Final Report

ASDS8 – conference support for vegetable specialists

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Tasmanian Institute of Agriculture (TIA) - University of Tas

Project Number: VG14700
VG14700

This project has been funded by Horticulture Innovation Australia Limited with co-investment from Australasian Soilborne Diseases Symposium and funds from the Australian Government.

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ISBN 0 7341 3563 7

Published and distributed by:
Horticulture Innovation Australia Limited
Level 8, 1 Chifley Square
Sydney NSW 2000
Tel: (02) 8295 2300
Fax: (02) 8295 2399

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Horticulture Innovation Australia
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The 8th Australasian Soil-borne Diseases Symposium (8ASDS) was held in Hobart 10-13th November 2014. This is one of the premier meetings for scientists working with soil-borne disease, soil microbial ecology and plant-microbe interactions in Australasia. The conference attracted 85 scientists and other attendees from seven countries with research students networking strongly encouraged. The scientific programme encompassed topics including pesticides and soil amendments, integrated pest management, plant-pathogen interactions, biological control and disease suppression, resistance, pathogen ecology and epidemiology, and diagnostics and risk management.

Two international specialists in vegetable soil-borne disease R,D&E (Dr Alison Lees, The James Hutton Institute, UK; and Dr Krishna Subbarao, University of California, Davis, USA) were supported to attend the conference. They presented keynote addresses and participated in an industry workshop in NW Tasmania following the conference where they presented to an industry audience.

The ASDS8 meeting provided an important opportunity for scientists to share their latest results and thoughts, network and develop collaborations that will aid in the development of more efficient and effective R,D&E in the future. The industry workshop enabled industry to learn from the experiences of our international specialists in a non-academic setting providing time for questions and informal discussions.
TECHNICAL SUMMARY

The 8th Australasian Soil-borne Diseases Symposium (8ASDS) was held in Hobart 10-13th November 2014. This is one of the premier meetings for scientists working with soil-borne disease, soil microbial ecology and plant-microbe interactions in Australasia. The conference was opened by Tasmanian Liberal MP for Lyons, Mark Shelton and attracted 85 scientists and other attendees. This included participants from Australia, New Zealand, USA, UK, the Netherlands, Brazil, Tunisia, and Malaysia. A good contingent of research students were in attendance with opportunities for networking encouraged. The scientific programme encompassed topics including pesticides and soil amendments, integrated pest management, plant-pathogen interactions, biological control and disease suppression, resistance, pathogen ecology and epidemiology, and diagnostics and risk management.

The HIA grant was primarily used to bring two international specialists in vegetable soil-borne disease R,D&E to the conference. They presented keynote addresses at the conference and participated in an industry workshop in NW Tasmania (at the Forthside Vegetable Research Farm) following the conference where they presented to an industry audience.

The invited speakers were:
Dr Alison Lees (The James Hutton Institute, UK) - a specialists in molecular detection of soil-borne pathogens and development of markers for host resistance selection, who discussed the successes and failures of real-time PCR diagnostic assays as both a research tool and as a predictive tool for soil-borne diseases of potato
Dr Krishna Subbarao (University of California, Davis, USA) - specialist in ecology, epidemiology and integrated control of fungal diseases of vegetables, who discussed how consumer demand (human activities) can alter soil borne diseases, as illustrated with ongoing studies on Sclerotinia sclerotiorum and Verticillium dahliae.

The ASDS8 meeting provided an important opportunity for scientists to share their latest results and thoughts, network and develop collaborations that will aid in the development of more efficient and effective R,D&E in the future.

The industry workshop enabled industry to learn from the experiences of our international specialists in a non-academic setting providing time for questions and informal discussions.
ASDS8 CONFERENCE AND ASSOCIATED INDUSTRY WORKSHOP

INTRODUCTION

The 8th Australasian Soil-borne Diseases Symposium (8ASDS) was held in Hobart 10-13th November 2014. This is one of the premier meetings for scientists working with soil-borne disease, soil microbial ecology and plant-microbe interactions in Australasia. The conference attracted 85 scientists and other attendees. This included participants from Australia, New Zealand, USA, UK, the Netherlands, Brazil, Tunisia, and Malaysia. A good contingent of research students were in attendance with opportunities for networking encouraged.

The HIA project had the following aims:

1. Assist in facilitating running of the ASDS8 conference.
2. Provide resources to invite two keynote speakers (experts in vegetable pathology) from the UK and the USA to the meetings.
3. Support an industry session where keynote speakers will present to an industry audience.
4. Support a prize for the best student presentation.

The HIA grant was used to bring two international specialists in vegetable soil-borne disease R, D & E to the conference. They presented keynote addresses at the conference and participated in an industry workshop in NW Tasmania (at the Forthside Vegetable Research Farm) following the conference where they presented to an industry audience.

The invited speakers were:
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The ASDS8 meeting provided an important opportunity for scientists to share their latest results and thoughts, network and develop collaborations that will aid in the development of more efficient and effective R, D&E in the future.

Quality student presentations were delivered throughout the conference. Natalia Cripps-Guazzone (Lincoln, University, New Zealand) was awarded a prize of $200 for best student presentation.

Immediately following the conference an industry workshop was held which enabled vegetable industry members to learn from the experiences of our international specialists in a non-academic setting providing time for questions and informal discussions.
ASDS8 CONFERENCE

The ASDS8 meeting provided an important opportunity for scientists to share their latest results and thoughts, network and develop collaborations that will aid in the development of more efficient and effective R, D & E in the future (Fig 1.).

The HIA grant was used to bring two international specialists in vegetable soil-borne disease R, D & E to the conference. They presented keynote addresses at the conference and participated in an industry workshop in NW Tasmania (at the Forthside Vegetable Research Farm) following the conference where they presented to an industry audience.

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Dr Krishna Subbarao (University of California, Davis, USA) - specialist in ecology, epidemiology and integrated control of fungal diseases of vegetables.

Student prize:

Quality student presentations were delivered throughout the conference. Natalia Cripps-Guazzone (Lincoln University, New Zealand) was awarded a prize of $200 for best student presentation.

Table 1: the ASDS8 conference program with presentation titles and authors

SESSION 1 - PESTICIDES AND SOIL AMENDMENTS

EVALUATION OF COMPOST TEAS FROM MATURED AGRICULTURAL WASTE, VERMICOMPOST AND SOLID MUNICIPAL WASTE COMPOSTS TO SUPPRESS BACTERIAL WILT OF POTATO
_W.K. Mengesha, S. Powell, K. Evans and K.M. Barry_

TARGETED APPLICATION IMPROVES EFFICACY OF IN-CROP FUNGICIDES AGAINST CROWN ROT IN WHEAT
_S. Simpfendorfer, F. Fensbo and R. Shapland_

CRITICAL PHOSPHOROUS ACID LEVELS TO MANAGE PHYTOPHTHORA ROOT ROT OF AVOCADO
_D.J. Armour and E.K. Dann_

RHIZOCTONIA CONTROL IMPROVED BY LIQUID BANDING OF FUNGICIDES
_P. Bogacki, J. Desbiolles, R. Correll, D. Hüberli, W, MacLeod and A. McKay_

NEMATOSTATIC NATURAL PRODUCTS FROM UNNATURAL SOURCES
_A.G.W. Murray, M. R. Rocha, C.B. Soll, T.L. Rocha and M.F. Grossi de Sa_

30 March 2015
SESSION 2 - INTEGRATED PEST MANAGEMENT

KEYNOTE: HUMAN ACTIVITIES AND SOILBORNE DISEASES: CONTEMPORARY EXPLORATIONS
K.V. Subbarao

THE CUP IS HALF FULL: SUCCESSFUL MANAGEMENT OF ROOT-LESION NEMATODES IN THE RAINFED SUBTROPICAL WHEAT REGION OF AUSTRALIA
K.J. Owen, T.G. Clewett and J.P. Thompson

COMPARISON OF CHEMICAL, BIOLOGICAL, AND CULTURAL TOOLS TO MANAGE SCLEROTINIA DROP OF LETTUCE
M.E. Matheron and M. Porchas

PHYSOPHTHORA CINNAMOMI IN MACADAMIA: ITS IMPACT AND STRATEGIES FOR SUSTAINABLE MANAGEMENT
O.A. Akinsanmi

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L.E. Parkinson, A.R. McTaggart, R.G. Shivas, and E. K. Dann

INFECTION AND COLONISATION OF POTATO PLANTS BY COLLETOTRICHUM COCCODES IN AUSTRALIA

POTATO ROOT EXUDATES STIMULATE ZOOSPORE RELEASE OF SPONGOSPORA SUBTERRANEA
M. Balendres, D. Nichols, R. Tegg and C. Wilson

STRIGOLACTONES, A NEW HORMONE GROUP WITH ROLES IN PLANT-MICROBE INTERACTIONS
S.N. Blake, K.M. Barry, B. Reid and E. Foo

FUSARIUM PSEUDOGRAMINEARUM CROWN ROT: GROWTH PATTERNS IN PLANTA
N.L. Knight and M.W. Sutherland

POSTER SESSION 1

SOMATIC CELL SELECTION AS A TOOL FOR DEVELOPING RESISTANCE AGAINST SOIL-BORNE POTATO PATHOGEN, SPONGOSPORA SUBTERRANEA
M. Balendres, R. Tegg and C. Wilson

EFFECT OF CROWN INFECTION BY STAGONOSPOROPSIS TANACETI ON GROWTH AND DEVELOPMENT OF PYRETHRUM
M.A.H.B. Bhuiyan and P.W.J. Taylor

CALCULATING HEAT HOURS FOR MAXIMUM PRODUCTION OF EGGS FOR 3 SPECIES OF MELOIDOGYNE
J.A. Cobon, W. O’Neill and T. Shuey

PRATYLENCHUS PENETRANS, A DEVASTATING PEST IN WESTERN AUSTRALIAN BROADACRE CROPS

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30 March 2015
RESISTANCE OF FIELD PEAS TO PRATYLENCHUS THORNEI
J.P. Fanning, P. R. Kennedy, B.J. Gogel and G.J. Hollaway

A NATIONAL APPROACH TO THE MANAGEMENT OF ROOT LESION NEMATODES IN AUSTRALIAN FIELD CROPS
G. Hollaway, S. Collins, A. McKay, K. Owen, S. Simpfendorfer and S. Taylor

IT'S A MYSTERY: WHY IS THERE DISEASE PRESENT IN CEREAL ROOTS IN THE ABSENCE OF PATHOGEN DNA IN THE SOIL?
D. Hüberli, S. Collins, M. Connor, W. MacLeod, R. Correll, and A. McKay

NEW ROLES FOR THE PLANT HORMONES STRIGOLACTONES, GIBBERELLINS AND AUXIN IN INFORMATION OF BENEFICIAL SYMBIOSIS WITH ARBUSCULAR MYCORRHIZAL FUNGI
C.J. Hugill, L.J. Quittenden, J.J. Ross, J.B. Reid and E. Foo

A QUALITATIVE PCR FOR DETECTION OF ASCOSPORIC INOCULUM OF SCLEROTINIA SCLEROTIORUM
S.J. Jones, S. Pilkington, D.H. Gent, F.S. Hay and S.J. Pethybridge

OCCURRENCE OF ROOT-LESION NEMATODES IN CENTRAL QUEENSLAND, AUSTRALIA
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SPONGOSPORA SUBTERRANEA ROOT INFECTION ASSESSED IN SIX POTATO CULTIVARS FOR RELATIVE SUSCEPTIBILITY TO POWDERY SCAB
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EVALUATING SALICYLIC ACID TO INDUCE PLANT INNATE IMMUNITY AGAINST SPONGOSPORA SUBTERRANEA ROOT INFECTION OF POTATO
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X.H. Le, C.M.M. Franco and R. Ballard

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D. Bienkowski, E. Hicks, M. Braithwaite and R.E. Falloon

BIOLOGICAL CONTROL OF PASTURE BARE-PATCH DISEASE WITH TRICHODERMA BIO-INOCULANTS
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MANAGEMENT OF TAKE-ALL IN WHEAT
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AGRONOMIC MANAGEMENT OF SOIL-BORNE DISEASES
John Kirkegaard

PLANT RESISTANCE TO SOILBORNE DISEASES
Karam Singh

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SOILBORNE DISEASES IN SEED POTATO CERTIFICATION
N.S. Crump

GENETIC, GENOMIC AND BIOLOGICAL CONTROL STRATEGIES TO MANAGE FUSARIUM CROWN ROT OF WHEAT
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NATIONAL STRAWBERRY INDUSTRY THREATENED
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MARKER-ASSISTED SELECTION OF BACTERIAL BIO-CONTROL AGENTS FOR THE CONTROL OF SCLEROTINIA DISEASES
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T. Thangavel, R.S. Tegg and C.R. Wilson

SOILBORNE DISEASE POTENTIAL IN VICTORIAN POTATO FIELDS
T.J. Wiechel, N.S. Crump, A. McKay and K. OphelKeller

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MANAGEMENT PRACTICES INFLUENCE RHIZOCTONIA SOLANI AG8 INOCULUM AND DISEASE IMPACTS IN CEREAL CROPS
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30 March 2015
D.P. Le, M.K. Smith and E.A.B. Aitken

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S.A. Rowe and A. McKay

CONTRIBUTION OF SPATIAL ANALYSIS TO UNDERSTANDING RISK AND MORTALITY IN ACACIA MANGIUM IN CENTRAL SUMATRA
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A. Moslemi, T. Groom and P.W.J. Taylor

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J. Fanning, A. McKay, C. Forknall, and G. Holloway

Fig 1: Group photo from the 8th Australasian Soilborne Diseases Symposium (8ASDS), November 2014 at The Hobart Function and Conference Centre Tasmania, Australia
INDUSTRY WORKSHOP

The industry workshop was held on the morning of Friday 14th November at the Forthside Vegetable research Farm (Fig 2.).

Presentations were given by the two international speakers to an audience of around 30-40 industry representatives.

The presentations were followed with a question session, and then lunch provided during which further interaction with the international guests was encouraged. Prof Subbarao was interviewed by AUSVEG representatives and featured within the following Vegetable Australia magazine highlighting his work managing *Verticillium dahliae* and *Sclerotinia* in brassica and lettuce crops, in particular about how changing farm management systems has altered disease incidence.

![Image of vegetable growers' workshop](image.jpg)

*Fig 2: Invitation letter to Industry Workshop*

A copy of slides of these two presentations are provided here.

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30 March 2015 — 15 —
Dr Alison Lee’s Presentation at Industry Workshop

Potato (& veg) diseases: UK research

Alison Lees & Jennie Brierley, JHI.

Our sites

Craigiebuckler, Aberdeen
Lanarkshire
350ha rotational and permanent
grazed land, root and woodland

Glencairn, Kincardineshire
485ha rotational grazed land,
permanent pasture, intensiver root and field

Hartwood Research Station, Lanarkshire
350ha rotational and permanent
grazed land, root and woodland

Invergowrie, Dundee
Laboratories, glasshouses and arable land

Salubberly Farm, Angus
Centre for Sustainable Cropping

UK vegetable sector

- UK Field Vegetable sector valued at £660 million. Crops > 130,000 ha, contributes > 30% of the total UK income.
- Primary R&D focus has been crop protection (75% of the research budget).

1. Availability of adequate and sustainable crop protection measures.

2. Increasing returns on investment through the efficient use of resources.
   - Improve farm efficiency, increased automation, precision agronomy, water, soil and waste management.

3. Supply consistent quality product and continuity of supply.
   - Breeding for F&B resistance and quality attributes, improving storage regimes, optimising nutrition and harvest scheduling.

4. Coordinated approach to R&D and technology transfer to farm level.
   - Ensure advances are taken up and used for the benefit of the UK industry as a whole.
   - Improved links with a field vegetable, DEFRA and consultants.

5. Information to promote consumption of home grown vegetables.
   - Heightening the awareness of consumers to the health benefits of vegetables and encouraging consumption.
Cabbage – blight / black rot (*Xanthomonas*)
Broccoli – head rot (*Pseudomonas; Pectobacterium*)
Radish – leaf blight (*Pseudomonas*)
Brussels sprouts – light leaf spot (*Pyrenopeziza*)
Red onion – soft rot (*Burkholderia*)

Aims

- No real treatment options for bacteria, except for copper oxychloride, which is toxic to the environment.
- Aim to promote plant defence response to help reduce bacterial load on plants.
- This project used treatments either already commercially available or with a good chance at being available soon (rather than ‘raw’ chemicals).

Are elicitors commercially available?

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<th>Product</th>
<th>Elicitor activity</th>
<th>Current use</th>
<th>Prospects</th>
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<tbody>
<tr>
<td>Amistar</td>
<td>Strobilurin</td>
<td>Brassica, White Blister, Ring Spot, Alternaria Onion and Radish, Downy Mildew</td>
<td>Good</td>
</tr>
<tr>
<td>Signum</td>
<td>Strobilurin</td>
<td>Brussels sprouts, cabbage, broccoli and radish, Downy Mildew</td>
<td>Good</td>
</tr>
<tr>
<td>Bluestar (Syngenta)</td>
<td>AEMSA mimic</td>
<td>Actigard (US) Label approved for various including <em>Brassica</em> and <em>Kohlrabi</em> (black rot)</td>
<td>Good - Fair</td>
</tr>
<tr>
<td>Stilo-SA (Growth Products UK)</td>
<td>SA - phosphite</td>
<td>Sold as a fertilizer in the USA, not currently sold in UK, but can be shipped.</td>
<td>Good - Fair</td>
</tr>
<tr>
<td>Softguard (Tavena, UK)</td>
<td>Chitosan</td>
<td>Sold as a plant health care or growth promoter product (fertilizer) in the UK.</td>
<td>Good</td>
</tr>
<tr>
<td>Algae GO products (Tavena, UK)</td>
<td>Sea weed extracts, aurantium in Saccharomyces</td>
<td>Sold as a nutritional supplement in the UK, often combined with Softguard.</td>
<td>Good</td>
</tr>
<tr>
<td>Harpina (Plant Health Care, USA)</td>
<td></td>
<td>Sold as a plant health promoter, available in the UK via Plant Health Care, UK office.</td>
<td>Good - Fair</td>
</tr>
<tr>
<td>Regalia / Keyta, Milliana (Syngenta)</td>
<td>Knotweed extract</td>
<td>To be marketed in Europe by Syngenta. Used on range of crops to control wide range of pathogens.</td>
<td>Good - Fair</td>
</tr>
</tbody>
</table>
Testing elicitor treatments for bacterial disease of Brassica

- Variety differences (same pathogen diff. variety)
- Species differences (same plant diff. pathogen)

Interactions with conventional fungicides

- Radish (Celesta)
- Cabbage (Tundra)

In some instances, elicitors with SFP increased disease severity, e.g., Harpin on Radish.

Conclusion:
- Elicitors can work, but in a very 'system' dependent manner
- Can be applied, but in an informed and targeted manner

Potato production - Scotland

Average production (2011) in the EU-27:
- ca. 14.5 t/Km² of land area

Additional notes:
- Average production per km²:
  - >24 t per km²
- Analysis and data from various European regions
Potato Production - Scotland

Tons produced (2009)
- Seed: 465,000
- Main crop: 680,000
- Total: 1,380,000

China >70,000,000 tons

Potato

Potato Council

- Projects aim to improve marketable yield, reduce defects, reduce input costs.
- Currently around 30 projects
  - total value of £10m (£5m is levy payer funding, remainder coming from other sponsors such as Scottish Government, DfE, Technology Strategy Board, BBSRC and potato industry businesses).
- 5 key areas: pest, disease, agronomy, storage, and consumer-related research.
- Projects are carried out at research centres throughout the UK and they involve collaborators in Australia, New Zealand, Switzerland and South Africa.

http://www.potato.org.uk/
Disease Management – soil-borne diseases

Quantify inoculum ➔ Select Field ➔ Select Cultivar ➔ Chemical Control ➔ Agronomy ➔ Less Disease

Economic & Environmental benefits

Potato examples – but approaches applicable to veg

The role of diagnostics in the management of soil-borne potato diseases: considerations

- Quantitative assay – which pathogen and how much?
- Sampling strategy – can we find the pathogen in the field?
- What do the results mean?
  - Inoculum thresholds for risk
  - Spread of individual diseases
  - Effect of environment on disease risk
  - Available control measures

- Disease Management
- Predicta Pt
Quantitative assay

- Specific real-time PCR assays available for most potato pathogens
- Able to detect very low levels of pathogen DNA in plant, tuber, soil and water samples.
- DNA of a specific pathogen is quantifiable

Sampling strategy

Soil sampling strategy underpins the reliability of soil testing:

- must be representative of field scale
- must be practical (sampling and processing time and cost)
- based on “old” PCR sampling strategy

- Sampling area: 4ha or less (divide larger fields)
- Sample size: 1kg for standard testing
- Sampling points: 100 x 10g samples (0-15 cm depth)
- Sampling pattern: W pattern.

Bursley et al., 2000 Quantifying potato pathogen DNA in soil. 
Analytical and Bioanalytical Chemistry 371: 350-8

What do the results mean?

- Inoculum Thresholds
Monitoring of commercial potato fields

In commercial crops the risk of progeny tubers having powdery scab increased from 25% to 65% based on pre-plant levels of soil inoculum.

Seed-borne inoculum responsible for disease where no soil-borne inoculum detected.

Inoculum levels: field trial results, powdery scab

- Level 4 = 40-50 sporeballs/g soil.
- □ = Agria ■ = Nicola

Efforts at reducing the spread of powdery scab in New Zealand through control of seed inoculum levels and powdery scab resistant varieties in New Zealand.
Conclusions

- Three years of field trial results show that the level of soil inoculum significantly affects amount of powdery scab on progeny tubers.
- Evidence towards use of diagnostic tests for field selection.

Colletotrichum coccodes - black dot soil inoculum
120 commercial fields x 3 years

Unmarketable tubers

<table>
<thead>
<tr>
<th>Soil inoculum (pg DNA g soil)</th>
<th>% Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low 2%</td>
<td>0%</td>
</tr>
<tr>
<td>Medium 7%</td>
<td>10%</td>
</tr>
<tr>
<td>High 22%</td>
<td>30%</td>
</tr>
</tbody>
</table>

What do the results mean?

- Epidemiology of individual diseases
  - Where does the inoculum come from?
  - When does infection take place?
  - What factors affect the development of symptoms?

Where does the inoculum come from?

Effect of seed- and soil-borne inoculum on progeny tuber contamination by C. coccodes

Powdery scab infection and symptoms
New information on infection and disease development
Trials in Scotland, Victoria, Tasmania

- Associated environmental variables known
- Can study relationship between environment and infection/disease
What do the results mean?

- Control options

**Control – black dot**

- Over all trials, thiamet-k reduced the percentage of tubers unmarketable due to black dot, from 26.7% to 14.6% (Maris Piper), and from 12.9% to 7.1% (Santo).
- Longer crop duration (120-130 days from 50% emergence to harvest date) increases the risk of black dot developing, particularly where a high level of soil inoculum is present.
Control - Powdery Scab

- Assess inoculum on seed and in soil
- Select fields and assign varieties accordingly
- Select a free-draining soil
- Avoid over-cultivation/compaction
- Avoid over-irrigation
- Consider chemical control
  - Fludioxonil (extension of Authorisation) in seed crops.

Disease risk assessment

- Soil test result → risk
- Variety grown → reduce/increase risk
- Likely crop duration → reduce/increase risk
- Irrigation → increased risk
- Chemical control → reduce risk (may depend on level of inoculum)
- Weather conditions?
Late Blight?

Populations — Implications for:
- Fungicidal control
- Host resistance
- Prediction/risk
- Precision approaches

Current and Future

- Field/site based diagnostics. Vegetables and sugar beet?
- PCN model – temperature vs infestation
- Late blight, populations, field-based risk, precision approaches
- FLN as indicators of soil health
- FLN mapping & targeting of nematicide
- Tramline erosion/run-off (spread of pathogens)
- Optical imaging to detect disease risk/map fields

Stuart Wale
Alex Hilton
Dean Kiesebriek

Jeff Peters
James Woodhall

Peter Gladders
Faye Ritchie

Tonya Weichel, Dept. Primary Industries, Aust.
Leigh Sparrow, Tasmania
Andrew Pitman, Plant & Food Research, NZ
Jacquie van der Woude, U of Victoria, SA

The Scottish Government
Horticulture
Innovation
Australia
Crop Duration

**High Risk:** Harvest date after early October or where crops are grown for a long duration (120-130 days from 50% emergence to harvest date)

**Technical:** Absolute date of harvest is less important than crop duration.

There is a good relationship between black dot development and crop duration (from 50% emergence to harvest).

The relationship is affected by maturity group — for susceptible maincrop varieties risk of economic loss is higher after 130 days.

**Action:** Harvest by early October or limit duration in ground according to susceptibility and maturity group.
Dr Krishna Subbarao’s presentation at Industry Workshop

Broccoli-Mediated Pathogen and Disease Suppression in Vegetable Cropping Systems

K. V. Subbarao

Department of Plant Pathology
University of California, Davis

### GROSS PRODUCTION VALUE

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>2013 TOTAL VALUE</th>
<th>2012 TOTAL VALUE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable Crops</td>
<td>$2,833,775,000</td>
<td>$2,557,772,000</td>
</tr>
<tr>
<td>Fruit &amp; Nuts</td>
<td>$1,159,589,000</td>
<td>$1,057,684,000</td>
</tr>
<tr>
<td>Nursery Crops</td>
<td>$312,346,000</td>
<td>$307,543,000</td>
</tr>
<tr>
<td>Livestock &amp; Poultry</td>
<td>$45,024,000</td>
<td>$53,126,000</td>
</tr>
<tr>
<td>Field Crops</td>
<td>$19,990,000</td>
<td>$19,338,000</td>
</tr>
<tr>
<td>Seed Crops</td>
<td>$8,803,000</td>
<td>$8,550,000</td>
</tr>
<tr>
<td>Apiary</td>
<td>$195,000</td>
<td>$204,000</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>$4,379,722,000</strong></td>
<td><strong>$4,004,217,000</strong></td>
</tr>
</tbody>
</table>
Background

- Extensive surveys revealed the high degree of susceptibility of cauliflower and near-immunity of broccoli to Verticillium wilt.

- *Verticillium dahliae* isolates from crucifer crops were weakly pathogenic on broccoli in greenhouse tests, and others were non-pathogenic.

- Dry crucifer residues are better than fresh residue.

<table>
<thead>
<tr>
<th>Reaction of broccoli to <em>Verticillium dahliae</em> from various hosts</th>
<th>Disease severity</th>
<th>Dry weight (g)</th>
<th>Root</th>
<th>Shoot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauliflower</td>
<td>1</td>
<td>2.31</td>
<td>4.07</td>
<td></td>
</tr>
<tr>
<td>Chilli pepper</td>
<td>0</td>
<td>2.57</td>
<td>3.90</td>
<td></td>
</tr>
<tr>
<td>Artichoke</td>
<td>1</td>
<td>2.28</td>
<td>3.58</td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td>1</td>
<td>2.18</td>
<td>4.34</td>
<td></td>
</tr>
<tr>
<td>Lettuce</td>
<td>0</td>
<td>2.52</td>
<td>4.02</td>
<td></td>
</tr>
<tr>
<td>Strawberry</td>
<td>0</td>
<td>2.41</td>
<td>3.60</td>
<td></td>
</tr>
<tr>
<td>Bell pepper</td>
<td>0</td>
<td>2.50</td>
<td>4.23</td>
<td></td>
</tr>
<tr>
<td>Eggplant</td>
<td>0</td>
<td>2.57</td>
<td>3.61</td>
<td></td>
</tr>
<tr>
<td>Tomato</td>
<td>1</td>
<td>2.14</td>
<td>4.06</td>
<td></td>
</tr>
<tr>
<td>Watermelon</td>
<td>0</td>
<td>1.90</td>
<td>3.76</td>
<td></td>
</tr>
<tr>
<td>Mint</td>
<td>1</td>
<td>2.29</td>
<td>4.22</td>
<td></td>
</tr>
<tr>
<td>Potato</td>
<td>1</td>
<td>2.79</td>
<td>3.82</td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>0</td>
<td>3.03</td>
<td>4.17</td>
<td></td>
</tr>
<tr>
<td>Alfalfa (<em>albo-ahum</em>)</td>
<td>0</td>
<td>2.61</td>
<td>3.97</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>2.71</td>
<td>4.42</td>
<td></td>
</tr>
<tr>
<td>LSD (p≤0.05)</td>
<td>0.56</td>
<td>0.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauliflower</td>
<td>5</td>
<td>1.80</td>
<td>2.25</td>
<td></td>
</tr>
</tbody>
</table>
Questions

- When should the broccoli crop be planted and residue incorporated?
- Is there a specific temperature at which propagule reduction by broccoli is maximized?
- Is dry broccoli better than fresh broccoli?

Methods

- **Soil:** Fields 1 & 2
- **Treatments:** Fresh (8%), dry, and no broccoli in 25 g dry soil.
- **Incubation:** 10, 15, 20, 25, 30, & 35°C
- **Assay:** After 45 days incubation using the Anderson sampler technique.
- In a parallel set of experiments, soil sampled after 15, 30, and 45 days incubation and assayed.
Are all broccoli varieties same?

Other Applications of this Research

- Efficacy of Broccoli - Strawberry Rotation
- Conventional versus organic production systems
- Reductions in *Sclerotinia minor* sclerotia and lettuce drop incidence.
Potential Mechanisms

- Why is broccoli resistant to *V. dahliae* infection?
- How does broccoli result in attrition of propagules?
  - Chemical
  - Microbial
    - Specific to pigmented propagules?
Summary of cover crop biomass and equivalent metam sodium content

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Biomass (T/A) 2004</th>
<th>Biomass (T/A) 2005</th>
<th>N (lb/A) 2004</th>
<th>N (lb/A) 2005</th>
<th>Metam sodium Eq (gal/A) 2004–2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>2.08</td>
<td>1.84</td>
<td>132.8</td>
<td>71.0</td>
<td>0.11</td>
</tr>
<tr>
<td>White Mustard</td>
<td>2.51</td>
<td>1.78</td>
<td>194.8</td>
<td>130.8</td>
<td>2.28</td>
</tr>
<tr>
<td>Indian Mustard</td>
<td>2.23</td>
<td>1.33</td>
<td>199.7</td>
<td>120.5</td>
<td>1.69</td>
</tr>
</tbody>
</table>

Labelled rates of metam sodium 30–75 gal/A

Soil Microbiological Changes

Significant differences between broccoli and cauliflower.

Broccoli residue incorporation results in 100-fold increases in bacteria and 1000-fold increase in actinomycetes.

Not only these changes are quantitative but also qualitative. The diversity of these groups is highest in broccoli-amended soils compared with cauliflower-residue amended soils.

Bacterial diversity - Broccoli

- Arthrobacter saerdae
- A. barkeri
- A. oxydans
- A. ramosus
- A. viscosus
- Aureobacterium esteraromaticum
- Bacillus circulans
- B. atrocyaneus
- B. brevis
- B. ferment
- B. pantothenicus
- B. psychrophilus
- B. pumilus
- Micrococcus lylae
- M. kristinae
- M. roseus
- Pseudomonas flectens
- Stephycoccus epidermis
- S. cohlini
- Stenotrophomonas maltophilia
Bacterial diversity – non-broccoli

- *Bacillus chlororaphis*
- *B. laterosprus*
- *B. linens*
- *B. psychrophilus*
- *Curtobacterium inologenes*
- *C. flaccumfaciens*
- *Micrococcus halobius*
- *Pseudomonas putida*

Myxobacteria

- Gram negative, gliding bacteria
- Produce swarms on nutrient poor media
- Produce characteristic fruiting bodies with dormant myxospores
- Lytic activity on microorganisms and nematodes
**Myxobacteria**

- *Myxococcus coralloides*
- *M. fulvus*
- *M. virescens*
- *M. xanthus* (2)
- *M. stipitatus*
- *M. flavascense*

**Benefits of Melanin**

- **Abiotic Stress**
  - UV radiation, temperature extremes, desiccation, free radicals, metal toxicity
- **Biotic Stress**
  - Soil microbial/host plant origin hydrolytic enzymes and free radicals
- **Pathogenicity**
  - Appressorial penetration, virulence factor?
Research Team

- Chang-Lin Xiao
- Li Liu
- Ashley Bell
- Ravi Bhat
- Kateel Shetty
- Judy Hubbard
- Steve Koike
- Qingming Qin
- Gary Vallad
- Cauliflower growers
- USDA-NRICGP
- USDA-CSREES
- USDA-SARE
- CA DPR
- CA Lettuce Research Board
- CA Strawberry Commission
- UCIPM
CONCLUSION

The ASDS8 conference was a success. Informal feedback from participants and invited speakers praised the quality of the meeting and the opportunities it raised.

The invited speakers were well received by both the scientific community and industry at the workshop. In particular, Prof Subbarao’s presentation on the limitations of biofumigants, but success with changes in farming systems was illuminating given current interest in biofumigants.
TECHNOLOGY TRANSFER

SCIENTIFIC CONFERENCE PAPERS

The ASDS8 conference featured 50 oral and 24 poster presentations relating to soil-borne disease (see attached program).

INDUSTRY & MEDIA PUBLICATIONS

Two articles about the keynote speaker featured within Vegetables Australia and Potatoes Australia.

One article interviewed Prof. Krishna Subbarao (UC Davis, USA) and focussed on his work with Verticillium dahliae and Sclerotinia spp. in Californian vegetable production systems. These diseases are very topical for Australian producers. His outcomes highlighted how changes in farming systems had dramatic effects on disease incidence.

The other article interviewed Dr Alison Lees, and focussed on her insights into potato diseases, and collaborations with Australian researchers within the APRP#2 program.

- “International researcher shares knowledge with Tassie growers”. Potatoes Australia Dec/Jan 2015: 18-19

Interviews during the conference by Dr Calum Wilson and Prof Subbarao were featured on radio during the ABC country hour.

An article on the ASDS conference appeared in the Tasmanian Country newspaper featuring interviews from Dr Jason Scott, Dr Robert Tegg and prof Krishna Subbarao.

INDUSTRY & PEER PRESENTATIONS

The industry workshop held at the Forthside Research Farm provided an opportunity for the Tasmanian vegetable sector to engage with the key note speakers.

The workshop featured presentations from both speakers followed by a formal question time and lunch with informal discussions.
The ASDS meetings are of critical importance to Australian horticulture. They provide one of the few opportunities for Australasian specialists in soil-borne disease to meet and discuss the latest developments in this field. There are many unanswered questions relating to control of soil-borne disease. This is reflected in the proportion of R, D&E projects in this area. With diminishing resources invested in soil-borne disease research it is imperative that those active in the area share information and form collaborations to use these resources in the most efficient manner. ASDS provide a perfect venue for such developments.

We recommend HIA consider sponsorship opportunities for future iterations of this important meeting (the next to be held in Hamner Springs, New Zealand)