6th Australasian Soilborne Diseases Symposium

Twin Waters, Queensland
9–11 August 2010

Proceedings
ORAL AND POSTER PRESENTATIONS

STRESS PREDISPOSES MACADAMIA ROOTS TO PHYTOPHTHORA INFECTION 28
O A Akinsanmi and A Drenth

USE OF TELONE C35 TO REDUCE SOILBORNE RHIZOCTONIA INOCULUM FOR MANAGEMENT OF ONION STUNT 29
S T Anstis, S J Pederick and T J Wicks

A DESCRIPTIVE MODEL FOR IMPROVED MANAGEMENT OF CROWN ROT OF WHEAT 30
D Backhouse

A MECHANISTIC MODEL FOR THE SPREAD OF CROWN ROT IN CONTINUOUS WHEAT 31
D Backhouse

GENETIC DIVERSITY OF PLASMODIOPHORA BRASSICAE IN AUSTRALIA 32
A Badi, A C Lawrie and EC Donald

EFFECT OF THE BIOPESTICIDE BACILLUS THURIENGENSIS ON POPULATIONS OF NON-TARGET NEMATODES 33
N L Bell and L T Aalders

ISOLATION AND CHARACTERISATION OF POTENTIAL BACTERIAL BIOCONTROL AGENTS FROM BRASSICA AND POTATO CROPPING SYSTEMS 34
M Braithwaite, E Hicks, A Stewart, L Loguercio, R E Falloon and D Bienkowski

BIOTAILOGICAL CONTROL OF RHIZOCTONIA SOLANI IN PERENNIAL RYEGRASS USING TRICHODERMA ATROVIRIDE ISOLATES 35
P K Chohan, D R W Kandula, A Stewart and J G Hampton

SOIL AND SEED Mn EFFECTS ON TAKE-ALL 36
S L Bithell, D Curtin, A McKay, M G Cromey

SOIL pH AND Ggt INOCULUM LEVEL EFFECTS ON TAKE-ALL 37
S L Bithell, D Curtin, R C Butler, A McKay and M G Cromey

SEED POTATO CERTIFICATION: ITS VALUE TO INDUSTRY 38
N S Crump and D ftMarshall

EVALUATION OF THE EFFICACY OF AVICTA AS SEED TREATMENT ALONE OR IN COMBINATION WITH FUSARIUM OXSPOHORUM STRAIN 162 FOR MANAGEMENT OF ROOT-KNOT NEMATODE ON TOMATO 39
A A Dababat, C Watrin, A Cochran, M Klix and R A Sikora

SOILBORNE DISEASES IMPACTING AVOCADO PRODUCTION IN AUSTRALIA 40
E K Dann, L A Smith and K G Pegg

CHARACTERISATION OF RHIZOCTONIA SOLANI ANASTOMOSIS GROUP 2-1 FROM POTATO TUBERS IN NEW ZEALAND 41
S Das, F A Shah, R E Falloon, R C Butler and A R Pitman

RESISTANT VARIETIES AS A MANAGEMENT TOOL FOR THE POTATO CYST NEMATODE (GLOBODERA ROSTOCHIENSIS) IN VICTORIA, AUSTRALIA. 42
R F de Boer, N S Crump, F Thomson, W S Washington, D V Beardsell and A L Yen

THE POTENTIAL OF BIOFUMIGANT AND GREEN MANURE CROPS AS A TOOL TO MANAGE SOILBORNE DISEASES IN VEGETABLE PRODUCTION 43
E C Donald, O N Villalta, C A Scoble, D Wite, D Riches, S Mattner, V Chandolu, R B Jones, M Imsic, D Allen and I J Porter
WHEAT GENETIC RESISTANCE TO DRYLAND CROWN ROT (*Fusarium culmorum*) FROM INVITRO SEEDLING AND ADULT PLANT SCREENING

G Erginbas, J M Nicol and E Kinaci

VISUAL DISEASE ASSESSMENT AS A RESEARCH TOOL – A CASE STUDY

M L Evans and H Wallwork

ELEVATED ZINC AND MANGANESE LEVELS GIVE MODERATE REDUCTIONS IN SPONGOSPORA SUBTERRANEA INFECTION OF POTATO ROOTS

R E Falloon, D Curtin, R A Lister, R C Butler, C L Scott and N S Crump

ARE ORGANIC FARMING SOILS MORE DISEASE SUPPRESSIVE?

P F Geense, L M Forsyth, T Kukulies, A B Pattison and A B Molina

POPULATION GENETICS OF THE PLANT PATHOGENIC PROTOZOA SPONGOSPORA SUBTERRANEA F.SP. SUBTERRANEA

R D Gau, B A McDonald, U Merz, P C Brunner and R E Falloon

SUPPRESSION OF DAMPING-OFF OF RADISH CAUSED BY RHIZOCTONIA SOLANI AG2.1 WITH SOIL CARBON AMENDMENTS


RESPONSE OF SOIL MICROFLORAL COMMUNITIES TO STUBBLE ADDITION DIFFERS BETWEEN DISEASE SUPPRESSIVE AND NON-SUPPRESSIVE SOILS

V V S R Gupta and N P E Reddy

TEMPORAL DYNAMICS OF RHIZOCTONIA SOLANI AG8 INOCULUM IN AUSTRALIAN SOILS

V V S R Gupta, A McKay, S Diallo, D Smith, A Cook, J Kirkegaard, K Ophel-Keller and D K Roget

BACTERIAL INOCULATION OF BANANA IMPROVES PLANT GROWTH UNDER REDUCED FERTILISER TREATMENT

S D Hamill and E Rames

SPATIAL DISTRIBUTION OF THE SOIL BORNE PATHOGEN COLLETOTRICHUM COCCODES AND SUBSEQUENT DISEASE EXPRESSION ON POTATOES AT HARVEST

R Harding, A Benger, C Todd, Herdina, A Mckay and K Ophel-Keller

A BIOASSAY TO SCREEN BIOLOGICAL CONTROL AGENTS AGAINST AERIAL INFECTIONS OF SCLEROTINIA SCLEROTIORUM ON Brassica LEAVES

E Hicks, M Braithwaite, M Pan and A Stewart

FIELD CROP NEMATOLOGY IN SOUTH-EASTERN AUSTRALIA

G J Hollaway, A B Purdue and A C McKay

YIELD LOSS CAUSED BY CROWN ROT IN CEREALS IS RELATED TO PRE-SOWING SOILBORNE PATHOGEN LEVELS AND RAINFALL

G J Hollaway, G K Exell and A C McKay

RHIZOSPHERE BACTERIA ASSOCIATED WITH TWO GRAPEVINE ROOTSTOCKS THAT VARY IN SUSCEPTIBILITY TO CYLINDROCARPON BLACK FOOT DISEASE

D S Dore, E E Jones, H J Ridgway and M V Jaspers

DOES ADDITION OF THE ELEMENT SILICON AFFECT THE INFECTION PROCESS OF *Fusarium oxysporum* F. SP. CUBENSE ON BANANA?

K W Jones, B Cribb and E A B Aitken
EFFECT OF TREHALOSE ON THE BIOLOGICAL ACTIVITY OF TRICHODERMA ATROVIRIDE, LU132 59
   J Kandula, M Braithwaite, A Hay and A Stewart

GROWTH PROMOTION AND BIOLOGICAL CONTROL OF RHIZOCTONIA SOLANI IN OILSEED RAPE USING BENEFICIAL BACTERIAL ISOLATES 60
   D R W Kandula, A Stewart, M Braithwaite and J G Hampton

HISTOPATHOLOGICAL INVESTIGATION OF FUSARIUM CROWN ROT IN WHEAT 61
   N L Knight, A Lehmensiek, D J Herde and M W Sutherland

PYTHIUM SPP. ON GINGER (ZINGIBER OFFICINALE ROSCOE) IN AUSTRALIA 62
   P D Le, M K Smith and E A B Aitken

A COMPARISON OF NEMATODE COMMUNITIES IN VERTOSOLS UNDER CROP AND PASTURE FROM THE DARLING DOWNS, QUEENSLAND 63
   Y Li and G R Stirling

BIOLOGICAL FACTORS INFLUENCE NEMATODE DISTRIBUTION IN VERTOSOLS FROM THE NORTHERN GRAIN-GROWING REGION 64
   Y Li and G R Stirling

MONITORING ROOT AND LEAF SALICYLIC ACID TO OPTIMISE INDUCTION OF SYSTEMIC ACQUIRED RESISTANCE IN BROCCOLI 65
   D Lovelock, A Agarwal, E C Donald, I J Porter and D M Cahill

PROPAMOCARB: MANAGING DAMPING-OFF IN PAPAYA 66
   M F Male and L L Vawdrey

SOIL UTILITY OF A UNIQUE STRAIN OF BACILLUS SUBTILIS, QST 713, FOR DISEASE CONTROL, CROP YIELD AND QUALITY IMPROVEMENTS 67
   D C Manker, E Martinez, D Long, D Warkentin, P Walgenbach, D Silva, M Guilhabert and S Lego

THE POTENTIAL OF SESAME OIL EXTRACTS FOR MELOIDOGYNE JAVANICA CONTROL 68
   J W McCarthy, E A B Aitken, M J Furlong and J A Cobon

ADAPTED SPRING AND WINTER WHEATS WITH RESISTANCE AGAINST MULTIPLE SOILBORNE PATHOGENS (CEREAL NEMATODES – HETERODERA FILIPJEVI AND PRATYLENCHUS SPP. AND CROWN ROT - FUSARIUM CULMORUM) TARGETED FOR RAINFED WHEAT PRODUCTION SYSTEMS 69
   J M Nicol, N Bolat, G Erginbas, A A Dababat, A Yorganicilar, A T Kilinc, İ H Elekcioglu, E Sahin and H Toktay

EFFICACY OF LOQUAT SEED TO CONTROL ROOT-KNOT NEMATODES IN VEGETABLES 70
   W T O’Neill, J A Cobon, A B Pattison and G W Berry

CHANGES IN POPULATION DENSITIES OF MERLINIUS BREVIDENS IN A 4-YEAR SUMMER CROP ROTATION EXPERIMENT 71
   K J Owen, T G Clewett and J P Thompson

CROWN ROT RESISTANCE IN BREAD WHEAT SIGNIFICANTLY ELEVATED THROUGH GENETIC RESEARCH 72
   D J Herde, C D Percy and T L Walters

FUNGI AND OOMYCETES ASSOCIATED WITH ROOT ROT COMPLEX IN PARSNIP CROPS 73
   J E Petkowski, E J Minchinton, R F de Boer and F Thomson
PROGRESS IN COMPARING FUSARIUM PSEUDOGRAMINEARUM INFECTION LEVELS AND CROWN ROT SYMPTOMS IN STEM INTERNODES OF CEREALS 74
    J E Petrisko, N Knight, and MW Sutherland

CALCULATING APPLICATION RATES FOR COMPOSTED MULCH AND SOIL CONDITIONERS TO MAXIMISE SOIL HEALTH 75
    P A Pittaway

IDENTIFYING QTL FOR FUSARIUM CROWN ROT RESISTANCE 76
    G J Poole, R W Smiley, T C Paulitz and K Garland-Campbell

INFLUENCE OF SOIL ORGANIC MATTER ON SOIL HEALTH, SOIL CARBON AND DISEASE SUPPRESSION IN VEGETABLE CROPS 77
    I Porter, S Mattner, R Brett, N O'Halloran, P Fisher, S Engleitner, E Williams, M Guijarro and J Edwards

CONSECUTIVE APPLICATIONS OF BRASSICA GREEN MANURES SUPPRESS MELOIDOGYNE JAVANICA AND INCREASE YIELD OF SEMILLON GRAPE 78
    L Rahman, M Weckert and B Orchard

THE ANTAGONISTIC EFFECT OF TRICHODERMA SPECIES FROM IRANIAN SOIL ON SCLEROTINIA SCLEROTIORUM, THE CAUSAL AGENT OF WHITE STEM ROT DISEASE IN OILSEED RAPE 79
    K Rahnama and F Nejad-nasrolah

VALIDITY OF COMMERCIAL SOIL HEALTH TESTS FOR VINEYARD SOILS 80
    B Rawnsley

GENETIC DIVERSITY OF FUSARIUM CULMORUM, CAUSAL AGENT OF WHEAT ROOT AND CROWN ROT DISEASES AS DETECTED BY REP-PCR MARKER 81
    E Sari, M Razavi and R Zare

BIOLOGICAL CONTROL OF COMMON ROOT ROT OF WHEAT BY FLUORESCENT PSEUDOMONADS FROM THE WHEAT RHIZOSPHERE 82
    N Ranjbar, K Behboudi, M Razavi, A Ghasemi and A Sharifi-Tehrani

SUPPRESSION OF PHYTOPHTHORA ROOT ROT IN PINUS RADIATA 83
    T Reglinski, T M Spiers, J T Taylor, M A Dick and G N Northcott

EFFECT OF PLANT EXTRACTS ON MYCELIAL GROWTH OF SOILBORNE PATHOGENS CAUSING ROOT ROT AND WILT OF VEGETABLES 84
    C A Scoble, K M Plummer, I J Porter and E C Donald

DEVELOPING A CONTROLLED ENVIRONMENT METHOD TO SCREEN WHEAT FOR RESISTANCE TO COMMON ROOT ROT: A PROGRESS REPORT. 85
    J G Sheedy and R A Reen

MANAGEMENT OF PHYTOPHTHORA CINNAMOMI IN AUSTRALIAN AVOCADO ORCHARDS 86
    L A Smith, E K Dann, K G Pegg and A W Whiley

SYMPHYLANS MAY NEGATE THE SOIL HEALTH BENEFITS OBTAINABLE FROM ORGANIC AMENDMENTS AND ROTATION CROPS 87
    M K Smith, J P Smith and G R Stirling

DECOMPOSING CROP RESIDUES ENHANCE SUPPRESSIVENESS TO PLANT-PARASITIC NEMATODES IN SUGARCANE SOILS 88
    G R Stirling, M J Bell and N V Halpin

IDENTIFYING AND DEVELOPING SOILS THAT ARE SUPPRESSIVE TO PYTHIUM RHIZOME ROT OF GINGER 89
    G R Stirling, J P Smith, S D Hamill and M K Smith
CONTROL OF OOMYCETES ASSOCIATED WITH PARSNIP CANKER

E J Minchinton, J E Petkowski, R F de Boer and F Thomson

INDEX OF AUTHORS

LIST OF DELEGATES
Soils are one of the great unknown realms on earth, despite decades of extensive research. We still see soils ‘through a ped darkly’ (Coleman 1985). This opacity in milieu and understanding rewards innovative study, however, as soils are ‘complex adaptive systems’ (Young and Crawford 2004; Crawford et al. 2005), with sophisticated levels of self-organization.

Viewed historically, soil ecological studies have progressed from what major groups of biota are present, what is their biomass, and what major processes occur. More recent studies have delineated multi-trophic interactions, extending both above- and below-ground, as well as specifically-targeted studies of substrates and organisms that are involved in the development and function of suppressive soils. One of the great unknowns in soil ecology is a fuller understanding of the complete array of predatory biota. Soils are teeming with organisms in all three Domains, but are also rife with many phages and other viruses infecting Archaea and Eukarya. Pursuing a more holistic approach including viral biology and ecology may enable us to more capably manage our soils that have supported the biosphere so much over the millennia.

Looking into the future, the opportunity to exploit soil biodiversity in the context of ecosystem development should pay considerable dividends. Following the fungal: bacterial ratios in ecosystem successions, sensu Harris (2009) deserves further exploration. Metatranscriptomics, i.e., the measurement of genomes that are active at any point in time, should be explored by soil ecologists. Using chronosequence analysis, the relationships between soil biodiversity and ecosystem function are beginning to be understood. Finally, management of the plant-soil-microbial-faunal food web via various organic amendments shows possibilities in the study and management of suppressive soils. I look forward to stimulating presentations on these topics during the meeting.

References
RISKS AND BENEFITS OF USING COMPOSTS AS ORGANIC SOIL AMENDMENTS

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The supply of composts has increased in many countries due to the enforced diversion from landfill of organic biodegradable wastes. These include green wastes such as yard trimmings and reject fruit and vegetables, carbon-rich materials such as paper and wood wastes, nitrogenous wastes such as animal manures and sewage sludge, and increasing quantities of food wastes. Often the primary financial incentive for composting is for this organic waste disposal, with income from low value end-products such as organic soil amendments being a secondary or negligible consideration. Composts can have a significant agricultural benefit, particularly on impoverished soils, in regions with limited rainfall, and in organic agriculture, where the use of synthetic fertilisers is not permitted. These benefits include the supply of plant nutrients, particularly P and K, increased soil organic matter, moisture retention, and cation exchange capacity, improved soil structure, and suppression of soil-borne diseases and weeds. However, the bulkiness of compost means that transport for use as an organic soil amendment is usually only viable over short distances. Regulations such as the EU nitrates directive (Anon, 1991) can limit permitted compost application rates to below those which result in significant benefit, at least in the short term. The use of composts can also pose risks such as those caused by contents of toxic elements and compounds such as herbicide residues, populations of plant and animal pathogens which may have survived the composting process, and man-made inerts such as glass and plastic (Noble et al., 2009). Composts may contain high levels of soluble salts or be too alkaline or immature, leading to the immobilisation of soil nitrogen and/or phytotoxicity caused by organic acids and other volatile organic compounds. Compost variability can also be a significant problem, leading to unpredictable crop response. This variability can be measurable such as nutrient content and salinity, but the causes and measurement of compost variability in relation to factors such as nitrogen supply and immobilisation, and disease suppressiveness may be elusive (Noble and Coventry, 2005). Greater control over variables in the composting process, such as in the selection and rejection of feedstock wastes, moisture content adjustment and in allowing for an adequate maturation period, can improve compost quality and uniformity although cost implications must also be considered if compost use as a soil organic amendment is to be viable. The introduction of compost quality standards such as PAS 100 in the UK (Anon., 2005) has been aimed at reducing risks to the compost end user and improving confidence in compost use. Composts can be incorporated into the soil profile or used as a surface mulch. Often the best methods and timing of compost application in the field have yet to be established for particular crops, cropping rotations, soil types, and locations.

Research at Warwick HRI has focused on reducing the risks posed by the plant pathogen content of composts, and improving the understanding, efficacy and reliability of disease suppression resulting from soil amendment with composts. The temperature and exposure time in compost required for eradicating a range of plant pathogens with hardy resting spores such as Plasmodiophora brassicae and Fusarium oxysporum formae speciales, or sclerotia such as Sclerotinia sclerotiorum and Sclerotium cepivorum has been established in both controlled laboratory and large-scale composting tests. The development of indicator organisms which can be inserted in compost and tested for subsequent viability has been used to augment time-temperature data for testing the sanitisation of composting wastes.

The suppression of soil-borne pathogens has frequently been shown to be due to microbial antagonism by demonstration of loss of suppressiveness following compost sterilisation (Noble and Coventry, 2005). However, abiotic factors such as increases in soil pH following compost amendment have also been correlated with control of wilt diseases.
caused by \textit{F. oxysporum} and clubroot of Brassicas caused by \textit{P. brassicae} (Termorshuizen \textit{et al.}, 2007; Noble \textit{et al.}, 2006). Composted onion waste, a significant disposal problem for the onion industry, has been shown to retain the onion volatiles that stimulate the germination and subsequent death of resting sclerotia of the Allium white rot pathogen, \textit{S. cepivorum}, before an onion crop is planted in infested soil. A significant problem in the biological control of soil-pathogens in the field has been the achievement of sufficiently high soil populations of biocontrol agents at an economically viable cost. Composts that support the growth of biocontrol agents such as \textit{Trichoderma viride} have been used to increase the soil population of these beneficial microorganisms to levels which give reproducible levels of control of both Allium white rot (Coventry \textit{et al.}, 2006) and Fusarium basal rot caused by \textit{F. oxysporum} f.sp. \textit{cepae}.

References
NEW TECHNOLOGIES TO BETTER UNDERSTAND ECOLOGICAL PROCESSES AND COMMUNITY DYNAMICS

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Advances in ‘Omics’ technologies is giving unprecedented insight into the biological world, and has been particularly impactful for microbial ecology since for the first time we can have a more comprehensive view of community structure, gene composition and at least some information on activity through expressed proteins and metabolic fluxes. These advances have been driven by advances in sequencing technologies, which have increased the capacity and lowered the cost, i.e. the democratisation of sequencing. A decade ago we were analysing Kb of sequence, a few years ago Mb, now Gb, and next year perhaps Tb. The problem has become how to analyse such massive data sets, not its generation. It is also changing the expertise needed for microbial ecology to one in which coding, computation, high throughput pipelines, and visualization tools are the daily activity. Nonetheless, the biological insight and questions must remain front and centre so that the most important knowledge is gained from the new technologies.

In microbial ecology we can now use these technologies to do certain things well. We can more comprehensively determine community structure to much greater depth and replication, and use that information to assess community differences over time and space, and correlate those differences with environmental attributes. We can also learn about the types and amounts of genes associated with key functions in communities by amplicon (gene-targeted) pyrosequencing (Iwai et. al., 2009) or microarray (GeoChip) technologies (He et. al., 2007). These are particularly useful for genes directly involved in biogeochemical cycles, cell signalling, pathogenicity, antibiotic resistance and biodegradation, for example, and will at some future period allow sequences to be diagnostic markers for ecologically important functions. Shotgun metagenomics, first used in marine microbial ecology, but now beginning to be used productively in soil (the most complex habitat) provides the catalogue for all genes in a community, some of which will reflect the selection that led to their occurrence. The current challenge for using metagenomics in soil is that its complexity makes it difficult to obtain sufficient assembly to interpret function. Deeper sequencing with the more advanced sequencing methods is beginning to make some progress on this key front. The deeper sequencing is also providing improved insight into expression using RNASeq, an approach we used with a bacterial culture under soil-inducing conditions (Yoder-Himes).

I will illustrate the uses and understanding gained from these methods in several studies including the rhizospheres of different crops, the effect of land-use change, and the effect of different ecosystems on the composition of targeted functional genes and taxa.

References


The following organisations sponsored this symposium and the Organising Committee and delegates thank them sincerely for their support.

**Major sponsors**

This conference has been funded by Horticulture Australia Limited using a voluntary contribution from the Organising Committee of the Sixth Australasian Soilborne Diseases Symposium and matched funds from the Federal Government.

**Brisbane City Council** is proud to support research into soil enhancement through the application of compost and biochar in a south-east Queensland context.

**Remote Microscopy: Protecting biosecurity through diagnostics and training**

Remote Microscopy (RM) was developed in response to the biosecurity threats posed by the Emergency Plant Pests (EPPs) and other pests and pathogens. RM overcomes the time and distance that exists between these threats and the experts that identify them to provide a valuable interactive diagnostic communication tool.

RM is unique in that it is a web-based real time diagnostic tool that allows non-experts to rapidly and easily collaborate with experts to identify pest specimens instantly, and so save money and resources. Rapid identification, particularly of exotic pests, is critical to biosecurity response and consequent incursion management.

Centred around Nikon web-based digital cameras and consoles, RM provides a real-time, affordable, widely accessible tool that connects experts and specimens, regardless of location.

The development of the RM network, which is a Cooperative Research Centre for National Plant Biosecurity initiative, is expanding rapidly. It currently extends throughout Australia and New Zealand, Thailand, Lao PDR, Vietnam and East Timor for a total of 41 sites. There are an additional 12 locations Australia wide within the Australian Quarantine and Inspection Service (AQIS).

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The Plant Science and Horticulture and Forestry Science groups are investigating management of soil borne diseases in winter cereals, summer field crops and horticultural crops. Some of the key research areas include developing germplasm with enhanced resistance to crown rot and root lesion nematodes of wheat, investigating reduction of F. oxysporum in cotton by rotational cropping sequences, developing rapid screening for resistance to white mould and black rot in peanuts and management of Phytophthora root rot in avocado and pineapple via selection of resistant varieties, and optimising traditional treatments.

For more information on Agri-Science Queensland and our work in soil borne diseases, visit www.deedi.qld.gov.au or call 13 25 23.
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Cover photograph
Pythium myriotylum causing rhizome rot of ginger at Eumundi, about 20 km from the conference venue
Welcome to the Sixth Australasian Soilborne Diseases Symposium

Two features of modern science are its fragmentation into disciplines and a necessity to specialise. Thus even in areas as specific as soilborne diseases, scientists tend to see themselves as plant pathologists, mycologists, nematologists, microbiologists, soil ecologists or molecular biologists. Also, knowledge is often limited to a few pathogens on one or two crops.

Although some specialisation is necessary if we are to continue to improve our understanding of the complex belowground world, those working on soilborne diseases cannot afford to ignore the broader picture. We may be working on one specific aspect of a problem, but we need to recognise that numerous pathogens and a myriad of competitors interact within the root zone and these interactions are influenced by many factors, including moisture, temperature and the soil’s physical and chemical environment. We also need to recognise that our current cropping systems are the result of years of research and numerous inputs from growers, so new and potentially useful management practices must pass the test of being practical, profitable and sustainable.

The purpose of this meeting is to encourage interaction between scientists with disparate skills but a common interest in soil biology and soilborne diseases. The expertise of participants covers a wide range of fields, so please take the opportunity to discuss your work with as many of our delegates as possible. Hopefully you will leave with many new ideas and some collaborative arrangements that will add value to your research and extension programs.

Enjoy your three days at Twin Waters!

Graham Stirling
Chair, Organising Committee, 6ASDS

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## PROGRAM

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
<th>Page number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monday 9 August</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>Registration and morning tea sponsored by CRDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1045</td>
<td>Opening of symposium</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Session 1</strong></td>
<td>Chair: Graham Stirling</td>
<td>David Coleman</td>
<td>1</td>
</tr>
<tr>
<td>1100</td>
<td><strong>Biological interactions in soil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1100</td>
<td>Understanding soil processes: one of the last frontiers in biological and ecological research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td>Lunch</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Session 2</strong></td>
<td>Chair: Kathy Ophel-Keller</td>
<td>James Tiedje</td>
<td>4</td>
</tr>
<tr>
<td>1300</td>
<td><strong>New insights into the structure and function of microbial communities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td>New technologies to better understand ecological processes and community dynamics</td>
<td>Pauline Mele</td>
<td>15</td>
</tr>
<tr>
<td>1400</td>
<td>Potential applications of soil microbial metagenomics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1430</td>
<td>Afternoon tea</td>
<td></td>
<td></td>
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<tr>
<td><strong>Session 3</strong></td>
<td><strong>Poster session</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>Welcome reception and dinner</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tuesday 10 August</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Session 4</strong></td>
<td>Chair: Matthew Cromey</td>
<td>Ralph Noble</td>
<td>2</td>
</tr>
<tr>
<td>0900</td>
<td><strong>Restoration of organic carbon in soil</strong></td>
<td>Peter McGee</td>
<td>10</td>
</tr>
<tr>
<td>0930</td>
<td>Risks and benefits of using compost as organic soil amendments</td>
<td>Lukas Van Zweiten</td>
<td>25</td>
</tr>
<tr>
<td>0950</td>
<td>Microbial sequestration of organic carbon</td>
<td>Ian Porter</td>
<td>20</td>
</tr>
<tr>
<td>1010</td>
<td>Potential for biochar in soilborne disease management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1030</td>
<td>Morning tea sponsored by SRDC</td>
<td></td>
<td></td>
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<tr>
<td><strong>Session 5</strong></td>
<td>Chair: Olufemi Akinsanmi</td>
<td>Subha Das</td>
<td>41</td>
</tr>
<tr>
<td>1100</td>
<td><strong>Contributed paper session 1</strong></td>
<td>Abdelwahab Badi</td>
<td>32</td>
</tr>
<tr>
<td>1115</td>
<td>Characterisation of <em>Rhizoctonia solani</em> anastomosis group 2-1 from potato tubers in New Zealand</td>
<td>Jill Petrisko</td>
<td>74</td>
</tr>
<tr>
<td>1130</td>
<td>Genetic diversity of <em>Plasmodiophora brassicae</em> in Australia</td>
<td>Kevan Jones</td>
<td>58</td>
</tr>
<tr>
<td>1145</td>
<td>Progress in comparing <em>Fusarium pseudograminearum</em> infection levels and crown rot symptoms in stem internodes of cereals</td>
<td>Vadakattu Gupta</td>
<td>50</td>
</tr>
<tr>
<td>1200</td>
<td>Does addition of the element silicon affect the infection process of <em>Fusarium oxysporum</em> f. sp. <em>cubense</em> on banana?</td>
<td>Grant Poole</td>
<td>76</td>
</tr>
<tr>
<td>1215</td>
<td>Response of soil microfloral communities to stubble addition differs between suppressive and non-suppressive soils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1230</td>
<td>Lunch</td>
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<tr>
<td>Session 6</td>
<td>Chair: Grant Hollaway</td>
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<tr>
<td><strong>Options for enhancing resistance to soilborne diseases of cereals</strong></td>
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<tr>
<td>1330</td>
<td>A commercial breeder’s perspective</td>
<td>Russell Eastwood</td>
<td>8</td>
</tr>
<tr>
<td>1400</td>
<td>A plant pathologist’s perspective</td>
<td>Hugh Wallwork</td>
<td>27</td>
</tr>
<tr>
<td>1430</td>
<td>An international perspective on breeding for resistance to soilborne pathogens</td>
<td>Richard Trethowan</td>
<td>24</td>
</tr>
<tr>
<td>1500</td>
<td>Afternoon tea</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Session 7</th>
<th>Chair: Jason Sheedy</th>
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</thead>
<tbody>
<tr>
<td><strong>The role of vegetable farming systems in disease management</strong></td>
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<tr>
<td>1530</td>
<td>Sustainable farming systems- key management factors and their application to subtropical and tropical vegetable production systems</td>
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<td>1630</td>
<td>Sustainability in temperate vegetable production</td>
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<tr>
<td>1640-1700</td>
<td>General discussion</td>
</tr>
<tr>
<td>1830</td>
<td>Symposium dinner</td>
</tr>
</tbody>
</table>

**Wednesday 11 August**

<table>
<thead>
<tr>
<th>Session 8</th>
<th>Chair: Alison Stewart</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contributed paper session 2</strong></td>
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</tr>
<tr>
<td>0900</td>
<td>2,4-Dichlorophenoxyacetic acid induced resistance to common scab of potato</td>
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<tr>
<td>0915</td>
<td>Are organic farming soils more disease suppressive?</td>
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<tr>
<td>0930</td>
<td>A descriptive model for improved management of crown rot of wheat</td>
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<tr>
<td>0945</td>
<td>Quantifying tuber- and soil-borne inoculum of <em>Rhizoctonia solani</em> in potato production systems in New Zealand</td>
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<td>1000</td>
<td>The potential of biofumigant and green manure crops as a tool to manage soilborne diseases in vegetable crops</td>
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<td>1015</td>
<td>Management of <em>Phytophthora cinnamomi</em> in Australian avocado orchards</td>
</tr>
<tr>
<td>1030</td>
<td>Morning tea</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Session 9</th>
<th>Chair: Richard Falloon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnosis and prediction in relation to soilborne diseases</strong></td>
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<tr>
<td>1100</td>
<td>New approaches for detecting <em>Phytophthora</em></td>
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<tr>
<td>1130</td>
<td>Use of molecular diagnostics for improved decision making by growers</td>
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<td><strong>Soil biology in the Australian grains industry</strong></td>
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<tr>
<td>1200</td>
<td>Harnessing the biological potential of Australia’s grain growing soils</td>
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<tr>
<td>1230</td>
<td>Lunch</td>
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</tbody>
</table>

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<thead>
<tr>
<th>Session 10</th>
<th>Chair: Kirsty Owen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biological control of soilborne pathogens</strong></td>
<td></td>
</tr>
<tr>
<td>1330</td>
<td>Understanding variability in biocontrol systems</td>
</tr>
<tr>
<td>1400</td>
<td>Using composts to suppress soilborne diseases</td>
</tr>
<tr>
<td><strong>International cereal research</strong></td>
<td></td>
</tr>
<tr>
<td>1430</td>
<td>International research and capacity building for control of soilborne pathogens in rainfed wheat</td>
</tr>
<tr>
<td>1500</td>
<td>Business session (arrangements for ASDS7)</td>
</tr>
<tr>
<td>1510</td>
<td>Afternoon tea and finish</td>
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</tbody>
</table>
The future of the Australasian Soilborne Diseases Symposium (ASDS)

The first ASDS was held in February 1999 on the Gold Coast (Queensland) and was followed by meetings in Lorne (Victoria), the Barossa Valley (South Australia), Queenstown (New Zealand) and Thredbo (New South Wales). These symposia have proved to be a valuable forum for those interested in soil health, soilborne diseases and soil biology. Our delegates have come from many countries and have worked on a wide range of crops, pathogens and beneficial organisms in diverse environments. Some have been experts in specific areas such as soil ecology and molecular biology while others have had a broader role in agronomy, extension, teaching or the commercial aspects of agriculture. In an era where science is becoming increasingly specialised, this interaction between people with different skills and backgrounds has contributed to the success of ASDS.

Previous arrangements for organizing ASDS have been quite informal, and we would like to see it remain that way. Although we don’t have a constitution or a management committee, the current system has worked well, as we have always been able to find a group of people prepared to organise the next symposium. This has allowed flexibility in the choice of meeting location, content of the scientific program and meeting theme, and ensured that ASDS has continued to evolve and remain relevant.

Since the meeting in Thredbo 18 months ago, we have made the following arrangements in the hope that they will make it easier to organise future symposia:

- **ASDS is now a formal sub-group within the Australasian Plant Pathology Society (APPS).** This ensures that ASDS has access to the APPS website and can readily communicate with the wider plant pathology community, both in Australasia and elsewhere.
- **Arrangements have been made to deposit any profits from symposia in an APPS account.** Not only will this provide accountability, but it will ensure that start-up funds are available to the organising committee of the next ASDS.
- **ASDS keynote papers have always been published in Australasian Plant Pathology, but the issue of whether ASDS is liable for page charges has never been fully clarified. Arrangements have now been made to ensure that our keynote papers are treated in the same way as keynote papers at APPS conferences.**
- **Within three months of the completion of 6ASDS, the current organising committee will report on the meeting, provide a profit/loss statement and summarise the results of a questionnaire completed by delegates. We hope that future committees will see such reporting as a worthwhile endeavour, as it should assist those planning the next symposium.**

We hope that these arrangements will help ensure that ASDS has a long term future and that it remains relevant to all those interested in soilborne pathogens and the complex world they inhabit.

Graham Stirling and Rob Magarey
Abstracts of keynote papers are presented in these Proceedings. Complete versions of these papers will be published in Australasian Plant Pathology (volume 40, first issue of 2011)

Biographical sketches of keynote speakers

David Coleman is Distinguished Research Professor Emeritus, University of Georgia, Athens, Georgia, USA. David obtained his PhD from the University of Oregon and after five years at the University of Georgia, moved to the University of Colorado at Fort Collins. During his time in Colorado (1972-1985) David played a key role in perhaps the world’s most influential soil ecology group, contributing to our understanding of biotic interactions in the rhizosphere; food web structure and function; organic matter decomposition and turnover; and nutrient dynamics in soil. On his return to the University of Georgia in 1985, he continued his research on energetics, decomposition, nutrient cycling and soil biodiversity. In 1996 he co-authored Fundamentals of Soil Ecology, which became an important reference text for scientists and students with an interest in soil biology and ecology. In 1979-80 he was Senior Research Fellow with the Soil Bureau at Lower Hutt, New Zealand, and in 2006, a McMaster Visiting Fellow with CSIRO in Adelaide, South Australia.

James Tiedje is Distinguished Professor of Microbiology and Molecular Genetics Michigan State University, East Lansing, Michigan, USA. After degrees from Iowa State University and Cornell University, James’ research has focused on microbial ecology, physiology and diversity, especially with regard to the nitrogen cycle, biodegradation of environmental pollutants and the use of molecular and genomic approaches to understand microbial community function. He was Editor of Applied and Environmental Microbiology and Microbial and Molecular Biology Reviews, served on the National Research Council’s Board on Life Sciences and Co-Chaired a Committee on the new science of Metagenomics. James was President of the American Society for Microbiology and the International Society of Microbial Ecology and is a member of the U.S. National Academy of Sciences. He shared the 1992 Finley Prize from UNESCO for research contributions in microbiology of international significance and was recently awarded an Einstein Professorship by the Chinese Academy of Sciences.

Ralph Noble is Professor and Principal Investigator at Warwick HRI (formerly Horticultural Research International but now part of the University of Warwick) in Wellesbourne, UK. He obtained his BSc from the University of Reading and a PhD from Cranfield University. After a short period of postdoctoral research at the Institut für Landtechnik at Bonn University, Germany, Ralph has worked in applied crop research in the UK since 1984. He was previously based at HRI Littelehampton and has been at Wellesbourne since 1994. His main research interests are: suppressing plant pathogens using composts; control of soil-borne plant pathogens using biocontrol agents; examining the survival of plant pathogens during composting; recycling wastes to produce peat-free horticultural growing media; reducing composting odours; and mushroom cultivation. He has been involved in horticultural research and development projects in several countries in Europe, as well as the USA, Mauritius, China, New Zealand and Australia.
# TABLE OF CONTENTS

## Keynote Speakers

- **Understanding Soil Processes: One of the Last Frontiers in Biological and Ecological Research**  
  *Coleman D C*  
  1

- **Risks and Benefits of Using Composts as Organic Soil Amendments**  
  *Noble R*  
  2

- **New Technologies to Better Understand Ecological Processes and Community Dynamics**  
  *Tiedje J M*  
  4

## Invited Speakers

- **Sustainable Farming Systems – Key Management Factors and Their Application in Subtropical and Tropical Vegetable Production Systems**  
  *Bell M J, Pattison, A B and Harper S*  
  5

- **Options for Enhancing Resistance to Soilborne Diseases of Cereals: A Commercial Plant Breeder’s Perspective**  
  *Eastwood R*  
  8

- **Microbial Sequestration of Organic Carbon**  
  *McGee P A*  
  10

- **Use of Molecular Diagnostics for Improved Decision-Making by Growers**  
  *McKay A C and Ophel Keller K M*  
  11

- **Harnessing the Biological Potential of Australia’s Grain Growing Soils**  
  *Mele P M and Blumenthal M J*  
  13

- **Potential Applications of Soil Microbial Metagenomics**  
  *Mele P M*  
  15

- **International Research and Capacity Building for the Control of Soilborne Pathogens in Rain-Fed Wheat Production Systems.**  
  *Nicol J M, Bolat N and Braun H J*  
  17

- **New Approaches to Detecting Phytophthora**  
  *O’Brien PA*  
  19

- **Importance of Soil Organic Matter to Soil Health and Disease Suppression in Vegetable Crops**  
  *Porter I J, Mattner S W and Edwards J*  
  20

- **Understanding Variability in Biocontrol Systems**  
  *Stewart A*  
  22

- **An International Perspective on Breeding for Resistance to Soil Borne Pathogens**  
  *Trethewan R, Mathews K, Manes Y and Nicol J M*  
  24

- **Potential for Biochar in Soilborne Disease Management**  
  *Van Zwieten L*  
  25

- **Strategies for Enhancing Resistance to Soilborne Pathogens of Cereals: A Plant Pathologist’s Perspective**  
  *Wallwork H*  
  27