice germplasm resistant to Magnaporthe grisea in Guizhou Province of China

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One of the main sources of upland rice germplasm in China is in Guizhou Province. In order to screen for resistance to rice blast as part of the drought-tolerance breeding program, artificial inoculation was used to characterise the resistance of 100 accesses of upland rice germplasm from different regions of Guizhou Province. The results revealed distinct differences and identified rich sources of resistance. Indica types showed better resistance than Japonica. Eight materials were resistant to both leaf blast and panicle blast. Meanwhile, 12 resistant genotypes were selected to analyse their resistance spectra to 6 groups with 17 physiological races of Magnaporthe grisea. These genotypes had wide resistance spectra to Magnaporthe grisea and the range of virulence frequency was from 58.78% to 80.59%. One accession was resistant to 4 groups and 9 physiological races, and others were resistant to more than 3 groups and 6 physiological races. Six upland rice accesses were recommended for inclusion in the resistance breeding program.
Posters—Disease surveys

86 Stenphylium grey leaf spot disease of lupins in Western Australia: past, present and future

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Stenphylium grey leaf spot disease has been among the major constraints to lupin production in Western Australia in the past. During the 1970s the disease caused heavy yield losses. Wild accessions of Lupinus angustifolius were found resistant to the disease in the USA. This provided a source of resistance that was later incorporated into Western Australian varieties. Though it remained continuously associated with the crop, over the last 20 years the disease has been inconsistent in Western Australian lupin crops due to the continued breeding of resistant cultivars. Recently however, Stenphylium grey leaf spot was discovered at damaging levels in lupin breeding experiments Perth, WA. Screening of breeding lines indicates that a proportion of the existing breeding material no longer contains resistance to this disease. During spring of 2009 and 2010 disease surveys were carried out across lupin growing regions of WA to assess the qualitative spatial distribution of the grey leaf spot pathogen. Symptoms of infection were not common, however Stenphylium botrysum was associated with leaf lesions in all the sampled areas. Virulence of survey isolates on susceptible genotypes was less than those from Perth. Physiological growth studies were carried out in vitro for representative isolates to investigate the difference in their nutritional and environmental conditions requirement in an attempt to correlate these with those existing in the field. Maximum in vitro colony growth and sporulation was recorded on V8 Agar at 20/25°C night/day temperature combination, with 75% Relative Humidity and 12 hour day/night cycles favouring sporulation.

87 Northern exposure: what’s in the water of the Ord River Irrigation Area?

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In August 2010 a pilot study was conducted in the Ord River Irrigation Area (ORIA) to assess the presence of plant pathogens in the irrigation water. As part of this initial study, water from the irrigation supply channels were sampled over a three week period towards the end of the dry season, to evaluate: (1) plant pathogen detection methods—baiting and filtering; and (2) spatial and temporal variations in plant pathogen detection. The objective of this work was to determine the best approach for detecting plant pathogens in irrigation water. From this work, a baseline of oomycete and fungal organisms present in the water was also established. These preliminary results will be discussed, as well as future objectives of this research.

88 First report of chilli pepper anthracnose, caused by Colletotrichum acutatum in the Fiji islands

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An outbreak of anthracnose disease—like symptoms in chillies (Capsicum annuum var. annuum), a major domestic trade and export commodity for the Fiji Islands, was reported in early 2010. Follow up visits were made to several locations in the Sigatoka valley and Naitasiri, on the island of Viti Levu. Symptomatic fruits of five different chilli varieties were collected, showing infection severity ranging from 30-60%. Fungal isolations were made on potato dextrose agar (PDA) amended with streptomycin. Subcultures on plain PDA were sent to CABI, UK, where the fungus was identified as Colletotrichum acutatum J.H. Simmonds.

This is the first record of Colletotrichum acutatum in Fiji, a pathogen recorded in only five other Pacific island nations. Plant disease surveys conducted in 1982 and 2002/3 did not record any occurrence of this pathogen in the country. A delimiting survey is now planned, together with further work that has important implications for control strategies. These are diversity studies to determine if other species, such as C. capsici or C. gloeosporioides are also present, and pathogenicity testing of all locally available varieties.

89 Incidence, severity and host range of Cercospora leaf spot of faba bean in southern Australia

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The distribution of cercospora leaf spot (CLS, Cercospora zonata) in faba bean (Vicia faba) was investigated in a survey of 100 crops across southern Australia in 2007. CLS was endemic to all major growing-districts, affecting 87% of crops, but was most severe in the south-east of SA. Disease incidence and severity were higher in fields cropped in short rotations (1-4 years) than in fields planted with longer rotations between faba bean crops. Disease severity was also higher in crops adjacent to fields containing faba bean residue than in crops planted in isolation from residues. Twenty-nine isolates of C. zonata collected throughout southern Australia from 1999 to 2008, including 10 from the survey, were inoculated onto faba bean in controlled conditions. Disease severity varied with isolates, but variation could not be attributed to geographical origin of isolates or in vitro growth rate. However, multiple analyses indicated that a larger proportion of isolates collected in the period of 2004-2008 was more aggressive than isolates collected in 1999-2003. In a host range study in controlled conditions a mixed-
isolate suspension of *C. zonata* infected narbon bean, lentil and vetch but not pea, canola, chickpea, lathyrus or lupin.

90 Status of Myrtle rust in Western Australia

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Myrtle rust (caused by *Uredo rangellii*) was first detected at a cut flower facility in New South Wales in April 2010.

Following the detection of the disease in NSW, Western Australia implemented emergency import restrictions on the importation of all Myrtaceae plant and parts of plant material entering into Western Australia.

Myrtle rust surveys were conducted in wholesale and retail nurseries and in forest plantations during autumn and spring. More than 121,300 Myrtaceae plants were visually inspected and found free of Myrtle rust symptoms.

Passive surveillance activities have also been undertaken. A Myrtle rust web page was created and an information sheet was sent to 1140 organisations and people involved with Myrtaceae across the state.

In addition, as part of on-going multi-pest surveillance program, DAFWA Officers have conducted Myrtaceae inspections at 78 sites across the Perth metropolitan area since January 2010. No rusts were detected on any Myrtaceae plant inspected.

Myrtle rust has never been detected in Western Australia and these surveys confirmed its official status as Absent: no pest records.

91 The disease complex causing wilt of chilli in Quang Nam Province, Vietnam

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Wilting and dead plants were commonly observed in chilli crops in 2006 and 2007 in Quang Nam province. Plants were sampled from affected crops on an *ad hoc* basis for further examination. Bacterial wilt was common and severe in some crops, and distinguished by the presence of stem vascular browning and bacterial ooze. *Ralstonia solanacearum* (R.s) was isolated, purified and identified. Root and stem rot was common and severe in many crops. Putative cultures of *Phytophthora capsici* were consistently isolated from newly diseased roots by direct plating on a semi-selective medium, and by baiting with rose petals from diseased roots and soil. The cultures were subsequently confirmed as *P. capsici* by N. V. Truong based on morphological and molecular markers.

Basal stem rot caused by *Sclerotium rolfsii* was common in some crops and could be diagnosed in the field based on the presence of abundant small round brown sclerotia and white mycelial sheets. An unidentified stem borer was also associated with wilted plants in a few crops. One or more of these four causes of wilt could be present in a crop, and basal stem rot was commonly associated with bacterial wilt or Phytophthora root rot. The findings emphasise the importance of accurate diagnosis of the cause of wilt in a chilli crop in Quang Nam before an IDM strategy is recommended.

Further studies are justified to find a compatible rootstock with resistance to *P. capsici* and R.s, and develop a simple, reliable and inexpensive grafting technique, for control of these serious diseases.

92 First report of *Colletotrichum acutatum* on anthracnose of peppers (*Capsicum annuum*) in Sri Lanka

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*Colletotrichum* is one of the most important plant pathogens, causing anthracnose in a wide range of economically important hosts. However, only a few studies have been carried out in Sri Lanka regarding the pre and postharvest diseases and losses caused by *Colletotrichum* spp. in chilli peppers. In this study, *C. acutatum* was identified, using morphological characters and benomyl sensitivity studies, as the causal agent of the pepper anthracnose (*Capsicum annuum*) for the first time in Sri Lanka. The colony of the isolate obtained from the diseased pepper (*Capsicum annuum*) cultivars Hungarian Yellow (HY) and CA-8, was white to orange in colour, with slight shades of pink and light mouse grey aerial mycelium. The pathogenicity test showed that the *C. acutatum* can produce the anthracnose lesions on both the wounded and unwounded fruits. Also, the benomyl sensitivity test was used to confirm the identity of the pathogen as *C. acutatum* and to distinguish this fungus from *C. gloeosporioides* which has also been known to cause anthracnose in chilli. However, the present study has not encountered *C. gloeosporioides* or *C. capsici* from chilli anthracnose. Based on these findings, we propose that *C. acutatum* is a contributing cause of anthracnose in chilli peppers in Sri Lanka.
93 The distribution of Phytophthora in the Greater Blue Mountains WHA

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Disease caused by Phytophthora cinnamomi is becoming increasingly prevalent within the Greater Blue Mountains World Heritage Area (GBMWHA), yet little is known of the distribution of pathogens or the impact of disease. To investigate the range of Phytophthora infestation soil sampling is being conducted within defined climatic regions using a stratified random approach. Triplicate samples are tested for the presence of Phytophthora using the lupin bioassay and results mapped using ArcGIS software. Additional samples have been provided by National Parks and Wildlife Services staff and by trained members of the public. Preliminary results indicate the pathogen is widespread across all eight national parks within the WHA. However, infestation is sporadic with negative samples occurring frequently. Isolation frequency was higher in areas of greater human activity, such as the highly visited Blue Mountains National Park. Results also implicate vehicles in anthropogenic dispersal. Further testing is being undertaken to improve our understanding of the pathogen-environment-disturbance relationship. Information gained from the survey will allow managers to prioritise hygiene and quarantine measures, and facilitate the development of ecological models of the distribution of Phytophthora within the GBMWHA.

94 Diseases surveillance of Mangosteen in West Sumatra, Indonesia

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Mangosteen (Garcinia mangostana) is an important export crop to West Sumatra, Indonesia. A specimen based pest list is essential to conform to International Plant Protection Convention (IPPC) requirements. To achieve this, a mangosteen plant health survey was undertaken in June 2010, by the Ministry of Agriculture, Directorate General of Horticulture, Indonesia (DGH) and the Australian Department of Agriculture Fisheries and Forestry. This joint activity focused on surveillance methodology, specimen collection, specimen preservation and processing techniques, and identification. Although most mangosteen trees were relatively disease free, pathology collections did include Pestalotiopsis sp., causing a leaf spot/stem canker; Meliola sp. causing black mildew; and Corynespora sp., and Cephalouros virescens causing leaf spots. Further surveys during different seasons and of other districts will provide a more comprehensive disease list for mangosteen in West Sumatra.

95 A survey on factors affecting genetic structure of Rhizoctonia solani (AG 2-2) populations causing sugar beet diseases in Iran

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Poster withdrawn.

96 Characterisation of Stemphylium species isolated from tomatoes in New Zealand

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The genus Stemphylium contains many saprobic species but also includes several species that are plant pathogens. Two Stemphylium species isolated from diseased stems and leaves of Solanum lycopersicum (tomato) exhibited characteristic Stemphylium morphology but were distinct from one another and the tomato pathogen Stemphylium lycopersici based on conidial morphology. Molecular analysis of the ITS region and the gpd gene of these species revealed two species previously unrecorded on tomato in New Zealand. The gpd gene of one of the Stemphylium species closely aligned to gpd sequences of S. astragali. S. astragali has been previously recorded only in Japan and Korea on Astragalus sinicus (Chinese milk-vetch). The other Stemphylium species exhibited high homology with the gpd gene of an undescribed species of Stemphylium previously isolated from blighted leaves of Medicago sativa (lucerne) in New Zealand. Pathogenicity testing to resolve whether these two species are saprobic or pathogenic on tomato is ongoing. The biological and molecular characteristics of these species, comparison with related species, and discussion on the diagnostic implications of these findings are presented.
**Phytophthora infestans**: an emerging disease of potato in East Timor and its management


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Potato is a stable food commodity in the upland areas of Timor Leste, including the Hatubublico Sub District and the District of Ainaro. Each year subsistence farmers suffer yield losses due to diseases and pests. The predominant pathogens affecting potatoes in the region are *Ralstonia solanacearum* and *Phytophthora infestans*, prevalent during the wet season.

The yield of potato has been drastically reduced by *P. infestans*. Experiments performed by the Department of Plant Protection, National Directorate of Agriculture and Horticulture, Ministry of Agriculture and Fisheries Timor Leste have demonstrated that during the summer period the intensity and population of *P. infestans* is low, but rises rapidly during the rainy season when the conditions are favourable for pathogen growth.

Trials have been conducted to investigate the chemical control of late blight by the Department of Crop Division in conjunction with the International NGO’s OMCAP (Ainaro Manatuto Cooperation Project) and AusAID. These trials demonstrated that the application of the fungicides Dithane M45, Ridomil Gold MZ and Klororanil significantly increased the number of tubers.

**Resistance of ryegrass to blast disease and fitness and distribution of the pathogen in Japan**

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Blast caused by *Magnaporthe oryzae* is one of the most important diseases of ryegrass, grass species widely used as forage and turf in temperate and subarctic regions, including Japan. Its damage is especially severe on susceptible cultivars under warm and wet weather. To observe the cytological reaction of resistant breeding lines to the pathogen and estimate the fitness of the pathogen, inoculation tests have been done under different temperature conditions. A selected resistant line of Italian ryegrass, ‘Yamaiku’, showed strong resistance to the disease producing no visible lesions after inoculation. Papilla-like structures were produced in the plant cells just beneath the appressoria of the pathogen and likely to be preventing its invasion. The cultivar, ‘Sachiaoba’, the only resistant one available in Japan, showed resistance to produce small lesions and fewer sporulation after inoculation. The pathogen showed different fitness under ranged temperatures and lesion enlargement and number of conidia per lesion were highest at 28–31°C compared to lower temperatures of 19–22°C. Since the northern limit of the disease distribution at present approximately matched with the northern limit of average temperature of 23°C in September in Japan, higher fitness of the pathogen seen under higher temperature might have some affect on the epidemic and expanding distribution of the disease in Japan under global warming situation.

**Presence and survival of Phytophthora cinnamomi after the fires in Victoria**

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*Phytophthora cinnamomi* is an invasive fungus-like pathogen that causes severe dieback and death of *Eucalyptus* trees and other native flora around Australia. Disease caused by *P. cinnamomi* in Victoria apparently declined during the long drought (1996–2008) and became undetectable in several previously infected areas. This research project focused on the effect of recent fires on the presence and survival of *P. cinnamomi* in such sites. Even high-intensity fires did not eliminate *P. cinnamomi* from the soil. *P. cinnamomi* was not detected in samples collected from previously infected sites in Kinglake National Park six months after the February 2009 fires, but was detected at these sites in September 2010, 18 months after the fire. *P. cinnamomi* was detected from more than 80% of such sites in Wilsons Promontory National Park and at some previously burnt sites in the Grampians Ranges and Brisbane Ranges National Parks, where it had ceased to be detectable in the past. These findings show that fire leads to the possibility of new outbreaks and resurgence of disease on return of favourable conditions such as high rainfall and regeneration of susceptible native vegetation. Smoke water inhibited the growth of *P. cinnamomi* and could possibly be used as an efficient and economical control measure.

**Huanglongbinh epidemic in limes in Vang Vieng area, Vientiane Province, LAO PDR**

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Huanglongbinh (HLB (Citrus Greening)) disease was first reported from Lao PDR in 1998 from samples collected from citrus in Vientiane Capital (see Garnier and Bove, 1998). We recently diagnosed HLB as the cause of serious losses of lime trees in the Vang Vieng area, Vientiane Province, at altitudes varying from approximately 300 to 500 m. This area is 160 km north of Vientiane in a mountainous region. Limes are a valuable cash crop for small-holder farmers in this area. Diseased trees were affected by dieback, had obvious interveinal yellowing of leaves, yellow shoots and lop-sided fruit, all typical symptoms of HLB. Young trees are traditionally propagated by aerial marcottage, a method favouring transmission of the pathogen, *Liberibacter asiaticus*. Some farmers had propagated trees from seed and the incidence of symptoms in these trees was quite low. The
impact of using trees propagated from seed on the progress of the epidemic will be assessed. The population dynamics of the vector will also be studied as resources become available. Farmers are being advised to remove all trees with symptoms and replant with trees raised from seed. Fortunately orchards are small and isolated from each other, a factor that may slow spread by the vector when the reservoir of inoculum is reduced.

101 The field correlation test between sunflower sowing date and incidence of sunflower white mold in BAYannaor Region of Inner Mongolia

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We study the correlation between sunflower sowing date and incidence of white mold in BAYannaor region using LD5009 sunflower variety. The filed data showed that the incidence of sunflower white rate was variable under different sowing date. The fifth sowing date (10th of June) had the lowest incidence of sunflower white mold. Compared with the other four sowing date, it reduced the incidence of sunflower white mold to 79.49%, 83.0%, 85.45% and 65.22%, separately. The yield data suggested that there is the highest yield which is 1141kg/hm² at the fourth sowing date. The fifth sowing date located in the second place which is 1081kg/hm². Based on our field data, the conclusion is that the best sowing date for LD5009 in BAYannaor region is the beginning of June.
**102 Canker and dieback of Metrosideros trees in New Zealand**

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Pohutukawa or New Zealand Christmas Tree, Metrosideros excelsa, is endemic to New Zealand and is the nation’s best known coastal tree due to its attractive and profuse red flowers. There are relatively few primary pathogens associated with Metrosideros that cause disease symptoms. In 2009, a M. excelsa tree in Auckland exhibited unusual large gall-shaped cankers and tree dieback. An investigation was conducted to determine the cause of the symptoms. Pohutukawa and other closely related Metrosideros spp., expressing similar symptoms, were sampled from seven sites in Auckland and one site in Wellington. Leaves, stems, roots and soil were collected for diagnosis. Several fungi were isolated from these samples, including three Paraconiothyrium species which had not been previously found in New Zealand. However, none of the isolated fungi can be considered as the primary cause of the symptoms with certainty at this stage. No plant pathogenic bacteria or nematodes were isolated and none of the insects collected are known to cause or contribute to the symptoms expressed. Infected and non-infected trees will be monitored to determine any spatial or temporal changes in symptom expression over time.

**103 Effect of mode of infection by Ceratocystis fimbriata on symptom expression of the mango sudden death disease**

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Mango sudden death (MSD) caused by Ceratocystis fimbriata, is a very destructive disease of mangoes in Pakistan. Visible symptoms of infection include the sudden collapse of a healthy-looking tree once infection is established. The mode of infection by C. fimbriata and changes that take place within the infected tree are still unclear. An experiment was conducted to understand the mode of entry of C. fimbriata and relate this to symptom expression on 30 month old greenhouse potted mango plants. The experiment had four treatments; T1, T2, T3 and T4, replicated five times. In T1, a flaps was made at the collar region and a 5mm culture plug aseptically inserted into it and wrapped with para film. In T2 a vertical cut was made at the collar region with a knife pre-dipped in a spore suspension of C. fimbriata. For T3 the roots were injured and a spore suspension applied in the pot as a soil drench while in T4 the spore suspension was applied as a soil drench on to an unwounded plant. For every treatment there was an appropriate control. Observations were recorded on treated plants based on the percentages of symptoms on leaves, stems and roots. After 8 weeks, 100% leaf drooping and drying was observed in T1 and T3. Maximum bark splitting of up to 50% was observed in T3. Gummosis was observed at a maximum of 25% in T1 and maximum canker of 35% was also observed on T1. All T3 plants died up after 3 months, while the others survived even with the symptoms expressed. No symptoms developed on any of the control treatments. This study demonstrates that direct injury to the stem and/or roots can accelerate MSD infection and spread and could lead to tree mortality. The findings have implications on field cultural operations that result in plant and root injury.

**104 Ultraviolet radiation affects germination of Puccinia striiformis urediniospores**

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The survival of fungal spores during dispersal over long distances is affected mainly by the ultraviolet (UV) component of solar radiation. A laboratory study was conducted to investigate the effect of short wavelength (254 nm) UV light on germinability of Puccinia striiformis urediniospores. Urediniospores of P. striiformis on microscope slides were exposed in the laboratory to 254 nm UV light for 1, 2, 4, 8, 16, 32 or 64 min. A duplicate set of slides was not exposed to UV light but was otherwise held under the same conditions in the dark. At the end of each exposure time, urediniospores (exposed and unexposed) were placed on Petri dishes containing 2% water agar and incubated for 48 h before germinability was assessed. Germinability declined with increasing exposure time, from 15.2% after 1 min exposure, to about 0.3% after 64 min of UV exposure. Although we observed germination throughout a wide UV254 dosage range, germ tubes shortened as UV254 dose increased. Germ tube shortening probably reflects the generally harmful effects of UV254 exposure and it is likely that infectivity of spores would also be impaired. The relationship between spore germination and exposure to UV light described here has a potential use in modelling spore survival in relation to long distance aerial dispersal of stripe rust.
105 Origin and dispersion of an un-common virus mix infected with common cucurbit viruses in *Trichosanthes cucumeroides*

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*Trichosanthes cucumeroides* is a perennial weed in Cucurbitaceae widely grown in Japan. We confirmed that it was often infected by *Cucumber mosaic virus* (CMV) and *Papaya ringspot virus* (PRSV) in addition to *Kyuri green mottle mosaic virus* (KGMMV) and *Zucchini yellow mosaic virus* (ZYMV) with lower frequency. As they are known for common viruses occurring on cucurbit crops in Japan, *T. cucumeroides* can be recognised as an alternative and overwintering host. Moreover isolates of an un-common virus (tentatively named as JK virus) were identified by biological, morphological, and molecular characters. JK virus has flexuous and filamentous particles of about 800 nm in length showing typical potyvirus inclusion bodies. The virus was transmissible to zucchini, bottle gourd, and snake gourd with mosaic or mottle symptoms, but not to papaya. In back-inoculation, it was systemically infective showing no symptom or chlorotic spots. Sequencing analysis of the RT-PCR amplified products revealed amino acid sequences on CP gene of JK virus were in the range of 97 to 100% among 7 isolates and those showed the closest relationship with *Papaya leaf distortion mosaic virus* (PLDMV) sharing 76.4 to 80% identity. PLDMV, a common papaya virus in Japan, was later reported its occurrence on *T. bracteata* in Ishigaki Island in 1995 (Maoka and Hataya, 2005), but not yet found in mainland where they do not have any papaya production. Different from other common cucurbit viruses and PLDMV, JK virus may have well adaptation to *T. cucumeroides*, even though it has infectivity to other cucurbit crops.

106 Understanding the epidemiology of Fusarium wilt (*Fusarium oxysporum* f.sp. *cucumerinum*) in greenhouse cucumbers

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Global restrictions on the use of soil fumigants along with an increasing demand for high quality food, has encouraged growers into soilless protected cropping systems. Over the past 10 years, the cucumber industry has grown, with corresponding yield increases from 13 tonnes/ha in 2001 to more than 70 tonnes/ha in 2008. This is largely due to improvements in greenhouse technology that have seen significant advances in the management of environmental parameters for optimum plant growth and yield. Growing high-density monoculture crops in the uniform environment of a greenhouse also increases the potential for catastrophic disease. *Fusarium oxysporum* f.sp. *cucumerinum* is the soil-borne fungal pathogen responsible for Fusarium vascular wilt of cucumber. There are limited controls against Fusarium wilt, and crop losses range between 30-80% once the pathogen is established, causing an estimated financial loss of $90,000/ha/year. The need to develop a sustainable integrated management system that comprises elements of biological and cultural control of diseases is evident. How Fusarium spores enter, establish and move through the greenhouse is being investigated using a mini-cyclone air sampler and real-time PCR to correlate aerial spore density to changes in environmental parameters, temperature and relative humidity. To better understand the mode of infection, the role of wound sites and the systemic movement of the pathogen through the plant are being examined. This will contribute to understanding the complete disease cycle of *F. oxysporum* f.sp. *cucumerinum* and will assist in developing an integrated management plan to control Fusarium wilt in greenhouse cucumbers.
107 Approaching the origins of *Phytophthora* taxon Agathis

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The origin of ‘*Phytophthora* taxon Agathis’ (PTA), the causal agent of the collar rot disease of kauri *Agathis australis* remains uncertain. Sharing a place in *Phytophthora* Clade 5 with *P. heveae* and *P. katsurae*, PTA was originally misidentified as the morphologically similar *P. heveae*. Subsequently, it has been established that PTA has a different oospore morphology to both *P. heveae* and *P. katsurae*. Initial studies have shown small genetic differences between these species and we have commenced a multigene phylogenetic study to better understand the genetic basis for morphological and cultural variation within the clade. We will source *P. heveae*, *P. katsurae* and other Clade 5 isolates across the geographic range of *Agathis*—eastern Australia, Fiji, New Caledonia, Vanuatu, Papua New Guinea and Taiwan. These areas are thought to include the natural geographic range of *P. katsurae* and *P. heveae*. To determine whether PTA is an exotic introduction to New Zealand we will use microsatellites to compare genotypic diversity in PTA in New Zealand with overseas isolates of PTA and related species. This should allow us to determine if the New Zealand PTA population is reproducing clonally, and the likelihood of it being the result of a single introduction.

108 Spotted gum canker: an emerging threat to eucalypt plantations in subtropical eastern Australia

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Spotted gums (*Corymbia variegata*, *C. citriodora*, *C. maculata* and *C. henryi*) are major species in eucalypt plantations in subtropical eastern Australia, encompassing up to a third of the area planted for solid wood products. These species are also a significant component of the native flora along the east coast of Australia. Forest health surveys over the past 15 years in New South Wales and Queensland have identified key pests and diseases of spotted gum plantations, chief amongst these being Quambalaria Shoot Blight. However, in recent years a stem canker disease has emerged as a threatening agent in young (3–10 year-old) spotted gum plantations. The disease appears to begin in the tips of branches in the upper crown, and ‘spreads’ down into the main stem, ultimately killing trees. Surveys have identified the disease from all regions in subtropical Australia where spotted gum is grown, but the disease is more severe in northern NSW, where up to 50% of trees have moderate to severe damage. Two fungi, tentatively identified as *Calciopsis pleomorpha* and *Guignardia* sp., have consistently been isolated from diseased material. The identity of these fungi is being determined using morphological and molecular characters and their role in disease confirmed using Koch’s Postulates. Pathogenicity work has identified *Corymbia* species as being highly susceptible. Ongoing work is identifying key features associated with the disease to develop sampling strategies and hazard risk maps.

109 Development of a drought-hazard rating system for *Pinus Radiata* plantations in New South Wales

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*Pinus radiata* is the key species in softwood plantations in Australia, making up 75% of the 1.02 million ha of pine plantations. A quarter of these plantations are in NSW; the majority managed by Forests NSW. Forest health surveys are conducted over Forests NSW’s plantation estate annually, identifying and mapping key damaging agents, including insect pests, diseases, vertebrate pests, nutritional imbalances, weeds and climatic disorders. The single most damaging agent identified during surveys over the past 15 years has been tree mortality associated with drought stress. Drought stress can kill trees and also predisposes them to attack from other damaging agents, such as Diplodia canker, Ips bark beetles and Sirex wood wasp. In years of severe drought (e.g. 2006-2007), up to 15% of the estate has been damaged by drought, with large scale tree mortality, significantly reducing timber yields and narrowing profit margins. We used a geographic information system (GIS) to develop hazard maps for drought susceptibility in *P. radiata* plantations in NSW. Key determining variables included (1) rainfall in previous 12 months, (2) silviculture x age (e.g., older unthinned stands more susceptible), (3) topography (e.g., upper slope more susceptible), and (4) previous history of drought-related tree mortality. These maps can be used by forest managers, as part of a decision support system, for site-specific silvicultural management, such as altering thinning schedules and stocking rates and planting drought-tolerant genotypes on high risk sites.

110 *Puccinia psidii*—a species complex?

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*Puccinia psidii* was first described from guava in Brazil in 1880. It has an unusually large host range for a rust fungus, encompassing at least 70 species of Myrtaceae in over 20 genera. As Australia is the centre of diversity for Myrtaceae, *P. psidii* is viewed as a biosecurity threat to the Australian environment as well as plant industries utilising Myrtaceae species, such as eucalyptus forestry. The taxonomy of *P. psidii* is in dispute, with some authors recognising more than one anamorph species based on morphological characters. However DNA sequences of the ribosomal DNA internal transcribed spacers, beta-tubulin 1
and elongation factor 1-α failed to support the species distinction. We present further morphological and DNA data to elucidate the status of *P. psidii*.

111 **Gnomoniopsis smithogilvii** sp. nov.: causal agent of Chestnut Rot in south-eastern Australia

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Chestnut Rot in *Castanea* sp. is a significant problem facing the Australian chestnut industry. It causes both economic losses and damage to the reputation of the industry. The Chestnut Rot pathogen has been reported to exist as an endophyte in healthy chestnut floral and vegetative tissues, as a saprophyte on decaying burls and branches, and as a pathogen in mature chestnut endosperm, embryo and shell tissues. During the 1990s the pathogen in Australia was identified as *Phomopsis castanea* (Sacc.) Höhn, and more recently, informally as *Gnomonia pascoe* sp. nov. Smith. The present study further clarified the taxonomy and phylogeny of the Chestnut Rot pathogen by analysing both morphological and molecular data. Morphological examination included descriptions and measurements of both teleomorph and anamorph characters including perithecia (n=65), asci (n=79), ascospores (n=101), anamorph colony structure, colony growth rate, conidiomata (n=397) and conidia (n=491). Twelve isolates of the pathogen were sequenced in this study collected from New South Wales and Victoria from various host tissue types including diseased kernel tissue, peritheciuni collected from decayed burl tissue, and endophytes isolated from female and male flowers, leaves, and stems. Ribosomal and protein encoding genes were amplified and sequenced including internal transcribed spacer regions 1 and 2, and translation elongation factor 1-alpha. Phylogenetic analysis was conducted in the context of the *Diaporthales* with a focus on the *Gnomoniaceae*. The Chestnut Rot pathogen was identified as a novel pyrenomycete taxon, *Gnomoniopsis smithogilvii* sp. nov.

112 Approaches to understanding and managing the complexities of woodland and forest declines in Western Australia

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In Western Australia there are a number of substantial declines and deaths across a number of forest and woodland tree species. These include *Eucalyptus marginata*, *E. gomphocephala* (tuart), *E. wandoow* (wandoow), *E. rudis* (swamp gum), *Aponis flexuosa* (peppermint) and *Corymbia calophylla* (marri). There are many theories put forward as to the reasons for these declines including: (i) global climate change; (ii) habitat loss and fragmentation; (iii) changes in land management, e.g. the absence of planned fire, damage from wildfires, and past timber harvesting and grazing; (iv) weeds, pests and diseases; (v) salinity; (vi) changes in hydrology; (vii) poorly developed links between research and management; and (viii) sub-optimal management policies and strategies at Local and State Government levels.

The Centre is made up of three core research organisations, 27 collaborating industry partners and seven collaborating international and national institutions. An overview of these declines, the possible causes, their implications to ecosystem function and health and the different research and adaptive management approaches that are in place to understand and mitigate these declines will be discussed.

113 Biogeography of species within the tree pathogen genus **Celoporthe** (Crypehonectriaceae)

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*Celoporthe dispersa* was first discovered in South Africa occurring on three hosts, namely native *Syzygium cordatum* and *Heteropyxis canescens* and non-native *Tibouchina granulosa* (Myrtales). Symptoms on these hosts were associated with die-back and cankers, although it could not be confirmed as the primary cause of the symptoms on all the hosts. Isolates previously obtained from *S. aromaticum* in Indonesia also grouped closely to *C. dispersa* based on DNA sequences but morphological comparison was not possible due to lack of specimens. Since then, additional isolates, morphologically similar to this monotypic genus were isolated from *S. legatti* in South Africa, *S. guineense* in Zambia and *S. cumini* and *Eucalyptus* spp. in China. Multigene phylogenetic analyses based on DNA sequences of the ITS region of the ribosomal operon, transmission elongation factor 1a and two areas in the BT-bisunin gene showed that various cryptic species exist in *Celoporthe*. The phylogenetic data was supported by morphological differences. Phylogenetic analyses showed two groups representing species from Africa and Asia, respectively. *Celoporthe* spp. are rare and the species from Africa frequently occur together with the well-known pathogen genus *Chrysoptrophe*, which *Celoporthe* resembles morphologically. Current data indicate that these fungi have a widespread, yet possibly structured occurrence in Africa and Asia. These species can readily infect *Eucalyptus* as well as *Syzygium* trees, which are native to many of these areas. Pathogenicity tests indicated that these species are pathogenic on *Eucalyptus*, sometimes equally pathogenic to *Chrysoptrophe* spp. They thus pose a potential threat to *Eucalyptus*-based forestry and continued monitoring is important.
114 Diseases of eucalypts in Mozambique

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In recent years, Mozambique has embarked on extensive afforestation programs using species of Eucalyptus, with E. grandis and its hybrids being the most commonly planted. Virtually nothing is, however, known regarding pests and pathogens of these trees in the country. Only one previous study, based on a very limited area, has considered diseases of Eucalyptus spp. in the country. Recently, two studies were conducted in five Provinces of Mozambique to identify disease and pest problems on these trees. Various symptoms of cankers caused by species of fungi in the Cryphonectriaceae, Teratosphaeriaceae and Botryosphaeriaceae were observed. Leaf blight and spot, caused by species of Pliliella (Coniella), Colonectria and an unidentified rust fungus was also commonly found. Additionally, Ophiostoma sp., and Valsa sp., were obtained from wounds and cankers on trees. Insect problems included those caused by the gall wasp, Leptocybe invasa and the sap sucker, Thaumastocoris peregrinus. Some of these diseases, such as canker caused by Teratosphaeria zulucens, the Botryosphaeriaceae and Chrysosporthe spp. can impart serious economic losses and requires immediate development of breeding and quarantine programs to reduce their impact. Further studies are under way to better understand the origin and diversity of the most important pathogens and to develop appropriate disease management strategies for the country.

115 Genetic variability of Puccinia psidii infecting Eucalyptus in Uruguay

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Over the last two decades, commercial plantations in Uruguay have increased rapidly, particularly those destined for pulp and paper industry. Nowadays health problems are an important threat to plantation productivity, especially for the about 680,000 ha of Eucalyptus, the most planted genus. The fungus Puccinia psidii is native to South and Central America and was first described infecting Psidium guajava (guava) in Brazil in 1854. Since then, it has been found on a broad range of hosts in the myrtle family (Myrtaceae) including Eucalyptus. This rust is considered a very serious threat for eucalypt as it causes severe damage to young trees. In Uruguay it has been recorded on Eucalyptus globulus, Eucalyptus grandis and native Myrtaceae. Despite the importance of the disease there is few literature regarding the intraespecific genetic variability of this pathogen. Thus, the objective of this study is to characterise the genetic variability of P. psidii in Uruguay. Rust infections were detected throughout the country from different hosts over the last three years. Phylogenetic analyses are being made based on the internal transcribed spacer (ITS) and intergenic spacer (IGS) region of the ribosomal nuclear DNA as well as on reported SSR markers. Specimens representing different genetic groups will be artificially inoculated on E. grandis, E. globulus and Syzygium jambos to characterise aggressiveness. The precise characterisation of the population of P. psidii will assist breeding programs to look for effective resistance.

116 Appearance of different Phytophthora species in Victoria, their virulence and pathogenicity

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Phytophthora species are among the most notorious plant pathogens, capable of causing large-scale damage to plant communities as well as enormous economic loss in agriculture, horticulture, forestry, and natural environments world-wide. P. cinnamomi has been officially recognised as a ‘Key Threatening Process’ under the Commonwealth Environmental Protection and Biodiversity Conservation Act-1999. Over 80 Phytophthora species have been identified so far. In recent years Phytophthora species other than P. cinnamomi, such as P. inundata, P. multivora and P. cinnamomi var. parvispora have been reported at sites previously infected with P. cinnamomi in Western Australia. This project focused on identifying possible misidentifications or unidentified species among previously collected Victorian isolates thought to be P. cinnamomi, and studying their virulence and the implications of the presence of more than one Phytophthora species on the same host. Six Phytophthora species and five Pythium species were identified among previously collected cultures initially reported as P. cinnamomi. Larger lesions and significant root restriction was observed when two Phytophthora species were present in the same host, as compared to the presence of any single Phytophthora species, suggesting possible increase in disease and virulence if more than one Phytophthora species is found in the same location and host.
117  Ectomycorrhizal fungi of exotic host species (*Pinus radiata* and *Pseudotsuga menziesii*) in nurseries and the initial year of out planting in New Zealand

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The symbiosis with ectomycorrhizal (ECM) fungi is known to be essential for a plants ability to take up sufficient nutrients and water and, to a certain degree, defend itself from soil pathogens. This symbiosis is particularly important when nursery grown seedlings are out planted into clear-cut land, where the natural soil environment is depleted. We investigated ECM of seedlings of different stock (bare root, cuttings and root trainer stock) and hosts (*Pinus radiata* and *Pseudotsuga menziesii*) in five nurseries and during the first year of out planting in the five sites across New Zealand. Roots were assessed for ECM colonisation percentage and species abundance. ECM were identified with a combined approach of morphological and sequence analysis. ECM of *Ps. menziesii* in New Zealand had not been assessed with sequence analysis previously. Overall, ECM abundance was low yet cuttings had higher species diversity. Most nursery ECM remained abundant in the plantation, only few non-nursery ECM were found one year after out planting. ECM colonisation and plant material varied between nurseries—plants with low ECM abundance and small root system in the nursery stagnated in the plantation. For both hosts, *Rhizopogon* spp. were the most abundant associate. The aim of this study was to create an inventory of ‘what is there’ for New Zealand’s two most important plantation species. This knowledge is building the base for work on future sustainable forestry management practises such as the influence of nursery fertiliser and fungicide applications on the growth of ECM fungi.

118  The effect of temperature on urediospore germination and infection of *Coleosporium phellodendri*

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Cortex phellodendri (*Phellodendron amurense* Rupr.) is an important medicinal plant. The Cortex phellodendri leaf rust caused by *Coleosporium phellodendri* Kom. is the most damaging foliar disease in China. There is no report on the influence of temperature on urediospore germination and infection of the pathogen. Germination of urediospores was studied on 1.5% water agar (WA) in petri dishes. Temperature treatments were at 10, 15, 20, 25, 30 and 35°C. Germination was observed microscopically after incubation for 24 h. No spores were observed to germinate at 35°C. The percentages of germination at 10, 15, 20, 25, and 30°C were 2.5%, 12.1%, 32.9%, 43.7%, and 56.1%, respectively. The growth of germination tubes and mycelia was lightly inhibited at 30°C. The experiment of infection was conducted in artificial growth cabinet maintained at 12 h illumination per day and 85% RH. Temperature treatments were 10, 15, 20, 25, 28, and 30°C. The plants were inoculated with urediospore suspension. The inoculated plants were wrapped with plastic bag for keeping moisture 24h, and transferred to different temperature growth cabinet. Each temperature treatment was replicated twice and there were three plants per replicate. The experiment results showed that no symptoms were occurred at 10 and 30°C treatment; The incubation period at 15, 20, 25, and 28°C was 13d, 8d, 8d, and 16d, respectively; The average numbers of disease lesion per leaf were 7.7, 10.6, 15.4, and 0.8 lesion, respectively; The lesion size was 2.3, 4.2, 5.5, and 2.1mm, respectively. The results also indicated that optimal infection temperature was between 20 to 25°C.
119 Preliminary studies of Phoma koolunga, a recently described fungus associated with Ascochyta blight of field peas

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Ascochyta blight is the most devastating disease of field peas worldwide. Three fungal pathogens are generally associated with this disease, however, recently a fourth pathogen was discovered in South Australia and subsequently described as a new component of the Ascochyta blight complex. This newly described fungus is Phoma koolunga.

The purpose of this research was to improve our understanding of the biology and role of P. koolunga in the Ascochyta blight disease complex of field peas. In vitro studies indicated that temperature has an effect on the germination of conidia and mycelial growth of P. koolunga on potato dextrose agar. The interaction of temperature and time post-inoculation was found to influence germination (P<0.001) and observations thus far show that mycelial growth was slower when incubated at 10°C and 30°C than at 15-25°C.

However, it has proved difficult to obtain sufficient conidia for inoculation experiments when generated on artificial media. After assessing growth in various culture media and environmental conditions, the method of passaging P. koolunga through pea leaves is being used. This method is described and will facilitate further epidemiological studies with this pathogen.

120 Quantification of necrotrophic pathogen biomass using an internal control in a real-time PCR assay

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A common approach for measuring the susceptibility of a plant to infection by a pathogen is to measure the pathogen biomass in planta using quantitative PCR. However, the processes such as the production of phenolics, or degradation of cellular DNA and cell collapse associated with necrosis process in plant tissue can lead to variation in DNA extraction efficiency, inhibition of PCR, or overestimation of pathogen biomass thereby affecting accurate measurement of pathogen biomass. Our approach to this is to add a control DNA (plasmid) to the plant tissue before the DNA extraction. By measuring the amount of plasmid DNA recovered in the DNA extract, and by normalising the amount of pathogen DNA to plasmid DNA we can allow for differences in DNA extraction efficiency and avoid overestimation of pathogen biomass. In both lupin–Phytophthora cinnamomi and Arabidopsis–Phytophthora cinnamomi pathosystems, cell collapse and tissue necrosis were observed and led to overestimation of pathogen biomass when normalised to host plant DNA. In lupin we observed up to 17 fold overestimation of pathogen biomass compared to three fold overestimation found in infected A. thaliana 72 h after inoculation with P. cinnamomi. Our results suggested that by increasing the degree of necrosis due to necrotrophic infection, the level of overestimation of pathogen biomass increases if normalised based on host DNA. We demonstrated the capability and robustness of this developed technique in two different plant-pathogen interactions with various levels of resistance. This method can also be adapted in quantification of pathogen biomass in other pathosystems.

121 On pathogenicity differentiation of Fusarium moniliforme to cotton seedlings and the inheritance in asexual progenies

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Fusarium moniliforme Shield is an economically important plant pathogenic fungus with a wide host range. It was the causal organism of cotton red rot, rice branke disease and maize ear rot in China. In this paper, the pathogenicity of the isolates of F. moniliforme from different hosts to the leaves of cotton was investigated by applying mycelial block wound inoculation, respectively. The results showed that all of the tested isolates caused occurrence of red rot lesions on the leaves of cotton, but there was significant difference in the average diameters of the lesions caused by different isolates, suggesting that there was significant differentiation in pathogenicity of F. moniliforme to the leaves of cotton among isolates. The isolates from cotton were strongly pathogenic to the leaves of cotton, while the isolates from maize and rice were weakly pathogenic to the leaves of cotton. However, there was difference in pathogenicity among the different isolates from the same host, and the pathogenicity difference was not obviously related to the localities of isolates. The genetic tests showed that the pathogenicity of F. moniliforme isolates from cotton, rice and maize plants to cotton seedling leaves could be inherited steadily in the same conidium progenies.

122 Are aggressiveness and proteinaceous toxin production related in Pyrenophora teres f. teres?

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Pyrenophora teres f. teres causes net form net blotch disease (NFNB) of barley. Isolates of P. teres f. teres differ in their ability to cause symptoms on different cultivars of barley. Our research is investigating whether growth patterns or differences in proteinaceous toxin production are responsible for differences in aggressiveness and/or virulence in barley.
Six isolates have been characterised for the ability to cause symptoms on the susceptible cultivar Sloop. All isolates were pathogenic to Sloop but differed in their aggressiveness from extreme to very low. Proteinaceous isolates were also extracted from these isolates and their effect on barley compared. Regardless of which isolate the toxin was extracted from, necrosis was induced when plants were injected with the extracted toxins (at the same concentration). These results suggest that the ability to produce toxin is not correlated with the extent to which symptoms are induced. However, preliminary research suggests the type of toxins produced and when they are produced during the plant-pathogen interaction may play a role in aggressiveness. Differences in the growth patterns of these isolates in planta and the effect of individual toxins on different cultivars are also currently being investigated.

123 Transcriptional and post-translational regulation of the mitogen-activated protein kinase phosphatase NtMKP1 in wounded tobacco plants

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The mitogen-activated protein kinases (MAPKs) are key molecules of signal transduction responses to various extracellular stimuli in eukaryotes. In tobacco, two pathogen- and wound-induced MAPKs, WIPK and SIPK, regulate stress-induced accumulation of jasmonic and salicylic acids (1, 2). MAPK phosphatases (MKPs) are negative regulators of MAPKs. Previously, we have reported that overexpression of a tobacco calmodulin-binding MKP, NtMKP1, compromised wound-induced activation of WIPK and SIPK (1, 3). In this study, we investigated the transcriptional and post-translational regulation of NtMKP1 in response to wounding. Quantitative RT-PCR analysis revealed that NtMKP1 mRNA is once decreased and then increased in response to wounding. The transient reduction of NtMKP1 mRNA by wounding was consistent with the hypothesis that NtMKP1 would be removed when WIPK and SIPK are activated by environmental stresses. However, the timing of the reduction in NtMKP1 mRNA was much slower than the activation of WIPK and SIPK. Therefore, the level of NtMKP1 protein was investigated by immunoblot analysis. Although we failed to detect NtMKP1 protein in the wild type plants, it was detected in the plants expressing NtMKP1 under Cauliflower mosaic virus 35S promoter. The level of NtMKP1 protein was rapidly decreased, kept at the lower level for several hours and then returned to the basal level after wounding. Thus, NtMKP1 is regulated at both transcriptional and post-translational levels. The importance of NtMKP1 regulation will be discussed.


124 Molecular cloning and sequence analysis of a new cellulose binding protein gene (Ha-cbp-1) from the cereal cyst nematode (Heterodera avenae)

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The cereal cyst nematode, Heterodera avenae, is an important nematode pathogen of wheat in China. Cellulose binding proteins are important for parasitism and invasion by these plant parasitic nematodes. The cDNA sequence of Ha-cbp-1 (GenBank accession GQ178086) was cloned by RACE kit based on homologous cloning method. The results showed that the cDNA sequences of Ha-cbp-1 contained an open reading frame, which encoding 131 amino acids with a predicted signal peptide sequence for secretion and a cellulose-binding domain. The gDNA sequence of Ha-cbp-1 contained two introns with the length of 932 bp. The predicted HA-CBP-1 amino acid sequence had 60% identity and 75%-76% similarity with HS-CBP-1 and HG-CBP-1, cellulase binding proteins from Heterodera schachtii.
125 Genetic diversity of Plasmodiophora brassicae in Australia

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Clubroot, a root galling disease caused by the soil-borne, obligate biotroph Plasmodiophora brassicae Woronin is the most destructive disease of Brassica crops worldwide. Very few resistant vegetable brassicas are available and effective/practical control is difficult. In this study the genetic variation among Australian collections of the pathogen was investigated using molecular methods, including RAPD and microsatellite primers. Genetic markers provided a useful means of investigating polymorphism in collections of P. brassicae, with RAPD primers OPA 1, 8, 11; OPB 3, 7, 20; OPM 2, 13, 16; and microsatellite primers (GACA)4, HKB 17/9 and HKB 23/52 revealing considerable genetic differences among the collections studied. A highly virulent population showed a very different genetic profile from others indicating that molecular techniques may replace current laborious and time-consuming differential host screening methods to determine virulence in future. Collections were also monitored over time through successive host-plant generations. There was no stability in the population over successive generations, even in single sporangia isolates, suggesting genetic exchange or competition between genotypes in the galls. Mixing two populations did not result in profiles of both the original populations but instead produced unique profiles, again suggesting genetic exchange during infection and gall development. Understanding the genetic diversity in pathogen populations revealed here is vital for the development of cultivars with effective and durable resistance to this disease.

126 Comparative genomics reveals key targets for environmental colonisation and cross-kingdom pathogenesis in Pantoaea ananatis

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Pantoaea ananatis is a ubiquitous bacterium that occurs in diverse ecological niches. It is frequently found associated with plant hosts as both endo- and endophytes and has also been implicated in a number of plant diseases as well as human pathogenesis. By means of genome comparisons we attempted to identify the molecular basis underlying its ecological success and cross-kingdom pathogenesis. The whole genome of the Eucalyptus pathogen P. ananatis strain LMG20103 was sequenced, assembled and annotated. Comparison of this genome to those of several closely related members of the Enterobacteriaceae revealed that this strain has an extensive flexible genome. This flexible genome was compared with all the genomes that are publicly available. Our results showed that it carries a number of genes which are restricted to bacteria occupying distinct ecological niches, namely plant-associated, animal-associated and insect-associated bacteria. These genes encode proteins that may play a role in its persistence in the environment and allows it to survive in insect vectors and on the plant host as epi- and endophytes. Furthermore, several genes shared only with animal-associated bacteria could allow P. ananatis to persist in the vertebrate host. A number of these genes reside on genomic islands which indicates that P. ananatis has adapted, through horizontal acquisition, to become adept at successfully colonising a range of environments. Several of these islands also carry pathogenicity determinants and based on their homologies to proteins encoded by other animal and plant-pathogenic bacteria may play a role in pathogenesis of both the plant and vertebrate host.

127 Phenotypic and genetic variation in Phytophthora infestans population from Gansu, China indicates the occurrence of sexual reproduction in the field

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Eighty-five isolates of Phytophthora infestans collected from 10 major potato-producing areas in Gansu, China in 2007, were characterised with respect to mating type, mtDNA haplotype, and DNA fingerprint pattern based on eight SSR markers. Among the 85 isolates, 70 belonged to the A1 mating type and 15 were self-fertile A2 isolates; the co-occurrence of A1 and A2 isolates was limited to the Tianshui area of Gansu. The self-fertile A2 isolates formed oospores in single culture on potato leaves. The genotype of mtDNA haplotypes revealed that both la and lila were present among the isolates, and that all the self-fertile A2 isolates were the la haplotypes. SSR genotyping revealed 26 genotypes among the 85 isolates from Gansu in 2007 and 18 genotypes among the 21 isolates collected before 2004, but no genotypes were common to the two groups. Isolates with different mtDNA haplotypes had different genotypes. Among the Gansu isolates, Nei’s gene diversity and Shannon’s diversity indices were highest from Tianshui where the A1 and the self-fertile A2 isolates co-existed. The results are consistent with the hypothesis that sexual reproduction of P. infestans has occurred in the field in Tianshui.

128 Multigene phylogeny of a non-cultivated soil population of Fusarium oxysporum from the Australian continent

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Fusarium oxysporum is a ubiquitous fungal species complex that includes both non-pathogenic and pathogenic strains, the latter being responsible for disease in over one hundred cultivated plant species. The origin of many of these strains is poorly understood. However, recent studies have demonstrated the horizontal transfer of pathogenicity
elements across *formae speciales*, as well as evidence of pathogens evolving from indigenous populations. Given the broad host range of *F. oxysporum* and its potential threat to agriculture, there is a clear need to characterise the overall species complex as research to date has focused on isolates from agricultural environments. These isolates are unlikely to represent the natural underlying diversity of the species complex in Australia due to anthropogenic distribution of pathogens and selection pressures that favour clonality. We have addressed this imbalance by isolates associated with native vegetation geographically isolated from cultivation throughout the continent. The phylogenetic relationships and lineage composition of the native soil population were investigated on the basis of DNA sequences of the EF-1α and mtSSU rDNA regions. The evolutionary potential and origin of native *F. oxysporum* populations in Australia is discussed.

### 129 Genetic variability of *Fusarium* spp.

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*Fusarium* is one of soil-borne pathogens causing diseases towards many agricultural crops. Identification of *Fusarium* based on morphological characters has been often done but there are many problems because of high variation of the fungal pathogen. The experiment was conducted to study genetic variability of *Fusarium* spp. using polymerase chain reaction (PCR) technique to amplify intergenic spacer (IGS) regions, continued by restriction fragment length polymorphism (RFLP) technique using six restriction enzymes, i.e., AluI, BsrDI, HaeIII, Hinfl, MspI and RsaI. Twenty-one isolates of *Fusarium* spp. were grown in potato broth medium for 7 days. Mycelia were filtered and extracted using CTAB method to obtain whole DNA. DNA templates were subjected to IGS primers and continued with RFLP technique. The result of IGS region PCR showed variation of DNA fragments number (1–8 fragments) and weight which were approximately 100 bp to 1,500 bp. IGS-RFLP technique could differentiate most of *Fusarium* spp. isolates. UPGMA dendogram based PCR-IGS-RFLP resulted 8 groups of isolates which had different relationship coefficients. Group I consisted of *Fusarium* spp. isolates from vanilla, watermelon, strawberry, orchid, tomato and banana (Pkr1, Bnt2, Wsb5 and A13 isolates); group II consisted of *Fusarium* sp. isolate from ginger (jahe1 isolate), *F. sacchari*, *F. verticillioides* and *F. heterosporum*; group III consisted of *Fusarium* spp. isolates from ginger (jahe2 isolate), shallot and *F. solani*; group IV consisted of *Fusarium* sp. isolate from banana (Mgl6 isolate); group V consisted of *F. fujikuroi*; group VI consisted of *Fusarium* sp. isolate from chili (cabai1 isolate), group VII consisted of *Fusarium* sp. isolate from pepper; group VIII consisted of *Fusarium* sp. isolate from chili (cabai2 isolate). This result indicated that PCR-IGS-RFLP was suitable and useful to analyse the diversity of *Fusarium* spp.

### 130 Molecular detection of Fumonisin production strains of *Fusarium verticillioides* isolated from different maize growing areas in Sichuan, China

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The maize ear and kernel rot caused by *Fusarium verticillioides* is the destructive disease in Sichuan Province, China. The pathogen induces serious production loss and produces mycotoxins in grain. One of the mycotoxins is fumonisins (FB). It can damage human and animal health. The production of fumonisins is controlled by genes. Some strains own the genes of fumonisin production, others have no the genes. The objective of this study was to determine the rate of fumonisin production strains among the population of *F. verticillioides* in Sichuan, China. 48 strains of *F. verticillioides* isolated from different maize growing areas in Sichuan were tested by PCR method to detect the presence of fumonisin producing strains of the pathogen. According to literature report, the primer pairs for FUm1 gene (previously designated FUm5 gene) encoding a polyketide synthetase were Fum5F and Fum5R for PCR. The tested strains of *F. verticillioides* were respectively cultured in liquid medium of PS at 25°C for 10d. Mycelia were harvested by filtration and stored at -20°C. DNA was extracted from mycelia using CTAB procedure, and amplified by PCR using the primer pairs Fum5F and Fum5R. PCR products were electrophoresis in 1.2% agarose gels. The strains were considered fumonisin producers if a DNA fragment of approximately 846 bp occurred in gel lane. Among the 48 tested strains, 41 were confirmed as fumonisin producers. The result provided a scientific base for understanding the rate of fumonisin producing strains in population of the pathogen from Sichuan, China.
131 Witches’ broom disease of lime, challenges and solutions

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Acid lime (Citrus aurantifolia) is ranked among the top four fruit trees in terms of production and area of cultivation in Oman. However, lime production has been threatened by witches’ broom disease (WBDL) which killed over half a million acid lime trees over the past three decades. Loss of area cultivated with lime trees is currently 50% of that in 1990. The disease, which is caused by Candidatus Phytoplasma aurantifolia has spread to the neighboring countries, the UAE and Iran, and is considered a threat to the world’s production of acid lime. Symptoms of the disease appear when the seedlings are 2-3 years old and complete death occurs within 5 to 10 years. Surveys which covered over 20,000 lime trees in different parts of the country showed that the disease is present in all regions and farms. Only three lime trees, which were over 30 years old, were found to survive without developing WBDL symptoms in areas affected by the disease. Although this may imply that the three lime trees may have tolerance/resistance to phytoplasma, work is ongoing to prove this hypothesis. Analysis of genetic diversity of acid lime from Oman and other parts of the world using AFLP fingerprinting showed that lime trees have a very high level of genetic similarity (95%). This may explain why most lime trees in the country are highly susceptible to the disease. Other areas of research on WBDL include phylogenetic analysis of the causal agent, physiological aspects of the phytoplasma-affected limes and management options.

132 Recent and historical detections of Pseudomonas syringae pv. Morsprunorum in New Zealand

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Fruits and leaves of sweet cherry (Prunus avium) exhibiting lesions and shot-hole symptoms were submitted to the MAF Biosecurity New Zealand’s Plant Health and Environment Laboratory (PHEL) for diagnosis in November 2008. Bacteria isolated from symptomatic tissue were identified as Pseudomonas syringae pv. morsprunorum through biochemical characterisation and sequencing of three DNA regions: 16S rDNA, gyrB and rpoD. The detection of P.s. pv. morsprunorum in cherry would have represented a new record of this pathovar in New Zealand, however, it was found that the recent isolates were identical to four isolates classified as ‘Pseudomonas sp.’, deposited in 1972 and 1976 in the International Collection of Microorganisms from Plants (ICMP). Comparison of the recent and historical isolates to authentic strains of P.s. pv. morsprunorum using BOX-PCR confirmed that all isolates had identical genetic fingerprints. When inoculated into cherry fruits, both the recent and historical isolates induced lesions typical for P.s. pv. morsprunorum and less extensive than those produced by P.s. pv. syringae. It is now recognised that, in addition to P.s. pv. syringae, P.s. pv. morsprunorum is associated with bacterial blast in cherry orchards in New Zealand.

133 Molecular diversity among fluorescent soft rot Pseudomonas bacteria: diagnostic challenges for species-level resolution

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Accurate detection and identification of pathogens of potential regulatory concern to species level is essential for effective biosecurity decision making. Routine DNA sequencing has played an increasing important role in species identification. Fluorescent Pseudomonas bacteria cause soft rot in a large number of plants and these organisms have been traditionally grouped based on their biochemical characteristics. These groups include the P. marginalis strains (LOPAT IVa) and the other ‘soft-rotting’ pseudomonads (LOPAT IVb) differing in negative reactions for levan formation from sucrose. Characterisation of two recent detections of soft rotting Pseudomonas on Smallanthus sonchifolius (Yacon) and Solanum laciniatum (Poroporo) highlighted the molecular diversity within these biochemical groups and the challenge in identifying these soft rot bacteria to species level. The two Pseudomonas species classified as LOPAT group IV induced soft rot in potato slices and in their respective hosts. Molecular analysis of the gyrB and rpoD genes suggests these species are phylogenetically distinct and reveals high genetic diversity among the soft rot pseudomonads. The biological and molecular characteristics of these species, comparison with related species, and discussion on the diagnostic implications of these findings are presented.
134 Occurrence, characterisation and management of soil-borne disease of cucurbits in Oman
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Cucurbits, mainly watermelon, muskmelon and cucumber, are considered the most important vegetable crops in Oman with demand for these crops increasing but production constrained by increasing disease problems in recent years. Damping-off and vine decline diseases and increasing irrigation water salinity levels are considered the most serious limiting factors. Losses from Pythium spp. have been reported to exceed 90% of plants in some farms in Oman. Temporal disease research showed mortality progress in cucumber to consist of two separate phases, damping-off and vine decline with Pythium species found to be the major causal agents. In addition, Fusarium solani and Rhizoctonia solani were found to associate with some declining adult plants. Analysis of tolerance of Pythium isolates to salinity showed isolates of P. aphanidermatum from greenhouses with no salinity problems to be as tolerant to salinity as isolates obtained from salinity affected greenhouses; suggesting a lack of evidence for ecological adaptation. Increasing irrigation water salinity increased mortality in cucumber inoculated with P. aphanidermatum, which may imply a synergistic interaction between salinity stress and salinity-tolerant Pythium species on cucumber seedlings, resulting in greater seedling losses. Other areas of research on soil-borne fungal diseases of cucurbits include characterisation of genetic diversity of the causal agents, identifying problems associated with failure of some important fungicides and the use of biocontrol agents and rootstocks which have tolerance/resistance to these diseases.

135 New Phytophthora basal rot disease of Japanese iris
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Japanese iris (Iris ensata var. ensata) is widely cultivated in Japan. Basal rot accompanying initial yellowing of a central leaf on the plants is visible from the early growing season until the flowering stage in wet cultivation conditions. Homothallic Phytophthora sp. was first isolated with high frequency from diseased plants collected at Suigō Sawara Aquatic Botanical Garden, Chiba. Typical symptoms developed on the plants when inoculated by root dipping in water containing cultured agar pieces of the fungus for 20–24 hr before transplantation to soil. The same fungus was recovered from the diseased tissues. The fungus formed oogonia with paragynous antheridia, oospores turning golden brown when aging, and non-papillate zoosporangia. Sequence analyses of DNA from ITS-1, ITS-2, beta-tubulin, and elongation factor 1 alpha regions revealed that the isolate showed high homology (99.5, 100, 99.5, and 98.3%, respectively) with Phytophthora europaea. Its morphological characteristics were also similar to Phytophthora europaea. Isolates with the same morphology and DNA sequence homology was isolated from diseased plants collected in several prefectures in Japan suggesting the disease is widely developed in Japan. We propose that the fungus is a new pathogen of Japanese iris, tentatively identified as P. europaea.

136 A survey of plant-parasitic nematodes in central and northern Queensland, Australia
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Seven sites in northern and central Queensland were surveyed for their plant-parasitic nematode status. Nematodes were identified to genus and quantified in seven depth intervals to 150 cm from each site. Non-plant parasitic nematodes were counted as a composite. The survey supported an innovative program researching the potential for wheat to be grown in agriculturally suitable soils west and north of current commercial grain cropping areas in Queensland. Plant-parasitic nematodes from seven genera were identified. Root-lesion nematodes (Pratylenchus sp.) were present in low to moderate populations from every site. Stunt nematodes (Tylenchorhynchus sp.) were present in low to moderate populations at all but one site. Root-knot nematodes (Meloidogyne sp.) were present at three sites, including one extremely high population. Rotylenchulus parvis were present in moderate populations at one site. Crenonemoides sp., Paratrichodorus sp. and Xiphinema sp. occurred at low levels at one site each. Non-parasitic nematodes were present at moderate to high populations at every site. The survey has identified plant parasitic nematodes that may pose a potential limitation to crop production. Wheat production depends on selections of cultivars with resistance and/or tolerance to biotic stresses. Crop rotation and management decisions to reduce the negative effects of plant parasitic nematodes will need to be devised should these nematode populations develop further and impact on agricultural productivity.

137 Sting nematode—a challenge for Western Australia’s turf industry
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Turf grasses are commonly infested with plant-parasitic nematodes. However, the ectoparasitic Sting Nematode Morulaimus gigas (or Ibi pola loli) is causing significant damage in Western Australia (WA). This nematode is not native to WA and was probably introduced on turf from New South Wales in the early 1970s. The nematode has continued to spread on infested turf and via soil attached to machinery and equipment. Typical symptoms are patches of yellowed and thinning turf, particularly when under drought, mowing
or wear stress. Sting Nematode is now significantly impacting sports fields, local government reserves, parks and recreational areas. Industry experts representing Local Government have confirmed that this pest is present in at least 50% of Perth’s amenity turf areas. Costs up to $10,000/ha are estimated for additional management required for infested areas. Once an area is infested, it is rarely practicable or even possible to eradicate the nematode. The Turf Growers Association WA proposes the introduction of a ‘clean scheme’ certification system to reduce further spread of Sting Nematode. Importantly, the Sting Nematode found in Australia is not the Belonolaimus species found in other parts of the world. Therefore, further study of the Australian species is required to develop management options to reduce its impacts to turf and other industries.

138 Suppression of damping-off of radish caused by Rhizoctonia solani AG 2.1 with soil carbon amendments

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Current and future pesticide withdrawals and sustainability issues are driving the Australian vegetable industry to re-examine the use of carbon amendments (CAs) for suppression of soil-borne diseases and improved soil health. Our study evaluated biochar, lignate, humate, and compost (applied at 650 mg C/g soil) as CA treatments for suppression of damping-off of radish caused by Rhizoctonia solani Rs (AG 2.1), over three rotations in the glasshouse. Controls included fumigated (dazomet, 10 mg/g soil) and untreated soil. Soil pH, microbial activity (using FDA) and Rs inoculum increased across all CA treatments with time. By the third rotation, there was 378–680 pg Rs DNA/g soil in the CA-treated soils, significantly higher than 123 pg Rs DNA/g soil in the untreated control. Despite this, a trend towards disease reduction was apparent in CA treatments, in some cases significantly. For example, humate was phytotoxic two weeks after incorporation, but by the third rotation, disease was significantly reduced. For compost, however, disease reduction occurred in the second rotation but was not carried into the third rotation. The increasing level of microbial activity in this trial suggests that CA may be capable of inducing disease suppression. CAs represent an important tool for improving soil health, but the challenge for plant pathologists is to better manipulate them for more reliable disease management.

139 Studies on differentiation of pathogenicity of Phytophthora capsici Leonian from different areas of China

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Twenty-three isolates of Phytophthora capsici Leonian were obtained from the diseased peppers collected in Hefei, Huainan, Hexian, Qianshan, Yuexi, Nanjing and Qionglai, by means of tissue isolating method. The pathogenicity of the isolates was investigated on 2 pepper cultivars with mycelium block wound inoculation to pepper seedlings and with leaf in vitro inoculation, respectively. The results showed that all of the tested isolates caused occurrence of pepper blight, but there was significant difference in the average diameters of the lesions caused by different isolates, suggesting that there was significant differentiation in pathogenicity of P. capsici to pepper among isolates. According to the average diameters of the lesions caused on Yangyang stems, the isolates could be classified into three types of pathogenicity and the pathogenicity difference was not obviously related to the localities of isolates. At the same time, the growth rate of the isolates was surveyed. The determination coefficient (R²) between pathogenicity and growth rate was 0.0137, indicating pathogenicity has little with growth rate.

140 The relationship between soil populations of Rhizoctonia solani AG2.1 and AG3 and potato tuber infection

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Rhizoctonia solani is a serious disease of potatoes which reduces yields and tuber quality. Recent research has shown potato plants can be infected with one or more anastomoses groups (AGs) of R. solani. In this study minitubers (cv. Shepody) were planted into soil containing varying levels of either AG2.1 or AG3. At 130 days post planting, levels of infection were assessed on tubers, stems and roots. It was observed that AG2.1 resulted in root necrosis and russetting of tuber surface whilst AG3 induced sclerotia on both roots and tubers. Results showed a strong relationship between concentration of DNA for AG2.1 and AG3 in spiked soil and severity of disease (% of surface area infected) expressed on daughter tubers at harvest ($r^2 = 0.67$ and $r^2 = 0.82$ respectively), however significantly lower levels of AG3 were required to induce a similar severity of disease as AG2.1. (25pg DNA/g soil and 1280pg DNA/g soil respectively). Only AG2.1 showed a correlation between the level in soil and severity on stems and roots ($r^2 = 0.64$ and $r^2 = 0.59$ respectively). Within each AG, no correlation was shown between level in soil and yield of tubers at harvest, however yields within AG3 tended to be higher. Results reaffirm the potential for using quantitative molecular diagnostic assays based on real-time PCR to quantify different R. solani AG2.1 and AG3 levels in soil. They also show that initial inoculum levels may correlated with the subsequent disease severity.
when using clean seed (cv. Shepody) under controlled environmental conditions.

141  **Intensity of Spongospora subterranea infection of potato roots measured by quantitative PCR (qPCR)**

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Powdery scab (caused by *Spongospora subterranea*) is an important disease of potato tubers. Intensity of infection of potato roots by the pathogen was measured using qPCR and direct observation, to test efficacy of the molecular method. Plants of cv. ‘Iwa’ (highly susceptible to tuber infection) and cv. ‘Gladiator’ (highly resistant) were grown in a glasshouse, and were either uninoculated or inoculated with *S. subterranea* spororosi. Plants were harvested on six occasions (0 to 6 weeks post-inoculation). At each harvest, intensity of *S. subterranea* infection (zoosporangia in stained roots and number of root galls) was assessed, and amount of *S. subterranea* DNA in roots was measured using qPCR. Small amounts of pathogen DNA were first detected 1 week after inoculation, and these increased in both cultivars in a similar pattern, although ‘Iwa’ had consistently twice the amount of pathogen DNA compared to ‘Gladiator’. Maximum mean amount of pathogen DNA was detected 4 weeks after inoculation. Relationships between qPCR results and directly observed intensity of infection were examined. This study demonstrates that qPCR efficiently detects early infection by *Spongospora*, and is a useful tool for studying host reaction to the pathogen.

142  **Identification of race of Phytophthora sojae in Shandong Province and screening of resistant soybean cultivars**

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The *Pythium* root rot of garlic occurred in most garlic-growing areas of the Shandong Province, causing considerable financial losses, nott been reported. The pathogenic infection from the seedling stage, and cause plants were dwarf, leaves were bottom-up yellowed, root and basal part of stem were discolorred and rot, garlic was small and directly affect production. According to the characteristics of the disease, the 50 samples of root rot of garlic were collected from the four counties in Shandong Province. According to the Koch’s postulates, *Pythium* was the main pathogen in all garlic-growing areas of Shandong Province with 46.78% isolation frequency. By morphological identification and ITS sequence alignment, the pathogenic strain were *Pythium sylvaticum* Campbell & Hendrix, *Pythium heterothallicum* Campbell & Hendrix, *Pythium paroecandrum* Drechsler and *Pythium violae* Chesters & Hickman, *Pythium sp.*

143  **Identification of new resources of resistance to *Heterodera filipjevi* in wheat and wheat-relative derivatives**

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*Heterodera filipjevi* is a newly identified species of cereal cyst nematode (CCN) in central China. Since previous tests for CCN resistance mainly focused on *H. avanae*, little is known about the resistance of wheat cultivars grown in China, and deployment of new sources of resistance to *H. filipjevi* is necessary for controlling this species of CCN through host resistance. In a two-year trial in an infested wheat field in Henan Province, China, none of the 74 wheat cultivars from China were highly resistant. Among 60 cultivars or lines tested, the wheat cultivars Madsen and two *Triticum durum* cultivars Waskowa and Waskana showed high resistant reaction. White females were rarely observed on the root systems of these cultivars. Five wheat-*Th. ponticum* partial amphiploids were also resistant to *H. filipjevi* in the field tests. Several other lines showed various levels of resistance to *H. filipjevi*. Seedling inoculation with *H. filipjevi* pathotype collected from the field test site indicated that these cultivars or lines showed similar reactions to the field tests. The newly identified sources of resistance to *H. filipjevi* will be valuable for improving wheat against the disease.

144  **The secretome of Phytophthora nicotianae zoospores**

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*Phytophthora* species cause millions of dollars damage to agriculture and threaten natural ecosystems across the globe. Chemical control of these pathogens is difficult and a greater understanding of the molecular and cellular mechanisms of host infection could lead to novel control methods. During initial plant host infection, motile *Phytophthora* zoospores encyst and the contents of three peripheral vesicles undergo regulated secretion. One of the proteins secreted during this stage is a complement control protein (Ccp) which is found in large peripheral vesicles. The objective of this project is to investigate the role of large peripheral vesicles in during plant infection. The project also seeks to identify novel proteins secreted from zoospores during encystment. Expression of Ccp in *P. nicotianae* (PnCcp) during development has been analysed by quantitative real-time PCR and showed that this gene is induced during sporulation and in zoospores whereas little expression occurs in vegetative hyphae or three hour germinated cysts. In a complementary study, immunofluorescence microscopy showed that the biogenesis of large peripheral vesicles begins prior to the development of small ventral vesicles. Immunofluorescence microscopy was also used to study the timing of secretion from these vesicles and indicated that there is a complex temporal and spatial development pattern of peripheral vesicles in *Phytophthora*. The complement of
secreted proteins is being investigated through proteomic techniques.

### 145 Presence of putative pathogenicity genes in *Fusarium oxysporum* f.sp. *cubense*

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Fusarium wilt is caused by a range of ‘formae specialae’ of *Fusarium oxysporum* which are classified according to the host plant genera to which they are specialised. Fusarium wilt of banana (*Musa* spp.) occurs when *F. oxysporum* *cubense* (Foc) invades the vascular system via the roots, inevitably leading to plant death. *Foc* is further divided into races, each of which affects a different range of banana cultivars. Race 4 is the most important as it has the widest host range and is the only race known to be a competent pathogen of the commercially significant Cavendish cultivars. Previously, researchers have identified pathogenicity genes in *F. oxysporum* *lycopersici* (Fol), based on proteins ‘secreted in xylem’ upon infection of tomato plants; these are SIX1 to SIX8 genes. The aim of the research reported here was to determine if SIX genes were present in *Foc* and identify differences in the SIX gene profiles among the different races of *Foc*. These studies have revealed the presence of SIX7 and SIX8 genes in race 4 isolates of *Foc*, which are absent in race 1 and 2 isolates. The results suggest that if these genes have a similar role in *Foc* as they do in *Fol*, then SIX7 and SIX8 genes may have a role in Cavendish infection and contribute to the broader host range of *Foc* race 4.

### 146 Investigation and development of management strategies for *Rhizoctonia* diseases on vegetables

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*Rhizoctonia solani* is common in most cropped soils and has often been associated with damping-off of seedlings, stunted plants, root, stem and hypocotyl rots. But there is been limited knowledge on the different strains of the pathogen and their impact on vegetable crops in north-west Tasmania, where a wide range of vegetable and potato crops are grown. Therefore, soil samples were collected over two years to test for *R. solani*. Molecular tests specific for anastomosis groups (AG) 2.1, 2.2, 3, 4, 5 and 8 showed that *R. solani* AG2.1 was the most common sub-group in north-west Tasmania, found in 83% of the soil samples. AG2.1 was also shown to be highly pathogenic to most vegetable seedlings. With a lack of management options to control *Rhizoctonia* diseases, trials were conducted to evaluate novel non-chemical treatment methods and fungicides for disease control. Seed treatments with azoxystrobin, fludioxonil or tolclofos-methyl were found to be more effective than captan or thiram in preventing early seedling damping off due to *R. solani* AG2.1. Azoxystrobin and tolclofos-methyl applied as in-furrow soil applications at sowing were also highly effective in preventing Rhizoctonia infections in infected soil. Other non-chemical soil treatments including gypsum, molasses and biocontrol agents had little or no effect in soils inoculated with high levels of *R. solani* AG2.1.

### 147 Isolation and identification of *Sclerotium* in Thailand

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The purpose of this research was to isolate and identify *Sclerotium* (an omnivorous soil-borne fungal pathogen) from soil and plant from various locations in Thailand. Four isolation techniques: the soil plate, moist chamber, direct isolation and tissue transplanting methods were used. Sixty samples of plant pathogenic *Sclerotium* were collected from twenty hosts during October 2007 – September 2010. Identification was characterised by colony growth pattern on medium and morphological characters observed under light microscope. *Sclerotium* sp. were encountered on *Capsicum* sp., *Lycopersicon esculentum* Mill., *Kaempferia parviflora* Wall. Ex Baker, *Glycine max* L., *Arachis hypogaea* L., *Asocceda* sp., *Mokara* sp., *Rhynchosystis* sp., *Vanda* sp., *Paphiopedilum* sp., *Spathoglottis plicata* Blume, *Heliathus annuus* L., *Callistephus chinensis*, *Crinum asiaticum* L., *Hippastrum johnsonii* Bury., *Zephyranthes* sp., *Dragaea sandieriana* Hort. Sander ex Mast., * Chlorophyrtum bichetti* (Karrer) Backer., *Alocasia sandieriana* Bull., and *Microsorum* sp. Sixty isolates of plant pathogenic *Sclerotium* were identified as *Sclerotium rolfsii*. Dried specimens were maintained at the Thai plant pathology herbarium, Plant pathology research group, Plant protection research and development office, Department of agriculture, Bangkok, Thailand.

### 148 Cotton stunting corrected by inoculation with arbuscular-mycorrhizal fungal spores

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Poor crop growth after long periods of fallow, called ‘long-fallow disorder’ in the Australian northern grain and cotton region, is caused by a decline in natural arbuscular-mycorrhizal fungi (AMF). In a glasshouse experiment, cotton plants (cv. Deltapine 90) were grown in pots containing 22 kg of pasteurised (steam at 70°C, for 1 h) or unpasteurised vertosol of moderate P fertility (29 mg P/kg soil, Colwell method) from Emerald, Qld (Lat. 23.53 S, Long. 148.67E). At 42 days after sowing, plants in pasteurised soil were stunted (tops 0.7g d.w./plant; AMF colonisation 0%) compared with those in unpasteurised soil (tops 6.2 g; AMF colonisation 47.9%). To determined if stunting resulted from loss of AMF, cotton plants already growing in the pasteurised soil were treated factorially: (a) left untreated, (b) inoculated with AMF spores (6 spores/g soil of *Glomus mosseae*, strain Hart S), (c) fertilised with P (50 mg/kg soil) or (d) a combination of AMF spores and P. Growth of plants treated with AMF or P...
improved from 40 days after treatment to maturity (total wt 27.6 g; raw cotton 10.5 g for +AMF -P). The untreated plants remained stunted (0.4 g) and produced no bolls. The high mycorrhizal dependency of cotton in this experiment (98% and 36% for total weight in –P and +P treatments respectively, and 100% and 36% for raw cotton) demonstrated the essentiality of the arbuscular-mycorrhizal symbiosis for cotton production in this region.

149 Optimisation of rates, timing and assessment of new compounds for control of common scab disease of potato through foliar applied treatments

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Common scab, a bacterial disease of potato, causes significant losses to the Australian potato industry through rejected seed, reduced ware tuber quality and/or increased processing costs. Essential to disease expression in potato is the production of the phytotoxin, thaxtomin A by plant pathogenic Streptomyces sp. Limited options exist for effective disease management and new cost-effective strategies to control or reduce the impact of common scab on the Australian potato industry would be desirable. Foliar sprays with the auxin 2,4-D have been shown to greatly reduce common scab disease but also affect yield and tuber quality. Here we describe optimisation of rates and timing of treatment with 2,4-D to obtain effective disease control whilst minimising any effect on tuber yield and quality. We found very low rates of 2,4-D applied shortly after plant emergence gave equivalent disease control to the much higher rates previously tested without noticeable effects on tubers.

Furthermore, pot studies have identified another two compounds that have no detrimental effects on plant growth that also inhibited disease, via competition with thaxtomin A. These outcomes suggest foliar treatments for effective control of common scab disease may well be commercially viable.

150 Soil-borne diseases of green beans in Australia, significance and management

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Green beans (Phaseolus vulgaris) consisting of French or dwarf, runner or climbing beans, grown for the fresh market or processing, are a valuable crop to Australia with production approximately 34,000 tonnes worth $63M. Queensland and Tasmania are the biggest producers of beans in Australia. Beans are susceptible to an array of soil-borne pathogens including Aphanomyces euteiches, Thielaviopsis basicola, Macrophomina phaseolina, Rhizoctonia solani, and species of Pythium and Fusarium. Sometimes considered as a disease complex, the symptoms they produce can be similar and it is often difficult to determine the main cause. Recent surveys, greenhouse and field trials have improved our knowledge of the spread and impact of these bean pathogens and options for their control. The diseases reduce yield by disrupting plant development, and when conditions are conducive, may cause the loss of whole plantings. Breeding any resistance to these diseases is difficult as the characteristics of the bean pod are of a higher priority due to market requirements. Many Australian growing regions have a long history of bean production and losses due to these diseases into the future are likely. Aphanomyces euteiches and Thielaviopsis basicola, both causing root and stem rot, are now seen more commonly in long-term bean producing areas.
151 Engaging industry personnel in biosecurity surveillance: Biosecurity Queensland’s exotic citrus pest training

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Biosecurity is a shared responsibility between government and industry. Industry pest scouts and consultants are a key part of the industry’s ‘frontline’ in exotic pest detection and reporting. Pests including huanglongbing, citrus psyllids, citrus canker, fruit borers, powdery mildew, exotic Citrus tristeza virus strains and mal secco present serious threats to Australia’s citrus production. Early detection facilitates successful eradication, containment or control.

In 2010, Exotic Citrus Pest Training was delivered in Queensland to industry pest scouts and consultants, and surveillance personnel from Biosecurity Queensland and AQIS. The training content was developed in consultation with nationally and internationally recognised citrus experts. Fact sheets, presentations and practical ‘hands on’ activities catered to individual learning styles and consolidated existing knowledge. The training also provided participants with information extendable to growers on how to protect farms from exotic citrus pests and diseases. Training evaluation activities were used to assess the effectiveness of the training in four key areas.

The training effectively raised awareness of ten important exotic citrus pest threats, and built skills in pest detection, identification, surveillance hygiene and reporting. By building strong partnerships between government and industry; our surveillance capacity and capability is enhanced, which greatly improves our ability to respond rapidly and effectively to exotic pest threats.

152 The genera of smut fungi—the third revision

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Smut fungi are plant parasitic basidiomycetous microfungi that have teliospores. During the last few decades the number of known species increased considerably and their classification changed radically. Since L. R. and C. Tulasne (1847) divided the order Ustilaginales into two families, Ustilaginaeae and Tilletiaeae, there has been a gradual increase in the number of genera. In the 1st edition of Illustrated Genera of Smut Fungi (Vánky 1987) 51 genera were recognised, comprising 1200 species. Bauer et al. (1997) introduced a new taxonomic classification for smut fungi, based on ultrastructure, molecular phylogeny and morphology, taking into consideration also host plant taxonomy. In the 2nd edition of Illustrated Genera of Smut Fungi (Vánky 2002), 1450 species of smut fungi were classified in 77 genera. Because of further progress in the knowledge of smut fungi, a 3rd revised edition of this book is necessary (Vánky 2010, manuscript). In this, the 1675 species are classified into one phylum, 2 subphyla, 4 classes, 8 orders, 26 families and 94 genera. Of the 94 genera, 19 are new since 2002. Some of these genera, described from Asia and Australasia are Ahmadiago Vánky (India), Anomalomyces Vánky, M. Lutz & R.G. Shivas (Australia), Centrolepidosporium R.G. Shivis & Vánky (Australia), Entylomaster Vánky & R.G. Shivas (Australia), Pilocintractia Vánky (India), Portalia V. González, Vánky & G. Platas (Kazakhstan). Cintractiella Boedijn (Indonesia, Irian Jaya), previously considered a doubtful smut, is now recognised as a good genus in the Cintractiellaceae.
153 Prevalence of diseases in mango nurseries in Punjab, Pakistan

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The sources of most field diseases on mangoes in Pakistan can be traced back to the nurseries where the seedlings were obtained to establish the new orchards. This is because most mango nurseries in the country are established inside orchards and sometimes directly under disease infected trees with high incidences of mango sudden death, malformation, anthracnose and powdery mildew. Seedlings from these nurseries become infected by the prevailing diseases and are the immediate source of spread to new orchards. The objective of this study was to survey a range of mango nurseries in production districts of Punjab, to determine the prevalence of diseases occurring in these nurseries so that growers could be advised on strategies to produce healthier nursery seedlings. The surveys were conducted in the production districts of Faisalabad, Jhang, Multan and Shujabad, to determine the incidence of the different diseases and physiological disorders occurring in the nurseries. Based mainly on symptoms typical for each of the diseases, anthracnose was found on 30% of the seedlings, mango malformation on 70%, mango sudden death on 43% and powdery mildew on 6%. These symptoms included leaf spots on young flushes for anthracnose, malformed florets for malformation, oozing and/or gummosis on seedling stems for mango sudden death and powdery coatings on leaves for powdery mildew. Up to 79% of the seedlings exhibited salt injury symptoms and 50% showed signs of nutrient deficiency. The surveys drew attention to the issues identified and follow up discussions with the nursery owners are helping to improve their nursery management strategies.

154 Efficiency of fungicide application in mango orchards for controlling postharvest diseases

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The efficiency of fungicides in controlling postharvest diseases in ‘Kensington Pride’ mangoes in the Darwin region was assessed in 2009. In a RCBD experiment with single tree plots, eleven treatments were applied including mancozeb 1500 mg.L⁻¹ a.i. and cupric hydroxide 788 mg.L⁻¹ a.i. sprayed fortnightly, and schedules of 2–3 sprays of azoxytrobin 200 mg.L⁻¹ + mancozeb 1500 mg.L⁻¹ a.i. combined with or without fortnightly sprays of mancozeb. Spraying began at ‘full bloom’/’fruit set’ phonological stage and finished 1–2 weeks before harvesting in November. No rainfall was recorded in the trial.

20 fruits of similar maturity were harvested per plot. For six treatments, a second 20-fruits sample was harvested and sprayed with prochloraz at 247.5 mg.L⁻¹ a.i. for 30 s. All fruits were kept at 20–22°C for 14 days then assessed for incidence and severity of Anthracnose using a 0-5 index scale: 0 (no disease), 1 (>0–1%), 2 (>1–5%), 3 (>5–10%), 4 (>10–50%) and 5 (>50% surface covered by lesions) and incidence of stem-end rot.

Stem-end rot incidence ranged from 1.3–5.1% with no significant differences. Anthracnose incidence in the control was 55% but severity very low. Fortnightly sprays of mancozeb or copper alone did not significantly reduce anthracnose incidence. Two sprays of azoxytrobin + mancozeb were not efficient and the effectiveness of three sprays was timing-dependent. The best results were obtained with 2–3 sprays of azoxytrobin + mancozeb combined with fortnightly sprays of mancozeb. Additional postharvest application of prochloraz markedly increased the control of anthracnose. When combined with fortnightly sprays of mancozeb, the timing of the azoxytrobin + mancozeb sprays appeared not to be critical.

155 Resistance to Fusarium oxysporum f. sp. cubense race 4 in Musa acuminata subsp. malaccensis

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Fusarium wilt of banana is considered one of the most destructive plant diseases in recorded history. It is caused by the fungal pathogen Fusarium oxysporum f. sp. cubense (Foc). A particularly devastating strain of the pathogen, tropical race 4, currently presents an emerging threat to banana production in Australia and other major banana producing regions throughout the world. No commercial banana cultivar is resistant to tropical race 4, and as with all strains of the Fusarium wilt pathogen, there is no effective chemical control. Resistance to subtropical and tropical race 4 has been observed in the wild banana subspecies, Musa acuminata subsp. malaccensis, which has consequently received attention as a potential source of Fusarium resistance genes.

The goal of this research is to screen a mapping population of Musa acuminata subsp. malaccensis for resistance to Foc subtropical and tropical race 4. To date, our research shows that F1 progeny challenged with Foc subtropical race 4 in pot trials segregate for resistance according to a Mendelian ratio of 3:1 suggesting that, in this population, resistance to subtropical race 4 is conferred by a single dominant gene. Further research to assess resistance to tropical race 4 in pot trials and under field conditions is ongoing.
156 Bacterial wilt devastated ginger in Quang Nam Province, Vietnam

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Ginger was promoted as a cash crop for poor farmers in the mountainous areas of Quang Nam in the late 1990s, and improved their socio-economic status. In 2000 farmers noted a few plants wilting and dying in some crops. By January 2006 it had become more common. The symptoms were typical of bacterial wilt caused by Ralstonia solanacearum (R.s). We consistently isolated bacterial cultures similar to R.s from wilted plants. However they proved negative on examination in Australia. In January 2007 we had detailed discussions with farmers prior to a further survey. A lady farmer claimed there were two types of wilt; quick wilt (‘boiled in water’ symptom) and a slow wilt (yellowing symptom). We surveyed 11 crops and collected 10 wilted plants on an ad hoc basis from each. The quick wilt symptoms were dominant and the presence of R.s in several plants was confirmed using Pocket Diagnostic® kits. Fusarium oxysporum was consistently isolated from all rhizomes of plants with slow wilt symptoms. Root knot nematode was also present in slow wilt plants. One plant with slow wilt symptoms tested negative with the kit. As these diseases severely affected all crops throughout the two districts where ginger was grown in Quang Nam we were unable to source pathogen-free planting material for pathogenicity tests. Sequencing and pathogenicity tests are necessary to confirm that the cultures of F. oxysporum are F. oxysporum f.sp. zingiberi. The disease devastated the industry and farmers replaced ginger with fast growing acacias and eucalypts for paper production.

157 Towards chemical management of the mango sudden death disease in Pakistan

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The mango sudden death (MSD) or quick decline is a very destructive disease of mangoes in Pakistan. The main visible symptom of infection is the sudden collapse of a healthy-looking tree soon after infection. The disease is caused by Ceratocystis fimbriata even though other biotic and abiotic factors may also be involved. An integrated approach is the best way to manage the disease and to undertake this, effective control components are needed. Fungicides can play a critical role in disease management if the right ones and application techniques are used. The objective of this study was to evaluate the efficacy of some synthetic fungicides and application techniques so that they could be incorporated into an integrated program for the management of MSD. In-vitro evaluation of 3 systemic fungicides; Topsin-M70WP, Carbendazim and Score 250 EC were undertaken to determine their effects on the growth of C. fimbriata on PDA medium. This was followed by field experiments on diseased mango trees to evaluate the most effective of 3 application techniques; drenching, pasting and trunk injection at recommended doses for each fungicide, in an RCBD with 3 tree replications. Data was collected on in-vitro mycelial growth inhibition and on disease severity on plant leaves, stem collar, roots and whole plants on a 0-3 rating scale for each symptom category. The efficacy of the fungicides in reducing mycelial growth of C. fimbriata varied greatly with Topsin M the most effective in growth inhibition even at low doses. It was also the most effective fungicide in field application using different techniques with the injection method being the most effective. These positive results suggest that all 3 fungicides could be incorporated into a holistic disease management program to manage MSD.

158 Managing banana wilt diseases in Indonesia and Australia

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Australian and Indonesian scientists are currently collaborating on an ACIAR funded project entitled ‘Integrated crop production of bananas to manage wilt diseases for improved livelihoods in Indonesia and Australia’. This project will attempt to reduce the impact of Fusarium wilt (and Banana Blood Disease in Indonesia) on banana production in the two countries.

The project is focusing on:

1. Developing packages of Integrated Pest Management (IPM)/Integrated Crop Management (ICM) guidelines for
rehabilitating and improving the livelihoods of banana farmers.

2. Evaluating and adapting packages of IPM/ICM technologies to develop sustainable and profitable banana production systems.

3. Undertaking research to refine management practices using IPM/ICM principles.

Sites in West Java and Lampung Province of Sumatra have been chosen for pilot studies of IPM/ICM practices in Indonesia. Australian project staff have provided training to Indonesian collaborators in methodologies used for chemical, physical and biological assessments of soil condition.

In Australia, farms in north Queensland and northern NSW with Fusarium wilt are being surveyed and soil health analyses are being carried out to determine differences between suppressive and conducive soils. Glasshouse and field studies on organic amendments and plant resistance activators are also being undertaken in Australia.

159 Field evaluation of systemic fungicides for the management of mango scab

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Mango scab, caused by Elsinoe mangiferae Bit. & Jenkins., is considered an important field disease affecting the fruit quality of 'Carabao' mango in the Philippines. Growers do not currently use any fungicide field sprays to manage the disease and it is becoming a fruit quality issue. A field study was conducted in the Southern Philippines during the 2009/2010 season to evaluate the efficacy of selected systemic fungicide treatments against mango scab and blossom blight caused by Colletotrichum gloeosporioides. Selected treatment trees were pruned and subjected to pre-conditioning following recommended cultural practices. Flowering was induced with potassium nitrate. The following treatments were evaluated: Control (no fungicide), Azoxystrobin (50mL), Tebuconazole (50mL), Carbendazim (125mL), Difenconazole (100mL), and Azoxystrobin + Difenconazole at 50, 100, and 200mL, per 200L water. The spray treatments were applied to 12-15 year old mango trees at bud break, pre-bloom, full bloom, fruit set, chicken egg size and two pre-mature stages, 69 and 85 days after flower induction. The experiment was conducted in a completely randomised design with 4 trees per treatment. For assessments, 50 panicles per tree, were randomly tagged and blossom blight, fruit set, fruit retention and fruit scab were assessed at 31, 35, 59 and 104 days after flower induction, respectively. Results of the experiment showed that all the fungicides evaluated significantly and effectively reduced fruit scab by 60 to 75% and blossom blight by up to 50%. Fruit set was improved from one to two per panicle and fruit retention by 0.11 to 0.40 per panicle.

160 Erwinia papayae-like bacteria from papaya showing symptoms of bacterial crown rot in the Kingdom of Tonga

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Symptoms typical of bacterial crown (dark green, water-soaked lesions on juvenile stem tissue developing into a rot which eventually kills the crown) were observed on ‘Sunrise Solo’ papaya in Tonga in 2009. Bacteria isolated from diseased tissue were gram negative facultative anaerobes, oxidase negative, non-fluorescent but producing a non-diffusible blue pigment on King’s medium B. They induced a hypersensitive reaction on tobacco, but not soft rot on potato. Inoculation of healthy seedlings of ‘Solo Sunrise’ resulted in typical water-soaked lesions within five days. Partial sequences of the 16S rDNA gene of four Tongan isolates (using primers 27F and 1492R) were 100% identical to one another, 99% and 98% identical to the 16S rDNA sequences of two Erwinia mallotivora strains, and 97% similar to the 16SrDNA sequence of a strain of E. papayae. E. mallotivora and E. papayae are closely related but cause different diseases on their respective hosts. Because the Tongan strains share characteristics of both species, they are currently referred to as an E. papayae-like bacterium. The taxonomic position of these isolates will be resolved using MLST analysis.
161 Characterisation of different isolates of zucchini yellow mosaic virus from three cucurbit species in Saudi Arabia

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Eleven samples were collected from symptomatic leaves and fruits of squash, pumpkin and muskmelon plants growing in Riyadh and Al-Madina regions. Foliation symptoms including mottling, mosaic, yellow mosaic, vein banding, blisters, and malformation were observed on mechanically inoculated test plants. Zucchini yellow mosaic virus (ZYMV) and other cucurbit viruses were detected by ELISA in the tested samples. The incidences of the other detected viruses were lower compared to ZYMV. Reverse transcription-polymerase chain reaction (RT-PCR) assay and a specific primer were used for detection of ZYMV isolates in nucleic acid extracts of infected squash, Pumpkin and muskmelon plants. The viral DNA amplified product was approximately 1185 bp as estimated by electrophoresis. A Southern blot hybridisation assay has been used to confirm the results obtained through RT-PCR using a specific DNA probe prepared for ZYMV. Neither RT-PCR product nor hybridisation reactions were observed in nucleic acid extracted from healthy plants. The determined nucleotide sequence for the coat protein gene of all four Saudi isolates indicated a similarity of 89.4 to 96.9% between them. Comparative analysis of nucleotide sequences of the Saudi isolates and other ZYMV isolates obtained from GenBank also showed a relatively high similarity that ranged between 82.4 and 96.4%. The highest similarity was found with Iran isolate, Azr.Mak.W, while a lower similarity was found with isolates from South Korea, Vietnam, USA and Spain. This study provides new information regarding the genetic make-up of the natural population of ZYMV isolates infecting cucurbits in Saudi Arabia.

162 A novel strain of Beet western yellows virus infecting sugar beet with two distinct genotypes differing in the 5’-terminal half of genome

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The Inner Mongolia strain of Beet western yellows virus (BWYV-IM) has previously been reported as an agent of sugar beet yellowing disease in China. In this research, the complete genomic sequences of two distinct BWYV genotypes infecting sugar beet in Beijing, named as BWYV-BJ1 and BWYV-BJ2, were determined by RT-PCR sub-cloning approach. BWYV-BJ1 and BWYV-BJ2 were 5674nt, 5626nt in length, respectively. BWYV-BJ1 was 48nt shorter than BWYV-BJ2 in the regions 1589-1615nt and 1629-1649nt. Sequence alignment analysis showed that the complete genomic sequence identity of BWYV-BJ1 and BWYV-BJ2 was 93%, with relatively high variability within the 5’-ORFs (at the nucleotide level was 86.3-88.8%) and low inconsistency within the 3’-ORFs (at the nucleotide level was 99.3-99.5%). In the complete genomic sequence, BWYV-BJ1 and BWYV-BJ2 were most related to BWYV-US (80.6% and 79%, respectively). The 5’-terminus of BWYV-BJ1 and BWYV-BJ2 shared the highest homology with BWYV-US (91.2-93.3%, 86.7%-89.5%, respectively) and their ORFs were more closely related to BWYV-IM; but their ORFs was more closely related to that of cucurbit aphid-borne yellows virus China strain (CABYV-CHN) with 68.1% and 68.5% nucleotide identity, respectively. Because the identity of any gene product between BWYV-BJ1 (BWYV-BJ1 and BWYV-BJ2) and BWYV-IM strain was < 90%, we proposed BWYV-BJ1 was at least a novel strain of BWYV with two distinct genotypes (BWYV-BJ1 and BWYV-BJ2). In addition, phylogenetic analysis and recombination analysis further revealed that BWYV-BJ1 and BWYV-BJ2 might be recombinant viruses.

163 Development of a reliable and efficient Agrobacterium-mediated barley stripe mosaic virus induced gene silencing system for cereals and Nicotiana benthamiana

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To permit more effective use of Barley stripe mosaic virus induced gene silencing (BSMV VIGS) for functional genomics experiments in cereals, we have developed a reliable approach by initiating BSMV infections upon agroinfiltration of Nicotiana benthamiana leaves. The T-DNA/LIC BSMV VIGS vectors were engineered by inserting BSMV cDNAs between the 35S promoter and a ribozyme sequence (Rz), and inserted a ligation independent cloning (LIC) site to downstream of the yb gene to permit more efficient cloning of desired gene fragments. The high efficiency and intensity of silencing phenotypes of PDS, ChlH and TK gene fragments in wheat, barley, B. distachyon and N. benthamiana plants are comparable to those triggered by other VIGS vectors system. The infiltrated N. benthamiana leaves provided continuously excellent sources for secondary infections and VIGS in cereals. Down regulation of wheat TaPMRS gene fragment, whose Arabidopsis thaliana PMRS loss-of-function homologue, has a substantial effect on wheat powdery mildew infection, imply that the PMRS gene has maintained similar functions across the monocot and dicot families. Our T-DNA/LIC BSMV VIGS system provides substantial advantages in expense, cloning efficiency, ease of manipulation and ability to rapidly scale up for high throughput genomics studies.

164 Low divergence of banana bract mosaic virus infecting abaca and banana in The Philippines

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Abaca (Musa textilis Nee) or ‘Manila hemp’ is indigenous to the Philippines. It is the main source of premier rope fiber and basic material for clothing, pulp and paper industries and...
fiber components for the automotive industry. Although the country gains monopoly in the world trade contributing 85% of the total abaca fiber production, biological constraints like virus diseases continuously threaten the industry. Bunchy top disease of abaca caused by *Banana bunchy top virus* (BBTV) is the most prevalent and contributes economic losses. The identity of BBTV has been thoroughly characterised serologically and molecularly as closely related but distinct to *Abaca bunchy top virus* (ABTV) (Sharman et al., 2008).

Recently, we detected *Banana bract mosaic virus* (BBrMV) which was first reported in Philippine bananas in many abaca samples showing typical mosaic and even bunchy top symptoms by mix infection with BBTV. Five clones representing three abaca cultivars namely; Negro, Resistan M. Puti and Abuab showed 97-98% nucleotide sequence similarity in the coat protein and 3’UTR regions of BBrMV isolates from banana. Taxonomic relatedness, ecological niche or cultivation and insect vector may affect the high homology of either BBTV or BBrMV from abaca and banana. This is the first report on the characterisation of BBrMV infecting abaca cultivars in the Philippines.
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