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Editor: Daniel Hüberli

In this issue:

ISPP President's Greetings for 2016

Linnea borealis - flowering in the exhibition by Ashwood Nurseries of the UK at the 2016 Chelsea Flower Show (picture Greg Johnson).

As plant pathologists and diagnosticians, we owe much to the 'father of modern taxonomy', Carl Linnaeus (Carl von Linné) for the binomial nomenclature used in naming organisms. During April and May, I visited Botanic Gardens and Museums dedicated

to Linneaus memory in the Netherlands and Sweden. Later in my travels I took this picture of the modest plant that was named in his honor - *Linnaea borealis* (above).

L. borealis, the Twin Flower, is found in the northern locations extending from the Nordic countries to Siberia and across North America. It modestly circles the earth - just like the ISPP Newsletter! Here on behalf of the ISPP Executive I extend Greetings and Good Wishes to all for 2017!

For the International Society of Plant Pathology, 2016 has been a busy year.

International Congress of Plant Pathology 2018 (ICPP2018) planning
The ICPP2018 Committee has been very active in the planning of the Scientific Program. The call for proposals for Concurrent Sessions closed in Mid-December 2016, and planning for plenary and keynote sessions has commenced.

ISPP Associated Societies
Starting late in 2015 and continuing through 2016 many ISPP Associate Society Members have taken advantage of the option of paying member-ship fees three years in advance - and several Societies also paid back dues. Two additional societies became financial members bring the total number of financial Societies to c. 25 out of 60 listed on the ISPP Website. During 2016 the ISPP also welcomed the Belarussian Phytopathological Society as the newest member of the ISPP.

Late in 2016, the listings of ISPP Associated Societies were updated with names in English and in many cases, the language used by the Societies on their websites. The ISPP business manager welcomes help to finish this process!

Jakob Eriksson Prize
The call for nominaitons for the Jakob Eriksson Prize to be awarded at ICPP2018 was made during 2016 and nominations close in mid-January 2017.

International Congress for Plant Pathology 2023 (ICPP2023) and ISPP Executive Committee (EC) 2018-2023
The call for bids to host ICPP2023 was made during 2016. The French, Indian, Netherlands and Thai Societies bid to host ICPP2023. After a two stage voting process, the French Society for Phytopathology (SFP) emerged as the successful bidder to host ICPP2013 in Lyon, France from 20-25 August 2023.

The election processes for the ISPP Executive Committee for 2018-2023 will be initiated early in 2017.

Food Security
In 2016, the ISPP journal Food Security: The Science, Sociology and Economics of Food Production and Access to Food completed its 8th year of publication, with Richard Strange as Editor in Chief. The December 2016 issue includes 10 papers covering various constraints to the acquisition of healthy diets, the diversity of these globally and the lack of diversity in specific regions being two reasons why food security is so hard to obtain where it is not present and often precarious where it is. These papers are just a sample:

- The impact of improved 'water-use security' on women's reliance on agricultural incomes in KwaZulu-Natal Province, South Africa
- The process of developing a nutrition-sensitive agriculture intervention: a multi-site experience
- The effectiveness of extension strategies for increasing the adoption of biofortified crops: the case of quality protein maize in East Africa
- Impacts of HIV / AIDS on food consumption and wild food use in rural South Africa
- On-farm maize storage systems and rodent postharvest losses in six maize growing agro-ecological zones of Kenya Agricultural support and vulnerability of food security to trade in developing countries

ISPP Book Series with Springer
ISPP has reached agreement with Springer to expand the book series Plant Pathology in the 21st Century beyond special topics from the International Congress of Plant Pathology. The expanded series will be launched during 2017 with ISPP Immediate Past President, Professor Maria Lodovica Gullino, as the series Editor.

ISPP Newsletter
During 2016, our Newsletter Editor, Dr Daniel Huberli, continued his sterling work on the ISPP Newsletter. Each issue includes a selection of plant pathology related news contributed by ISPP and Associated Societies and other plant pathology related sources. As I said in 2015: "This is your newsletter, so please consider sending news about your Society's conferences and workshops!" There's no need to draft extensive text, links of interest and sending your own Society News to the Editor are welcome.

ISPP Website
The ISPP web site was regularly maintained and updated during 2016. Although the site is very old in style it is hosted on the latest servers and serves the society very well. SPAM is an ever increasing problem for web sites. To reduce the problem all email addresses appearing on the web site were converted to unicode. It is hoped that this will protect email addresses from spam crawlers and reduce the problem in the future.

ISPP Taskforce on Global Food Security

With Professor Lise Korsten from the University of Pretoria, South Africa as Chair, the Taskforce held several Skype meetings during 2016. Major activities during 2015-2016 have included:

Development of knowledge bases at the University of Pretoria to facilitate access to information about:

- Institutions having a Food Security initiative or programme
- Funding programmes relating to Food Security
- Meetings with a Food Security theme
- Think tanks relating to Food Security

Food Security Session proposals for ICPP2018 - Three sessions have been proposed on "Emerging Plant Diseases: the Threat to Global Food Security" (titles are provisional):

- A public meeting - From the Irish Famine to Today: Crop Diseases Still Threaten Global Food Security
- A plenary session - Emerging Plant Diseases and Global Food Security
- A concurrent session - Management of Emerging Diseases

In line with recent practice the plenary session is expected to include the Glenn Anderson Lecture. This is under discussion with the Canadian Phytopathological Society which, with ISPP, sponsors the lecture.

A position paper on genetic modification by Task Force members was published:

Peter Scott, Jennifer Thomson, David Grzywacz, Serge Savary, Richard Strange, Lise Korsten (2016). Genetic modification for disease resistance: a position paper. Food Sec. 8: 865-870. DOI 10.1007/s12571-016-0591-9.

Associated Society Milestones
The ISPP President represented ISPP at the 125 years celebration of the Royal Netherlands Society for Plant Pathology (Koninklijke Nederlandse Plantenziektekundige Vereniging - KNPV) during April 2016 (as reported in ISPP Newsletter). ISPP Vice President, Serge Savary represented the ISPP at the 6th International Conference of the Indian Phytopathological Society during February 2016.

ISPP Subject Matter Committees (SMC)
During November 2016 the ISPP Crop Loss Subject Matter Committee launched a Global Crop Loss Survey. The response to the survey has surpassed expectations and the latest update on progress is in this issue of the ISPP Newsletter.

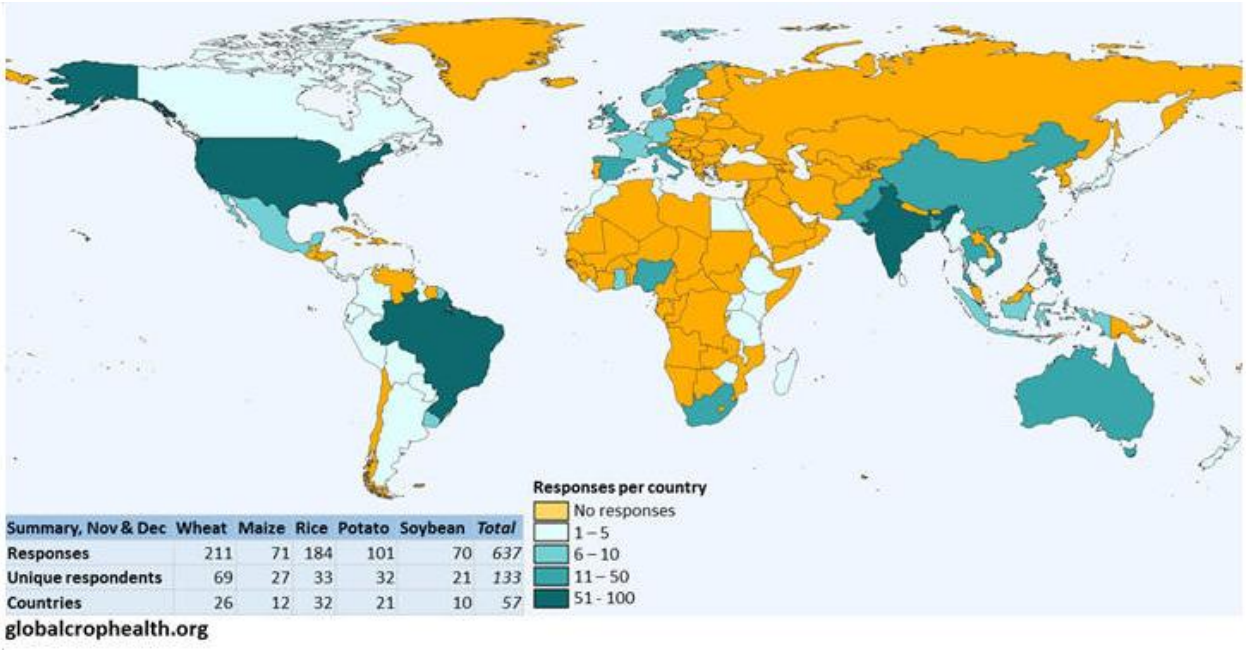
ISPP Executive Committee meeting
The ISPP Executive met in Boston Massachusetts during October 2016. This provided opportunities for detailed discussions about ICPP2018 Scientific Session planning and for a visit to the ICPP2018 Congress Center.

Greg Johnson
President
International Society for Plant Pathology

ISPP Global Crop Loss Survey: Success - Yet more responses still needed Latest update on the Survey
Over 600 responses, from 133 colleagues in 57 countries all over the world: After a little more than seven weeks, and half-way into its completion, the Global Crop Loss Survey undertaken by the Crop Loss Subject Matter Committee has met with considerable success so far. The table and map below shows the contributions to the Survey, expressed as number of responses by country.

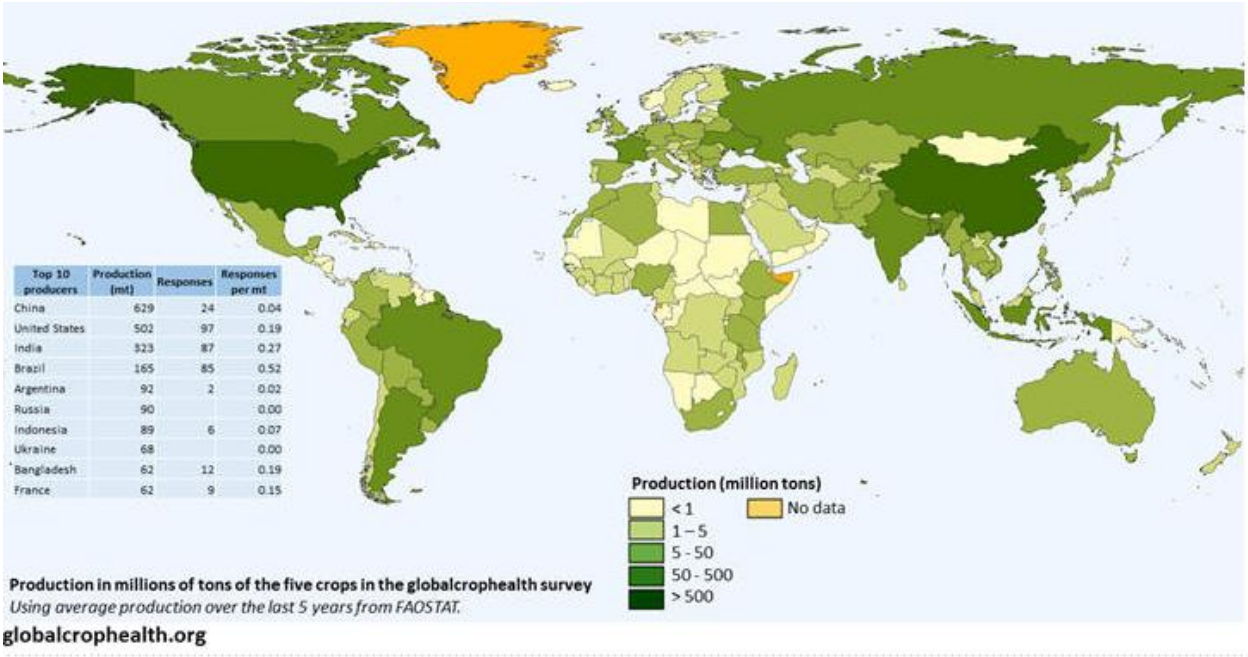
Number of responses	Country
97	United States
85	Brazil
78	India
37	Australia
24	China
21	Italy, South Africa
20	Vietnam
17	Thailand
16	Pakistan
15	United Kingdom, Sweden
14	Philippines
13	Spain
12	Bangladesh
11	Nigeria
9	France, Germany

8	Norway
7	Mexico, Uruguay
6	Indonesia, Ghana
5	Tanzania
5	Peru, Kenya
4	Myanmar, Egypt, Belgium,, Colombia, Uganda, Switzerland
3	Ethiopia, Rwanda, Taiwan, Latvia
2	Argentina, Cambodia, Ecuador, New Zealand, Ireland, Nicaragua, Panama, Costa Rica
1	Canada, Japan, Paraguay, Netherlands, Malawi, Morocco, Bolivia, Madagascar, Sri Lanka, Tunisia, Zimbabwe, Guyana, Liberia



Note: The boundaries, colours, denominations, and other information shown on this map do not imply any judgment on the part of the ISPP or the authors or the respondents concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Although the results so far are very encouraging, when we look at production of the five crops (wheat, maize, rice, potato and soybean) there are geographic gaps that suggest more responses are necessary from some key agricultural countries, which perhaps have not yet been sufficiently reached by earlier messages.



Note: The boundaries, colours, denominations, and other information shown on this map do not imply any judgment on the part of the ISPP or the authors or the respondents concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

More inputs from Eastern Europe, Russia, China, several countries in Western Europe (Denmark, France, Germany, Spain, the UK), Canada, Mexico, Central Asia, North Africa, Argentina, Indonesia, Bangladesh, the Mediterranean, and Sub Saharan Africa, are necessary.

How to contribute to the Survey
You are invited to contribute to this survey. If you would like to participate in this global effort, please use this link: https://globalcrophealth.org/

This link will direct you to a survey questionnaire. The questionnaire has been devised to be simple and flexible, so that you would need as little of your time to provide inputs. If you have any queries about this survey, please email us.

About the Survey
Quantifying the importance of crop diseases and pests is a necessary first step towards a better understanding of crop health and its management. The exercise initiated by the ISPP aims at addressing the fragmented, heterogeneous, and incomplete information about the losses caused by plant diseases and pests in agriculture. This survey had been discussed by the Crop Loss Subject Matter Committee of the ISPP during its first meeting in August 2013 in Beijing.

This survey is intended to help document crop losses in major world crops. The information sought on each crop disease or pest (location, frequency and loss) is very simplified, in order to both reduce the time required to answering the questionnaire, and to generate homogeneous information across multiple diseases and pests of several crops.

At this stage, the survey focuses on five major crops worldwide: wheat, rice, potato, soybean, and maize. It might be expanded to other crops in the future. For each of these five crops, up to 10 pests and diseases have been listed. These are only suggestions, and the survey forms provide opportunity to submit information on other pests and diseases as well. Common names and scientific names of suggested pathogens and pests are tabulated below.

The survey asks contributors to provide their name, institute and e-mail address. Providing this information is optional. However, this will enable the recognition of contributions in future reports.

Hopefully, this survey will collect as many inputs from numerous contributors worldwide, on as many diseases and pests as possible. **The survey will end on 31 Jan 2017**. If the survey is successful in eliciting a sufficient number of responses, a report will be made public by 31 Apr 2017, where the detail of individual contributions will not be presented, but where contributions will be explicitly acknowledged.

Queries about the Survey
Some frequently asked questions have been listed in the last issue of the ISPP. We discuss an additional question below.

Q : When I am submitting my responses to the questionnaire, I receive an e-mail with a very detailed description of the location pertaining to my responses. However, my intention was only to provide information over a fairly wide area, not the very precise location that this e-mail indicates. Should I worry about this?

R: No. The survey was actually designed for respondents having in mind a fairly wide area (a district, a province, for example) - any geographical unit where diseases and pests have consistent patterns over time and space (see also explanations on the website of the Survey). In practice, moving the pin on the map provided in the survey questionnaire to the center of the area of interest, and then providing responses, is adequate. This will result in the generation of a geo-localisation, with a precision that far exceeds what the respondent has in mind, but this has no implication on the way the responses will be processed: analysis of the data will be done at a very coarse geographical grain, consistent with the respondent's inputs.

Thanking everyone for your support in this effort,
S. Savary, INRA, Centre INRA de Toulouse, France; Chair, Crop Loss Subject Matter Committee of the ISPP;
A. Nelson, ITC, University of Twente, The Netherlands;
L. Willocquet, INRA, Centre INRA de Toulouse, France ;
Sarah Pethybridge, Cornell University, USA;
Asimina Mila, North Carolina State University, USA;
Paul Esker, University of Costa Rica;
Neil McRoberts, UC Davis, USA.

Regional action plan to combat cocoa swollen shoot virus
In October 2016, the World Cocoa Foundation (WCF) convened a regional forum about the growing problem of cocoa swollen shoot virus (CSSV) in West Africa. The meeting attracted more than 30 research scientists, policymakers and industry representatives.

WCF President Rick Scobey stressed to participants the importance of addressing CSSV from a regional perspective, noting that the disease knows no borders. He cited evidence that CSSV is rapidly spreading and poses a serious threat to cocoa sustainability. He called for a regional approach to coordinate work and research, and that the responsibility for making this happen lies with cocoa-producing countries in the region.

The forum included a review of the Grand Bassam 2013 recommendations to situate the current discussion within a historical context about the disease. The review provided participants with an overview of the disease, its history in West Africa and its evolution over time. There was also a discussion about previous meetings and regional efforts to combat the disease. An outline was suggested for priority elements of regional control and containment strategy.

The group endorsed a proposal to develop a coordinated, cross-border, and collaborative action plan, in which policy makers from the affected countries mobilize scientists to share results and put research into action with outside donors invited to provide support. This strategy would include long-term commitments from governments, industry, research institutes, and other partners such as WCF and the International Cocoa Organization (ICCO).

Participants further agreed to develop a funding proposal for submission to the African Development Bank. A sub-group was constituted to prepare and circulate for review of the proposal.

(WCF Newsletter, 15 December 2016)
Special issue on clubroot and blackleg diseases of brassicas
The two plant pathogens Leptosphaeria maculans (anamorph Phoma lingam), causal agent of blackleg disease, and Plasmodiophora brassicae Wor., causal agent of clubroot disease, are leading to significant yield and quality losses in both agricultural and horticultural brassica crops worldwide. The increasing economic and social importance of brassica crops, which are hosts to both pathogens, has enhanced and financed international research collaborations over the past two decades.

The European Journal of Plant Pathology has published a dedicated special issue (Volume 145, Issue 3, July 2016). The special issue highlights significant advances in the understanding of both host-pathogen interactions at the populations and molecular level.

Special issue on plant's response to biotic and abiotic stresses and global climate change
Special issues form an important part of Current Plant Biology's contribution to plant science so far, with in total 18 publications on three current topics in plant sciences. The most recent special issue is on "Plant's response to biotic and abiotic stresses and global climate change," Volume 6 (2016) with guest editor, Sushma Naithani.

Horticulture in the movies: Interstellar
The plausibility of the science in the feature film by Christopher Nolan "Interstellar" is dissected by Horticulture Extension Educator, Christopher Enroth on his blog, Green Speak. The film is about a blight killing off the world's food crops.

Vale Mark Schwinghamer (1951 - 2016)
Mark Wayne Schwinghamer was born in St Paul, Minnesota, USA, the eldest of three children. From the very start, Mark was interested in and curious about the natural world around him. In the 50's he lived in a semi-rural area on Long Island, New York near the Great South Bay. Mark would spend hours exploring the surrounding woods, catching tadpoles or examining interesting-looking insects. When he lived in Oregon he often filled the house on weekends with a chant of 'Fish, fish, fish' until his father gave in and took him fly- fishing for trout or steelhead. On family camping trips and bushwalks he was always the first one to reach the top of the peak or cross a stream. He was in his element in the wild and had a life-long love of nature.

Mark was undoubtedly influenced by his father Dr Erwin Schwinghamer (now aged 96), a microbial geneticist who during Mark's years at Long Island worked on radiation - induced mutations in rust fungi and who subsequently researched nitrogen-fixing bacteria. Like his father, Mark was thorough and methodical in his research. Erwin held a 3- year research fellowship with CSIRO in the 1960's, then moved back to the USA (Oregon State University) for a few years and finally back to Canberra with

CSIRO in the 1970's to round out his research career. It was at the Australian National University that Mark did his BSc (Hon) within the Department of Biochemistry (1969- 1972).

Mark began his career in plant pathology as a virologist, and undertook a PhD at the University of Adelaide (1973-77) under the supervision of Professor Bob Symons. His topic of study was the 'Separation and in vitro translation of the four major species of virion RNA of cucumber mosaic virus'. Among the many achievements of his PhD were to demonstrate that the coat protein of this virus was translated from sub- genomic RNA 4 (Schwinghamer and Symons, 1975, 1977). Following completion of his PhD, Mark again returned to the USA to undertake post-doctoral research in the laboratory of Professor Bob Shepherd at the University of California Davis (1977-80). Utilising the skills he had acquired in Adelaide, he investigated the replication of cauliflower mosaic virus. In a final trans-hemispheric migration, Mark returned to the NSW Department of Agriculture at Rydalmere to investigate viroid-like diseases (1980 - 85). One important achievement during this period was the first detection of potato spindle tuber viroid (PSTVd) in Australia, within the potato breeders' germplasm collection at Glen Innes (Schwinghamer and Conroy, 1983). Trace-forward operations led to subsequent detections in experimental plots in Victoria and South Australia, and the mounting of a successful, nationwide pathogen eradication program. The fact that the Australian potato industry remains free of PSTVd no doubt reflects the speed of the incursion response during the '80's. In a second line of research, Mark demonstrated that the graft-transmissible dwarfing agents in sweet orange were in fact viroids (Schwinghamer and Broadbent, 1987a; Schwinghamer and Broadbent, 1987b).

It was in Tamworth, while still working with the NSW Department of Agriculture, that Mark had his longest period in one spot (1986-2013). During this time he contributed to a series of projects investigating both fungal and viral diseases of pulse legumes and canola, including phytophthora resistance breeding in chickpea (Knights et al. , 2008), the characterization of several new species of mastrevirus (Schwinghamer et al., 2010; Thomas et al., 2010; Hadfield et al., 2012; Kraberger et al., 2013), and studies of viral disease aetiology and epidemiology (Schwinghamer *et al*., 1999; Thomas et al. , 2004; Schwinghamer *et al*., 2007; Schwinghamer et al., 2009; Schwinghamer et al., 2014; Yasaka *et al*., 2015). Mark was a significant contributor (eleven sections) to the APS Compendium of Chickpea and Lentil Diseases and Pests (published 2010), described as 'the first ever comprehensive treatise on diseases and insect pests affecting two crops that play an important role in ensuring food and nutritional security to millions of people'. He continued Grains Research Development Corporation-funded research at the University of New England, Armidale, after leaving the NSW Department of Agriculture in 2013.

Mark loved music, and was an accomplished fiddler, guitarist and tin whistler in many bush bands in the USA and Australia. Wallace Cowling met Mark at UC Davis in 1977 while studying for the PhD in plant pathology. Mark soon roped him into playing piano in the "Anchor String and Whistle Band" - named after the San Francisco "Anchor Steam Beer". This bush -band led to many life-long friendships for Mark. Wallace was privileged to be asked to join Mark's wedding as groomsman in Merriwa, NSW. Mark endured major operations in the past two years of his life, but this did not deter his interest and love in music. He passed away from cancer on 2nd September 2016 and his funeral service was 12 September St at Paul's Anglican Church in West Tamworth.

Acknowledgments: I thank Glenn Schwinghamer and Wallace Cowling for personal insights into the life of Mark.

(Andrew DW Geering, The University of Queensland, The Australasian Plant Pathology Society News, December, 2016)

Trevor Jon Wicks (1945 - 2016)

Dr Trevor Jon Wicks, a distinguished and long-standing member of The Australasian Plant Pathology Society (APPS), passed away on 22 August 2016. Trevor was a plant pathologist in the South Australian Department of Agriculture and the South Australian Research and Development Institute (SARDI) for over 40 years. He began as a cadet in 1964 while studying for a Bachelor of Agricultural Science at the University of Adelaide. This was followed by a Master in Crop Protection at the University of Reading, UK and he completed a PhD at the University of Adelaide on Phytophthora crown rot of almonds and cherries in 1987.

Trevor made significant contributions to identification and management of diseases in horticulture, particularly potatoes, onions and grapes. He was involved in identifying onion smut, a notifiable quarantine disease in South Australia, in the 1970s as well as surveys to determine the extent of the problem. Recent research focused on identifying the causal agents of Mallee Onion Stunt, a disease widespread in the South Australian Mallee. Through his strong network of international collaborators, the same disease was later confirmed to occur in the US. Trevor's contribution to the Australian wine sector includes the evaluation of new fungicides and fungicide application and resistance management programs that have revolutionised viticulture. In this, he worked closely with crop protection companies and growers as well as fellow researchers. He was also interested in alternatives to conventional fungicides.

As an affiliate Senior Lecturer at the University of Adelaide, Trevor gave occasional guest lectures and co-supervised or mentored students undertaking Honours, Masters and PhD research projects on diseases of horticultural crops and grapevines. He was also a wonderful mentor to staff at SARDI and numerous other organisations, which he continued to do even after diagnosis of a brain tumour in January this year.

Trevor received the prestigious Graham Gregory Award for horticulture in 1995, a national award recognising outstanding achievements in horticulture, and the Reg Miller award in 2009, for his sustained contribution to the Australian onion industry. On the international stage, Trevor was also highly regarded for his wealth of knowledge and experience in horticultural pathology, and was invited to speak at industry and scientific meetings around the world. Through this he developed a great love of travel, established scientific collaborations between SARDI and many well- known international organisations and was a strong advocate for encouraging students and young scientists to develop their careers through gaining experience overseas.

Trevor is sadly missed by his wife Keren, colleagues, former students and his many friends in the scientific community and

agricultural industries locally and internationally.

(Eileen Scott, The University of Adelaide, and Kathy Ophel Keller, SARDI, on behalf of the management committee, The Australasian Plant Pathology Society News, December, 2016)

Just add water: New discovery in plant-disease mechanism

New research led by plant scientists at Michigan State University has found that too much rain, coupled with prolonged high levels of humidity, can result in more plant disease. The research, detailed in the publication Nature, sheds new light on how climate conditions can influence disease outbreaks in all plants, including field crops, something of concern as we confront climate change.

The scientists discovered that certain virulent bacteria are able to directly inject a protein into a plant's cells that increases the levels of water content in the apoplast, where bacteria live. This, in turn, results in an increase in the prevalence of disease.

"We discovered a new mechanism that allows bacteria to infect plants," said Sheng-Yang He, a University Distinguished Professor of plant biology, an investigator at the Howard Hughes Medical Institute-Gordon and Betty Moore Foundation, and a member of the research team. "What we discovered, in addition to their ability to suppress the plant's immune system, is that bacteria also create a watery environment inside the plant so that they can cause disease."

It has been a long-standing concept among plant scientists that for disease to occur, the plant needs to be susceptible and the pathogen that attacks it must be very virulent. However, said Xiu-Fang Xin, MSU research associate and lead author of the paper, it turns out that's not enough. "What we discovered in this study is that humidity is required for bacteria inside the leaf to accumulate water," she said. "Conditions need to be right. That's why we don't see widespread plant diseases every year."

It's easy to look through past historical weather records to see when a period of high humidity correlated with a disease outbreak. One example: A devastating outbreak of apple fire blight about 10 years ago that wiped out much of west Michigan's apple crop. "The apples are always there and the pathogens that live in them are always there," He said. "That year, there were rains and long periods of high humidity during apple blossom season that created a perfect storm for disease."

The researchers are hopeful that this discovery will guide efforts to prevent future outbreaks. "For example, if we were able to accurately forecast the weather we could take some precautionary measures to prevent this from happening," Xin said.

(EurekAlert, 23 November 2016)

Durable wheat resistance gene that provides resistance to Fusarium head blight

Researchers from USA say they have isolated and cloned a gene that provides resistance to Fusarium head blight, or wheat scab, a crippling disease that caused several billion dollars in direct grower losses in USA wheat fields between 1993 and 2001. Their findings are published online in the journal Nature Genetics. The article details nearly 20 years of research that included nearly 100 scientists, faculty, staff and students, in China and several American universities.

"The breakthrough that we're reporting is the cloning of a resistance gene," Bikram Gill said, Kansas State University (KSU) Distinguished Professor of Plant Pathology and Director of the Wheat Genetics Resource Center. "We have identified the DNA and protein sequence, and we are getting some idea of how this gene provides resistance to the wheat plant for controlling the disease. The cloning of this gene is the key to unlock quicker progress for control of this disease."

A disease that shows up periodically in more humid growing regions, Fusarium head blight caused severe damage in Minnesota and North Dakota in 1993 and subsequent years. Gill noted that a 1993 epidemic in Minnesota, which ruined 50 percent of the state's wheat crop that year, caused an estimated $1 billion in losses.

Fusarium head blight is caused by the fungus Fusarium graminearum, which produces a toxin that makes the crop unfit for human and animal consumption. University of Minnesota Professor of Wheat Breeding and Genetics James Anderson said there are frequent epidemics of the disease reported in the United States, Canada, Europe, Asia and South America.

In 1993, all spring wheat varieties grown in the region were susceptible or moderately susceptible. As recently as 2006, 85% (23 out of 27) of regionally adapted varieties were rated as susceptible or moderately susceptible, whereas today about 35% of varieties are susceptible, partially due to the incorporation of this resistance gene into new varieties. This improvement is the result of two decades of research funded by state and federal programs to help reduce losses to the disease.

KSU faculty and students used sophisticated wheat genome sequencing techniques to isolate the gene. Gill said that Eduard Akhunov, associate professor of plant pathology, prepared a library of "millions of clones" of Sumai 3 DNA. Lead scientists Nidhi Rawat, now at the University of Maryland, and Mike Pumphrey, now at Washington State University, sifted through the library.

"It looks like when the fungus attacks the wheat plant, the resistance gene protein has domains for binding and making pores in the cell wall of the fungus, and stopping it from spreading and infecting the developing grain," he said.

(University of Minnesota News, 17 November 2016)

Trade-offs for viruses in overcoming innate immunities in plants

A paper by Yuri Miyashita et al. titled "Trade-offs for viruses in overcoming innate immunities in plants" was published in August 2016 by Molecular Plant-Microbe Interactions. The abstract is as follows:-

Plants recognize viral infection via an immune receptor, i.e., nucleotide-binding site (NB)-leucine-rich repeat (LRR) proteins. Another immune receptor, receptor-like kinase proteins, which share an LRR domain with NB-LRRs, perceive conserved molecules of pathogens called pathogen- or microbe-associated molecular patterns, but NB-LRRs generally perceive particular viral proteins. As viruses can evolve more rapidly than the host immune system, how do plant immune systems, which rely on the perception of proteins, remain effective? Viral adaptive evolution may be controlled by penalties that result from mutations in viral proteins that are perceived by NB-LRRs. Our recent studies in pea (*Pisum sativum*) suggest a penalty of increased susceptibility to another immune system. When a viral protein mutates to evade one immune system, the virus with the mutated protein becomes more susceptible to another. Such antagonistic pleiotropy of a viral protein by two independent plant immune systems may have precedents. Plants may rely on pairs of immune systems to constrain adaptive evolution by viruses and thereby maintain durable antiviral immunity.

Read paper.

Acknowledgements
Thanks to Grahame Jackson, Greg Johnson, List Korsten, Serge Savary, and Peter Williamson for contributions.