ISPP INTERNATIONAL SOCIETY FOR PLANT PATHOLOGY

PROMOTING WORLD-WIDE PLANT HEALTH AND FOOD SECURITY

INTERNATIONAL SOCIETY FOR PLANT PATHOLOGY

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IN THIS ISSUE:

THE INSTITUTE OF BIOLOGICAL CONTROL, JILIN AGRICULTURAL UNIVERSITY, CHINA

YING HU AND JUNJIE ZHANG

Biological control, a crucial component of integrated plant protection, aims to reduce chemical pesticide use while maintaining healthy crops and ecosystem balance by employing natural enemy insects, along with naturally occurring bacteria, fungi and nematodes to manage pests and pathogens.

The Institute of Biological Control (IBC) at Jilin Agricultural University, China, has dedicated nearly 40 years to promoting sustainable agricultural practices through the development and application of natural enemies and biological control products. IBC have abundant natural enemy resources, including species of *Trichogramma*, *Muscidifurax* and *Aphelinus*, to control agricultural pests. IBC has successfully developed leading technologies in *Trichogramma* breeding and production, including the diapause production technology for *T. dendrolimi*, the co-parasitism and breeding technology for *T. dendrolimi* and *T. chilonis*, the factory production technology for *Corcyra cephalonica* eggs, and the Drone Release Technology for *Trichogramma*. These *Trichogramma* species have been applied to control *Ostrinia furnacalis* (Asian corn borer) and *Chilo suppressalis* (rice stem borer) through wide scale inundative releases over an area of 20.4 Million hectares in northeast China. Additionally, IBC's research concentrates on isolating and developing biocontrol bacteria, specifically *Bacillus* and *Pseudomonas* species, from insects, soil, and plants to manage fungal diseases in corn and soybeans.

"We see a rapidly increasing market demand of biological control products and have reason to believe that biological control will continue to play more critical roles in agricultural production in China in the future," said Junjie Zhang, a Director of IBC.

Left: Members of IBC. In the front row, from left to right: Ms. Wenmei Du, Dr. Ying Hu, Dr. Xue Zhang, Ms. Xianjiao Liu, Dr. Xiumei Wang, Dr. Yangyang Hou. In the back row, from left to right: Dr. Peng Wang, Dr. Changchun Ruan, Dr. Junjie Zhang, Dr. Peng Dai, Dr. Yue Zhao. Top right: Students are packaging the *Trichogramma* balls using an automatic packaging machine. Inset top: Drone is releasing the *Trichogramma* balls in the rice field (Photo credit: IBC).

THE ROAD TO FOOD SECURITY THROUGH BETTER PLANT DISEASE MANAGEMENT

THE UNIVERSITY OF QUEENSLAND NEWS, 25 JULY 2024

The colourful history of plant pathology in Australia since colonisation is the subject of special edition of Historical Records of Australian Science, edited by QAAFI's Associate Professor Andrew Geering.

Despite the challenges of academic isolation and lack of communication, the profession flourished and made many world-first discoveries.

Dr Geering said the issue pays special attention to some of the major plant diseases that affected agriculture in the 19th and early 20th centuries, with several common themes emerging.

"Thre was no scientific specialisation among the early plant pathologists – they were equally adept at researching plant pathogenic bacteria as fungi," Dr Geering said.

Associate Professor Andrew Geering (Photo credit: Megan Pope).

"Joseph Bancroft, the first person to describe Fusarium wilt of banana, was a practicing surgeon in Wickham Terrace in the Brisbane suburb of Spring Hill.

"Secondly, they had to work in isolation, unaware of what was happening in neighbouring states or overseas.

"This makes the discoveries they made even more remarkable.

"Thirdly, the problems of communication and the small scale of research in Australia meant there was slow recognition of the discoveries made here by scientists in the Northern Hemisphere.

"Rupert Best deserved to have been one of Australia's first Nobel Prize winners for his characterisation of tobacco mosaic virus, but his research was not widely publicised overseas."

He said despite the success of agriculture in modern Australia, farmers had to overcome many challenges to grow a crop.

"There was extreme weather variability, shallow and infertile soils and attacks by pests and pathogens.

"Early attempts to transplant European farming practices into Australia often failed, and a great deal of scientific research had to be done before the current level of success was achieved."

Another area of focus of the special issue is biosecurity.

"Our plant quarantine system is the envy of the world," Dr Geering said.

"Richard Davis and colleagues describe the history of the Northern Australia Quarantine Strategy, which has been responsible for providing early warning of plant pathogens like the fungus responsible for black Sigatoka disease in bananas."

But Dr Geering said some of the articles featured show that history should not be viewed with rose-tinted glasses.

"One striking feature of the early history of Australia is the gender bias towards men in professional life as is shown in the career of Gretna Weste, while racial prejudice was widespread in some farming communities," he said.

"Australians of Chinese heritage were the pioneers of the Australian banana industry but had to cope with very discriminatory government regulations that were implemented as part of the White Australia policy.

"There was also strong interstate rivalry between the state governments, which hindered a fully collaborative approach to solving plant disease problems.

"In 1923, the Queensland Minister for Agriculture and Stock refused to cross the state border to meet with his counterpart from New South Wales at Tweed Heads to discuss how a research project on banana bunchy top disease could be jointly funded.

"A class system existed between the formally educated and uneducated, and the contributions of lay farmers to solving plant disease problems were sometimes ignored or not properly recognised."

Articles for this edition are available for full open access on the website for Historical Records of Australian Science.

Banana bunchy top disease (centre foreground), destroyer of the Australian banana industry (Photo credit: UQ).

SPIDER ROBOT TO HELP UNTANGLE CUCUMBER DISEASE

DEE SHORE, NC STATE UNIVERSITY NEWS, 18 JULY 2024

An NC State engineer and plant pathologist work together to create robotics to get ahead of cucurbit downy mildew, a devastating cucumber disease.

Under the control of NC State University biological and agricultural engineering graduate student Zhenghua Zhang, a six-legged, spider-like robot skitters across cucumber rows at the Central Crops Research Station in Clayton.

His faculty mentor, Lirong Xiang, and plant pathologist Lina Quesada-Ocampo are counting on the robot to help get farmers out of the pickle they're in when it comes to combating the worst disease affecting the U.S. crop and its cousins.

NC State graduate student Zhenghua Zhang and assistant professor Lirong Xiang demonstrate their disease-detecting spider robot at the Central Crops Research Station. (Photo credit: NC State University).

For nearly two years, the N.C. Plant Sciences Initiative-affiliated researchers have worked together to come up with ways to help growers better manage cucurbit downy mildew. This summer, they hope to test the robot, which was built in Xiang's lab, on farmers' fields. That wil give them a better idea of whether it will indeed be something growers can use to get ahead of the disease.

Present in the United States since the late 1800s, cucurbit downy mildew causes leaf lesions that can lower yields and even kill plants of the gourd family, including cucumbers, cantaloupes, watermelons, squash and pumpkins.

Growers had long avoided the disease by planting resistant crop varieties. But in 2004, that changed. In an epidemic that was first noticed in North Carolina, the disease devastated once-resistant cucumber varieties, leaving some farmers to abandon their fields rather than harvest them.

As Quesada-Ocampo explains, inexpensive broad-spectrum fungicides didn't work against the disease, so growers had to turn to expensive chemicals to stop their losses.

Not only that, farmers weren't always sure which of these sprays would work against the fungus-like pathogen that causes the disease.

"The growers have this kind of catch-22, where they need to start spraying before the disease comes so that the fungicide is most effective, but they don't want to do it too early, because then it becomes financially difficult for them to be able to afford all those sprays," says Quesada-Ocampo, a William Neal Reynolds Distinguished Professor in NC State's Department of Entomology and Plant Pathology.

"Not only that, the pathogen, which is called *Pseudoperonospora cubensis*, can develop resistance very quickly," she adds. "So sometimes growers will be applying these various expensive sprays, and they're not working. It's like a double whammy. Our goal is to help growers know precisely when to spray and what to spray."

Enter Xiang, who joined NC State's Department of Biological and Agricultural Engineering as an assistant professor in 2022. As a Ph.D. student and postdoctoral researcher at Iowa State University, Xiang had studied agricultural robotics, artificial intelligence and machine vision. Quesada-Ocampo and Xiang talked about ways to partner to take the cucurbit downy mildew project in new directions. Xiang initially designed a vacuum trap that hangs on a cable from the drone and sucks spores from the air.

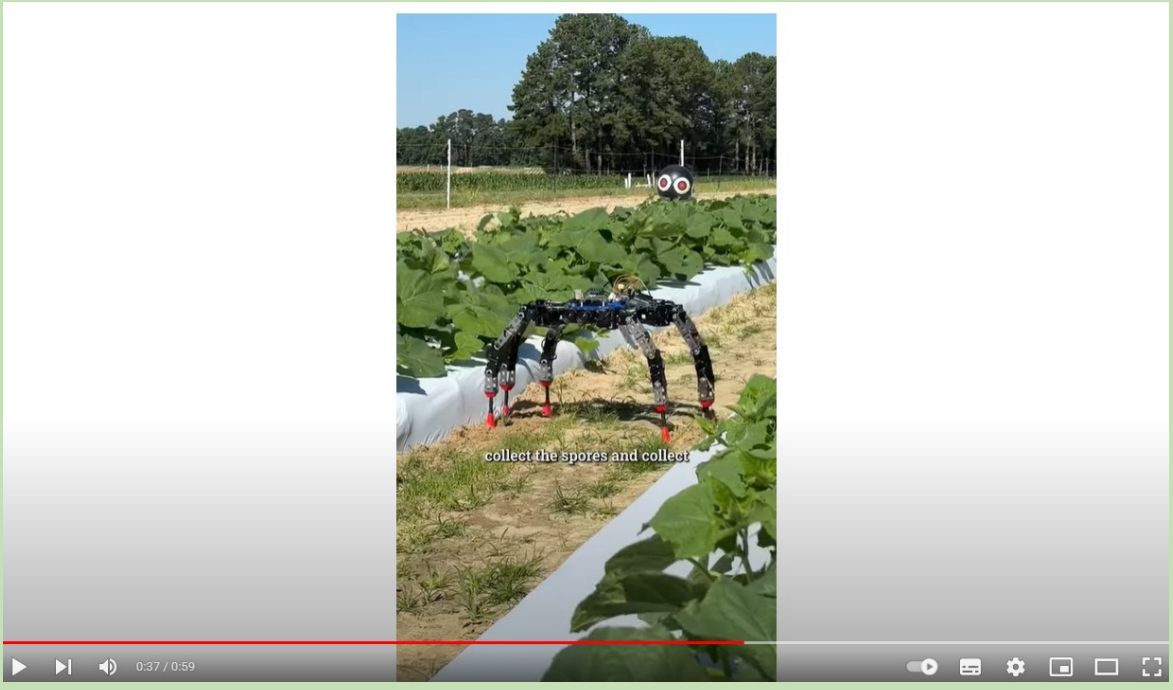
hile it worked better than the traditional stationary trap they'd been using, there were still problems. Spore trapping works best when it happens close to the plant canopy, not from far above, and drone flight restrictions can be an obstacle.

"The trap in the drone works great because it can fly right over the crop canopy and sample large areas quickly, but there may be limitations of using the drone itself in certain areas due to local regulations," Quesada-Ocampo says.

She had another idea: hitching the vacuum trap to a robot. A robot on wheels wouldn't work because it would get tangled in the cucumber vines.

But what about a spider-shaped robot?

Read more.



BIOCONTROL OF PHYTOPATHOGENS-RECENT PROGRESS FOR IMPROVEMENT IN EFFICACY AND UNDERSTANDING ACTION MECHANISM

FRONTIERS OF MICROBIOLOGY, 30 JULY 2024

Biocontrol bears the promise of becoming an appealing solution to plant diseases. Many biocontrol agents are widely investigated and an increasing number of microbes are recognised as biocontrol agent against plant pathogens, but only a few of them have been commercialised. Efforts to field utilisation of biocontrol agents have been limited by an insufficient understanding of the factors that contribute to its biocontrol efficacy and action mechanism which is now a day more than just the initially reported few familiar and general action mechanisms. Now it is crucial to investigate the detail action mechanism of biocontrol agents in order to use them effectively and discourage the chemical management of plant diseases.

There have been many efforts to understand the action mechanism of biocontrol agents. Microscopic, biochemical and microbiological approaches applied over the years have elucidated these mechanisms, but have not fully demonstrated them. In the last decade, the developments in molecular approaches and advancements in omics technologies have yielded innovative strategies for demonstrating and understanding the action mechanism of biocontrol agents and helped to enhance its biocontrol efficacy. The molecular interactions of *Trichoderma* with the plant pathogen and host have been studied. Efforts are on the way to demonstrate the action mechanism of biocontrol agents and improving their biocontrol efficacy.

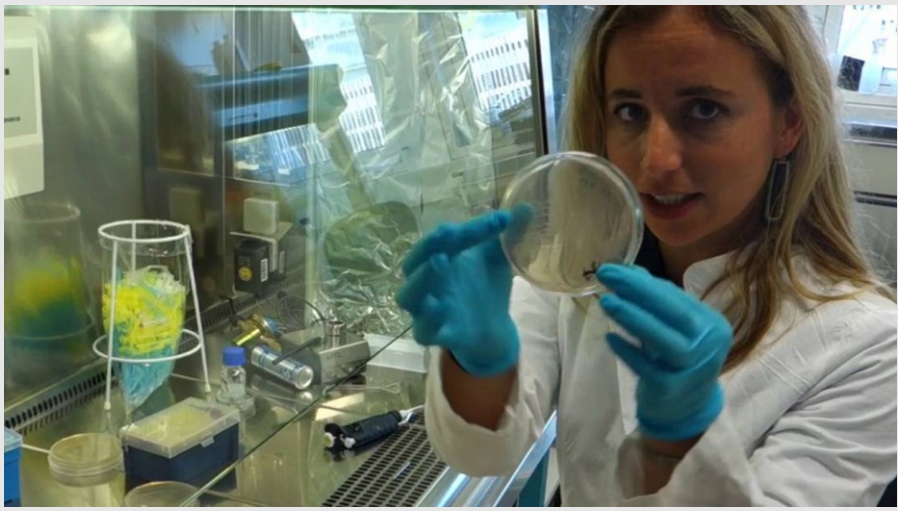
In this research topic of *Frontiers of Microbiology*, 8 articles have been included from volumes 14 (2023) and 15 (2024):

- Editorial: Biocontrol of phytopathogens-recent progress for improvement in efficacy and understanding action mechanism
- Endophytic *Bacillus atrophaeus* CHGP13 and salicylic acid inhibit blue mold of lemon by regulating defense enzymes
- Enhancing plant defense using rhizobacteria in processing tomatoes: a bioprospecting approach to overcoming Early Blight and Alternaria toxins
- *Streptomyces* as a promising biological control agents for plant pathogensGgg
- Characterization of a broad-spectrum antifungal strain, *Streptomyces graminearus* STR-1, against *Magnaporthe oryzae*
- Aptly chosen, effectively emphasizing the action and mechanism of antimycin A_1
- Pre-soil fumigation with ammonium bicarbonate and lime modulates the rhizosphere microbiome to mitigate clubroot disease in Chinese cabbage
- Nematicidal glycosylated resorcylic acid lactones from the fungus *Pochonia chlamydosporia* PC-170 and their key biosynthetic genes

THE PROMISING WORLD OF BACTERIOPHAGES, THE PATHOGEN'S PATHOGEN

BRIAN MAFFLY, THE UNIVERSITY OF UTAH RESEARCH, 13 JUNE 2024

Bacteriophages, viruses that attack and destroy bacteria, are everywhere in the natural world where they play a vital role in regulating microbe populations in ways that are not yet well understood. New research led by the University of Utah and University College London (UCL) has found that plant bacterial pathogens are able to repurpose elements of their own bacteriophages, or phages, to wipe out competing microbes. These surprise findings suggest such phage-derived elements could someday be harnessed as an alternative to antibiotics, according to Talia Karasov, an assistant professor in the University of Utah's School of Biological Sciences.



Talia Karasov (Photo credit: University of Utah).

Microbial pathogens are all around, but only a fraction of the time do they sicken humans, other animals or plants, according to Karasov, whose primary research interest is in interactions between plants and microbial pathogens. The Karasov lab is seeking to understand the factors that lead to sickness and epidemics versus keeping the pathogens in check.

For its prior research, the lab looked at how a particular bacterial pathogen, *Pseudomonas viridiflava*, manifests in agricultural and wild settings. On cultivated land, they found, one variant would spread broadly in a crop field and become the dominant microbe present. But that was not the case on uncultivated land, prompting Karasov to find out why.

"We see that no single lineage of bacteria can dominate. We wondered whether the phages, the pathogens of our bacterial pathogens, could prevent single lineages from spreading – maybe phages were killing some strains and not others. That's where our study started, but that's not where it ended up," Karasov said. "We looked in the genomes of plant bacterial pathogens to see which phages were infecting them. But it wasn't the phage we found that was interesting. The bacteria had taken a phage and repurposed it for warfare with other bacteria, now using it to kill competing bacteria."

According to her study published recently in *Science*, the pathogen acquires elements of the phages in the form of non-self-replicating clusters of repurposed phage called tailocins, which penetrate the outer membranes of other pathogens and kill them. After discovering this ongoing warfare in the bacterial pathogen populations, the Karasov lab and lab of Hernán Burbano at UCL mined the genomes of modern and historical pathogens to determine how the bacteria evolve to target one another.

"You can imagine an arms race between the bacteria where they're trying to kill each other and trying to evolve resistance to one another over time," Burbano said. "The herbarium samples from the past 200 years that we analyzed, provided a window into this arms race, providing insight into how bacteria evade being killed by their competitors."

MINING HERBARIUM SPECIMENS FOR THEIR MICROBIAL DNA

Burbano has pioneered the use of herbarium specimens to explore the evolution of plants and their microbial pathogens. His lab sequences the genomes of both host plants and those of the microbes associated with the plant at the time of collection more than a century ago.

For the phage research, Burbano analysed historical specimens of *Arabidopsis thaliana*, a plant from the mustard family commonly called thale cress, collected in southwestern Germany, comparing them and the microbes they harbored to plants growing today in the same part of Germany.

"We discovered that all the historical tailocins were present in our present-day dataset, suggesting that evolution has maintained the diversity of tailocin variants over the century-scale," he said. "This likely indicates a finite set of possible resistance/sensitivity mechanisms within our studied bacterial population.

Lead author Talia Backman wonders if tailocins could help solve the impending crisis in antibiotic resistance seen in harmful bacteria that infect humans.

"We as a society are in dire need of new antibiotics, and tailocins have potential as new antimicrobial treatments," said Backman, a graduate student in the Karasov lab. "While tailocins have been found previously in other bacterial genomes, and have been studied in lab settings, their impact and evolution in wild bacterial populations was not known. The fact that we found that these wild plant pathogens all have tailocins and these tailocins are evolving to kill neighboring bacteria shows how significant they may be in nature."

Like most pesticides, many of our antibiotics were developed decades ago to kill a broad array of harmful organisms, ones that are both harmful and beneficial to human and plant health. Tailocins on the other hand, have greater specificity than most modern antibiotics, killing only a select few strains of bacteria, suggesting they could be deployed without laying waste to entire biological communities.

"This is basic research at this point, not yet ready for application, but I think that there is good potential that this could be adapted for treating infection," Karasov said. "We as a society have, in how we treat both pests in agriculture and bacterial pathogens in humans, used uniform and broad-spectrum treatments. The specificity of tailocin killing is a way that you could imagine doing more finely tailored treatments."

Hiding in plain sight: A widespread native perennial habors diverse haplotypes of 'Candidatus Liberibacter solanacearum' and its potato psyllid vector

A paper by Jaimie R. Kenney *et al.* titled "Hiding in plain sight: A widespread native perennial harbors diverse haplotypes of '*Candidatus* Liberibacter solanacearum' and its potato psyllid vector" was published on 10 July 2024 by *Phytopathology* (Volume 114 – July 2024). The abstract is as follows:-

The unculturable bacterium '*Candidatus* Liberibacter solanacearum' (CLso) is responsible for a growing number of emerging crop diseases. However, we know little about the diversity and ecology of CLso and its psyllid vectors outside of agricultural systems, which limits our ability to manage crop disease and understand the impacts this pathogen may have on wild plants in natural ecosystems. In North America, CLso is transmitted to crops by the native potato psyllid (*Bactericera cockerelli*). However, the geographic and host plant range of the potato psyllid and CLso beyond the borders of agriculture are not well understood. A recent study of historic herbarium specimens revealed that a unique haplotype of CLso was present infecting populations of the native perennial *Solanum umbelliferum* in California decades before CLso was first detected in crops. We hypothesized that this haplotype and other potentially novel CLso variants are still present in *S. umbelliferum* populations. To test this, we surveyed populations of *S. umbelliferum* in Southern California for CLso and potato psyllid vectors. We found multiple haplotypes of CLso and the potato psyllid associated with these populations, with none of these genetic variants having been previously reported in California crops. These results suggest that CLso and its psyllid vectors are much more widespread and diverse in North American natural plant communities than suggested by data collected solely from crops and weeds in agricultural fields. Further characterization of these apparently asymptomatic haplotypes will facilitate comparison with disease-causing variants and provide insights into the continued emergence and spread of CLso.

Read paper.

Sensitivity of Globisporangium ultimum to the fungicide metalaxyl is enhanced by the infection with a toti-like mycovirus

A paper by Aika Higuchi *et al.* titled "Sensitivity of *Globisporangium ultimum* to the fungicide metalaxyl is enhanced by the infection with a toti-like mycovirus" was published in August 2024 by *Microbiological Research* (vol. 285, 127742). The abstract is as follows:-

In recent years, numerous oomycete mycoviruses have been discovered; however, very few studies have focused on their effects on the host oomycete phenotype. In this study, we investigated the impact of toti-like *Pythium ultimum* RNA virus 2 (PuRV2) infection on the phytopathogenic soil-borne oomycete *Globisporangium ultimum*, which serves as a model species for *Globisporangium* and *Pythium*, specifically the UOP226 isolate in Japan. We generated a PuRV2-free isogenic line through hyphal tip isolation using high-temperature culture and subsequently compared the phenotypic characteristics and gene expression profiles of UOP226 and the PuRV2-free isogenic line. Our findings revealed that the metalaxyl sensitivity of UOP226 was greater than that of the PuRV2-free isogenic line, whereas the mycelial growth rate and colony morphology remained unchanged in the absence of the fungicide. Furthermore, transcriptome analyses using RNA-seq revealed significant downregulation of ABC-type transporter genes, which are involved in fungicide sensitivity, in UOP226. Our results suggest that PuRV2 infection influences the ecology of *G. ultimum* in agricultural ecosystems where metalaxyl is applied.

Read paper.

SHORT SUMMARY ON THE XX INTERNATIONAL PLANT PROTECTION CONGRESS IN ATHENS GREECE

ERIS TJAMOS, CHAIR XX IPPC ATHNES 2024

The XX IPPC congress was very successfully organised in Athens between 1-5 July 2024.

It was a premier scientific event and provided an excellent platform for exchanging information and updating the achievements in plant protection. It offered a valuable opportunity for lively presentations, recognising efforts, and rewarding scientists.

Over 56 concurrent sessions, 11 plenary keynote presentations and 220 posters were presented from a tremendous multi-ethnic and multidisciplinary research community, representing nearly 70 countries worldwide.

As congress organisers, we were delighted under difficult circumstances to have attracted nearly 800 attendees and extremely proud to welcome hundreds of young scientists. More than 300 graduate and postgraduate students, as well as postdocs, attended the congress, exchanged current scientific experiences, and established connections for their future careers.

For program information: ippcathens2024.gr

CURRENT VACANCIES

Professor of Plant Disease Dynamics, The Department of Environmental Systems Science

(www.usys.ethz.ch) at ETH Zurich

The ideal candidate centers their research on the organismal biology of plant-pathogen interactions as related to global environmental problems (e.g., emerging and introduced plant diseases, biodiversity change) and solutions (e.g., ecosystem management, sustainable agriculture). Example topics include (but are not limited to): the drivers of emerging plant diseases (e.g., of agricultural crops, trees, and other plants of concern) and/or the ecological and evolutionary dynamics of plant-pathogen dynamics in species or ecosystems of interest (e.g., agricultural systems, forest ecosystems). Candidates applying integrative toolboxes, by combining field and greenhouse experiments or observations, mathematical modelling, and state-of-the-art tools (e.g., genomics, phenotyping, eDNA), would be a perfect fit for the position. The future professor is invited to take advantage of the opportunities for collaboration offered by the department, where environmental problems and the development of sustainable solutions are central motivators of research by all research groups.

Successful candidates must have established a strong research portfolio and leadership in the field and possess ample experience in teaching and mentoring. The future professor will be expected to teach undergraduate level courses (in German or English) and graduate level courses (in English) within the programs in Agricultural and Environmental Sciences. The hiring package includes base funding at a level commensurate with the appointment.

Closing date: 15 September 2024

More information on job and submit application online.

ACKNOWLEDGEMENTS

Thanks to David Guest, Ying Hu, Grahame Jackson, Greg Johnson, Yong-Hwan Lee, Eris Tjamos, and Junjie Zhang for contributions.

COMING EVENTS

Asian Conference on Plant Pathology 2024
3 August – 7 August, 2024
Changchun, Jilin, China
Website: acpp2024.tri-think.cn

12th International Mycological Congress
11 August – 15 August, 2024
Maastricht, Netherlands
Website: imc12.org

Australasian Soilborne Disease Symposium (ASDS) 2024
27 August – 29 August, 2024 (plus pre and post field trips/workshops)
Peppers Salt Resort and Spa, Kingscliff, New South Wales, Australia
Email: asds@kamevents.com.au
Website: www.asds-apps.com

11th IUFRO *Phytophthora* in Forests and Natural Ecosystems working party
8 September – 13 September, 2024
Bay of Islands (Paihia), New Zealand
Website: www.scienceevents.co.nz/iufro2024

International Phytobiomes Conference 2024
8 October – 10 October, 2024
St. Louis, MO, USA
Website: phytobiomesconference.org

Australasian plant virology workshop (APVW) 2024
29 October – 31 October, 2024
Crowne Plaza, Surfers Paradise, Gold Coast, Queensland, Australia
Email: apvw@kamevents.com.au
Website: www.apvw2024.com.au

9th ISHS International Postharvest Symposium
11 November – 15 November, 2024
Rotorua, New Zealand
Website: scienceevents.co.nz/postharvest2024

16th International *Trichoderma* & *Gliocladium* Workshop
12 November – 14 November, 2024
Lincoln University, Canterbury, New Zealand
Website: www.tg2024.org

International Symposium on Plant Pathogenic Sclerotiniaceae - BotryScleroMoni 2025. Joint meetings of XIX International *Botrytis* Symposium, XVII International *Sclerotinia* Workshop, and II International *Monilinia* Workshop
25 May – 30 May, 2025
Thessaloniki, Greece
Website: botryscleromoni.com

Australasian Plant Pathology Society Conference
26 May – 28 May, 2025
International Convention Centre at Darling Harbour, Sydney, Australia
Website: under construction

14th Conference of the European Foundation for Plant Pathology (EFPP)
2 June – 5 June, 2025
Uppsala, Sweden
Website: www.efpp2025.com

XVII Working Group "Biological and integrated control of plant pathogens." From single microbes to microbiome targeting One Health.
11 June – 14 June, 2025
University of Torino, Torino, Italy
Website: www.iobctorino2025.org

17th Congress of the Mediterranean Phytopathological Union - New phytopathology frontiers of research and education for plant health and food safety
7 July – 10 July, 2025
Ciheam-Bari, Italy
Contact and Email: Anna Maria D'Onghia,e-mail: mpu2025@iamb.it
Website: www.mpunion.org

13th International Workshop on Grapevine Trunk Diseases
21 July – 25 July, 2025
Ensenada, Baja California, México
Contact and Email: Rufina Hernández 13iwgtd@cicese.mx
Website (under construction): 13iwgtd.cicese.mx

14th Arab Congress of Plant Protection Sciences
3 November – 7 November, 2025
Algeria
Contact and Email: hou.boureghda@gmail.com
Website will be developed soon.

8th International Bacterial Wilt Symposium (IBWS)
22 March – 26 March, 2026
Wageningen, the Netherlands
Website: event.wur.nl/ibws2026

International Congress of Plant Pathology 2028
19 August – 25 August, 2028
Gold Coast, Queensland, Australia
Website: www.icpp2028.org

INTERNATIONAL SOCIETY FOR PLANT PATHOLOGY (ISPP)

WWW.ISPPWEB.ORG

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In accordance with the guidelines and recommendations established by the new EU General Data Protection Regulation 679/2016 (GDPR), the International Society for Plant Pathology has created a Privacy Information Notice containing all the information you need to know about how we collect, use and protect your personal data.

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