Bio-Protection
Bio-Protection Science for New Zealand

June 2007

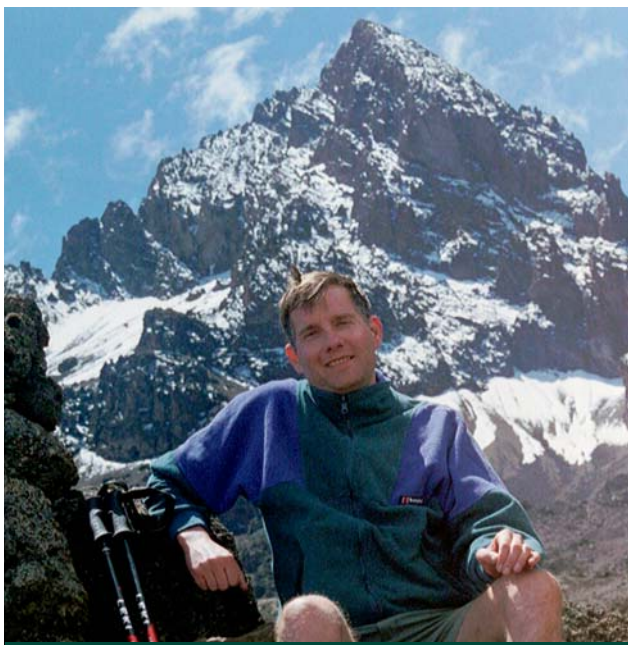
Professor of Plant Biosecurity appointed

The Bio-Protection Centre has achieved an important milestone with the recent appointment of Prof Philip Hulme to a new Chair of Plant Biosecurity. This position is jointly funded by Lincoln University and the Ministry of Agriculture and Forestry.

Biological invasions pose significant threats to natural and managed ecosystems worldwide. Prof Hulme's research aims to provide scientists, conservationists and policymakers with the tools to address these problems. Some key questions are: Can we predict which species will become invasive? How will changes in climate and land-use impact on biological invasions? Which species do we prioritise for management - the most widespread, the most noxious, the easiest to control? Where do we target our resources for the most cost-effective control efforts? Can we deal with the complex issues where alien species provide some benefits as well as some costs? To address these issues, Prof Hulme's research is integrating statistical analyses of large databases, spatial modelling of species distributions, large scale field surveys, and manipulative field experiments.

Prof Hulme says his focus has been on invasive plants with study species including annual weeds, leguminous shrubs and tropical forest trees. "Biological invasions are a global problem and an international perspective is essential since similar problems are often found in different parts of the world. I've been lucky enough to work in the agricultural landscapes of Britain, Arctic tundra of Norway, the Mediterranean shrublands of the Aegean islands, semi-arid caatinga of Brazil, humid tropical forests of Tanzania and the cloud forest of Sri Lanka. These sites reflect the diversity of threats to the world's ecosystems and emphasise that a holistic rather than piecemeal approach needs to be taken if we are to stem the tide of biological invasions."

With this global emphasis, why move to New Zealand? "New Zealand offers both huge challenges and great opportunities. The country faces a higher level of threat from introduced species than many other parts of the globe. Yet, the wide range of invasive problems already here present considerable opportunities, each one offering insights into fundamental issues in invasion biology. There is an urgent need to implement new tools to combat potential threats, but there is also a need for political awareness and implementation of scientific advice into policy."



Prof Philip Hulme, Professor of Plant Biosecurity, and Kilimanjaro.

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CoRE Fund Success

In early June, the Tertiary Education Commission announced that the Bio-Protection Centre had succeeded in its application to the Centres of Research Excellence (CoRE) Fund. This ensures funding for the Centre until 2015, for leading research on bio-protection of New Zealand's managed terrestrial ecosystems.

In this issue

Prof Alison Stewart.

From the Director

The last six months has been a crucial time for the Centre. A significant amount of senior management time has been focussed on preparing the submission to RSNZ for continued TEC funding for the Centre beyond its current contract period. Amongst this, we found time to submit two major grant applications to FRST along with numerous other smaller funding requests. To say that the summer break came and went rather quickly is an understatement. I am confident that our funding applications are of the highest standard, so, whatever the outcomes of these initiatives, there will be no 'if only' excuses made. By mid-July, we should have a clear idea of the Centre's future through until 2015. A positive outcome from the TEC application will provide a stable funding environment and allow Centre researchers the opportunity to focus on continued delivery of exciting research initiatives.

A very important milestone for the Centre has been the arrival of Prof Philip Hulme to take up the Chair in Plant Biosecurity. His experience and expertise is already providing leadership in key aspects of our research.

The Centre welcomes a new cohort of postdoctoral fellows and postgraduate students who begin the second round of three-year research projects. Some of these people are profiled in this newsletter. It is pleasing to see the diversity of their backgrounds and the scope of their research. This edition of Bio-Protection also highlights research successes, from fundamental study of novel pathogenicity genes to the development of commercial biocontrol products. Seeing such a wealth of new knowledge along with tangible benefits for industry is clear evidence of the value that the Centre is delivering to New Zealand's science capability.

It was good to have off-site researchers at Lincoln for the Centre's 'after-Xmas' party. One of the biggest challenges in running a virtual research centre is to create a feeling of unity, and social functions such as this make a big difference in connecting people outside the immediate project teams. We are looking at other initiatives for combined work/social functions in the coming year, particularly focused around our young researchers.

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Enhancing pasture growth with beneficial soil microbes

The Bio-Protection Centre is working in partnership with Agrimm Technologies Ltd and Key Industries Ltd to develop a prototype bio-inoculant product for use in the pastoral sector.

Janet McDermid and Dr Wadia Kandula sample newly-established pasture.

Extensive laborabory and glasshouse screening trials, as part of the Centre's FRST-funded programme "Sustainable Bio-Protection of NZ's Productive Ecosystems", have identified a number of beneficial fungi. These are able to suppress damping-off diseases and promote plant growth in a number of different pasture species.

The best four fungi (all strains of beneficial soilborne *Trichoderma* spp.) were combined into a prototype pasture seed additive (PSA) product. This is being evaluated by Dr Wadia Kandula (Bio-Protection Centre) and Mrs Janet McDermid (Agrimm Technologies) in large scale field trials at Lincoln University and on-farm trials throughout the Canterbury region.

The PSA product is a prill formulation developed by Agrimm Technologies. The prills are mixed with pasture seeds and applied using standard seed drilling equipment. The PSA treated blocks have shown improved seedling establishment and increased pasture dry matter (10-40%) relative to untreated control blocks, for all trial sites. On-going experiments and trials are aimed at increasing our knowledge of the interaction of the PSA product with other farming practices, such as plant protection sprays and fertiliser application. An expansion of field testing is planned for the coming summer, aiming to develop full technical specifications for a new commercial product.

The research and commercialisation team in this project includes Prof Alison Stewart, Dr Wadia Kandula and Dr Peter John (Lincoln University), Dr John Hunt, Mr David Gale and Mrs Janet McDermid (Agrimm Technologies Ltd) and Mr Frank Visser (Key Industries).

Untreated (left) and PSA-treated establishing pasture.

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Workshop on soil/plant/microbe interactions and plant health

Soil biology is of intense international research interest, and is of critical importance within New Zealand, as the role and function of soil biota in maintaining plant productivity and health is increasingly recognised. Plant health is largely determined by soil biological processes that influence the occurrence and activity of both beneficial and pathogenic microorganisms.

Workshop organisers Prof Leo Condron and Dr Maureen O'Callaghan, with keynote speakers Dr Alan Richardson and Dr Mark Osborn.

Microbes also play key roles in the dynamics of organic matter and associated major nutrients. The rhizosphere is the biological 'engine room' of soil-plant systems, and improved understanding of the complex interactions between plant and soil biological health will lead to improved plant and crop productivity. Research in this area is inherently challenging and demands multidisciplinary approaches using leading-edge methodologies and facilities. The Bio-Protection Centre is ideally positioned to significantly advance soil biology research, by bringing together the appropriate blend of skills and expertise in plant pathology, biocontrol, soil microbiology and molecular biology, together with the unique NZ Biotron facility.

The recent workshop on soil/plant/microbe interactions and plant health (April 11-12) identified and co-ordinated key science capabilities by updating researchers of new developments in research trends, facilities and techniques, and identifying knowledge gaps and new research opportunities. A key outcome will be rapid uptake of the most recent techniques and their application to research questions within New Zealand's productive sectors.

Keynote addresses were presented by Dr Mark Osborn (University of Sheffield, UK) on the role of microbial diversity in soil ecosystem function; and Dr Alan Richardson (CSIRO Plant Industry, Australia), who described how rhizosphere processes influence plant growth.

Forty delegates participated in the workshop, including researchers from CRIs (AgResearch, Crop & Food Research, Ensis, ESR, HortResearch, Landcare Research), staff and students from Lincoln and Massey Universities, together with industry representatives. Four sessions covered the keynote addresses together with specific topics relating to the general areas of plant pathology and environmental microbiology, rhizosphere and soil biology, and new methodologies.

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Taewa (Māori potatoes) show commercial promise

A young Tutaekuri plant with developing tubers.

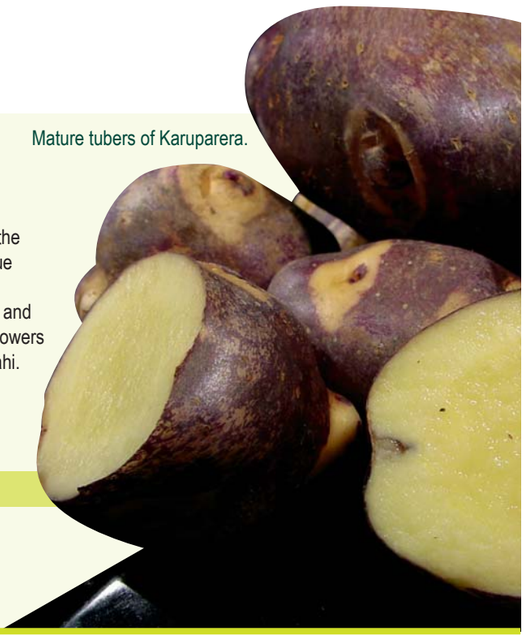
During the 2006/07 cropping season an agronomy trial was completed with three taewa varieties (Huakaroro, Moemoe and Tutaekuri) and one conventional potato cultivar (Rua). As taewa are a new crop for commercial production, little is known about their physiology, responses to soil, climatic or biological influences, or their handling and storage characteristics.

The trial was repeated on sites at Lincoln, Palmerston North and Hastings. The crops were managed throughout the season, and data collected on tuber initiation and crop assimilate partitioning from week 4 after planting to harvest (approx 12 weeks after planting). The information gained will contribute to knowledge upon which efficient management of commercial taewa crops will be based.

All three sites provided unique situations for the trials. The Hawkes Bay site had an early start to the season, on a soil which becomes very dry. At the Palmerston North site crop growth was slow due to cold, wet spring and early summer weather. Similarly, the Lincoln site was planted later in the season and experienced cool damp conditions. Kaitiaki (managers for the trials) were Te Ari Prendergast and Dr Shaun Ogilvie (Lincoln), Brad Tatere, Applied Science (Horticulture) graduate (Hastings), and Nick Roskruge (Palmerston North).

All three plots produced good sets of data which are being analysed to determine future research directions. As expected cv. Rua gave a more consistent tuber set of fewer numbers and better size than the taewa varieties. Tutaekuri (see photo left) and Huakaroro both set large numbers of tubers from reasonably strong foliage growth, but too many tubers often leads to small final produce. Moemoe was the weakest of the varieties, possibly responding to the cold early season conditions.

The trials were a valuable introduction to the physiology of taewa. The trials will continue during coming seasons, to consolidate information and incorporate it into cultural and commercial management packages for growers of taewa crops. Nga mihi atu ki nga kaimahi.



Mature tubers of Karuparera.

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Red band needle blight of pine trees - dispelling a myth

Dothistroma needle blight has affected pine plantations in the Southern hemisphere for many decades. The disease is reaching epidemic levels in parts of the Northern hemisphere, where increased needle blight severity has been correlated with climate change.

This disease is being studied by Bio-Protection Centre researchers at Massey University, including Dr Rosie Bradshaw working with Arne Schwelm (PhD), Naydene Barron (MSc) and summer student Justine Baker, with Margaret Dick (Ensis, Forest Biosecurity and Protection).

Pine needles infected with the *Dothistroma* pathogen usually display red bands containing a fungal toxin, dothistromin. This compound is highly toxic to plant tissue, and was thought to be a key component used by the fungus to invade and colonise pine needles.

The Massey team are determining the role of dothistromin in needle blight. Mutant strains of the fungal pathogen were made that do not produce dothistromin, and these have been tested for their ability to infect pine needles. The mutant strains were labelled with a green fluorescent protein that enabled them to be distinguished from toxin-producing wild-type strains. The mutants were able to cause needle blight (see photo), demonstrating that dothistromin is not an essential attack weapon for the pathogen.

What, then, is the role of dothistromin? A clue comes from the observation that dothistromin is produced during the early growth stages of the fungus. This is unusual for fungal secondary metabolites, which are usually produced by older cultures. Early dothistromin production suggests that the toxin may enhance the competitive ability of the pathogen against other fungi on needle surfaces. Growth inhibition studies with competitor fungi have supported this hypothesis (see photo). A few competitor fungi, however, were able to resist the effects of the toxin and overgrow the *Dothistroma* pathogen. These are candidates for biocontrol of Dothistroma needle blight.

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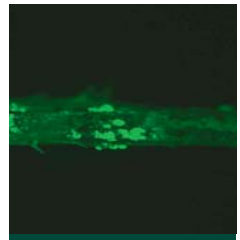
Pine needle infected with a toxin-deficient *Dothistroma* mutant.



Under UV light the mutant fluoresces.

Dothistroma (left) inhibits growth of a competitor fungus (right).

Genetics of the Brassica clubroot pathogen

Simon Bulman has successfully defended his PhD thesis, which described research on *Plasmodiophora brassicae*, a protozoan pathogen that causes clubroot in Brassicas. These include cabbage, cauliflower and animal forages (kale, turnip and rape). Clubroot is the most important soilborne disease of these plants, capable of completely destroying crops, preventing growing of crops in infested land, or drastically reducing crop productivity through damage to plant roots.

Recently a molecular defence system (RNA interference; RNAi) has been discovered in eukaryotic cells (the subject of the 2006 Nobel Prize for Medicine). The aim of Simon's research was to re-target the RNAi in plant cells to degrade genes from *Plasmodiophora*. He created transgenic *Arabidopsis* plants with a modified RNAi system targeting the *Plasmodiophora* actin gene, and then infected the plants with *Plasmodiophora*. Using a number of techniques he showed, however, that the modified RNAi did not affect clubroot development. *Plasmodiophora* either did not take up the RNAi signal from the host plants, or did not propagate the RNAi.

Despite RNAi in transgenic plants appearing not to hold promise as a clubroot control strategy, Simon's research has made several important advances. Beforehand, little was known about the molecular biology of *Plasmodiophora* or its relatives, because they cannot be grown and studied in culture. Simon identified a new collection of genes from *Plasmodiophora*, providing important clues about the lifecycle of the organism. He also found that the structure of these genes was unusual for a parasite living inside the cells of its host.

"The Centre-funded project allowed me to carry out fundamental studies that complement applied work at Crop & Food Research," says Simon. That work concentrates on detection of *Plasmodiophora* in soil and development of practical clubroot management methods. During the project he also strengthened relationships with researchers in Canada, Germany and Denmark. These collaborations will continue in a new Centre postdoctoral project on the roles of proteins secreted by *Plasmodiophora* into plant cells.

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Transformed (GUS reporter gene) *Arabidopsis* plant infected with clubroot.

Dr Mike Watts, Dr Sue Worner and Dr Dean Paini (seated).

Centre collaboration with the CRC for Plant Biosecurity, Australia

Assessing the risk of a new species invasion into a new area is usually done on a species by species basis. Species that have suddenly become troublesome elsewhere in the world are prime targets. The real problem, however, is that biosecurity agencies are faced with lists of many hundreds of species that could potentially invade New Zealand. There have been few tools that allow those species to be prioritised for their threats to New Zealand or any country. Methods developed at the Centre can now do just that.

A total of 844 insect plant pests have been ranked with regard to those that most threaten New Zealand. In March, the Centre hosted Dr Dean Paini, a post-doctoral fellow from the newly established Australian Co-operative Research Centre (CRC) in National Plant Biosecurity. Dr Sue Worner of the Bio-Protection Centre and the CRC have a collaborative project to identify and prioritise new or pre-emergent insect and plant disease threats to Australia. This work will be carried out by Dr Paini over the next 3 years. He visited Lincoln to become familiar with the analysis methods, computational intelligence models, and special purpose computer programs that have been developed by members of Dr Worner's team.

This research will allow specific insect and disease threats to various states or territories throughout Australia to be ranked as either high, medium or low risks of establishing. Following additional research carried out by Dr Worner's team, other models will be used to identify climate variables that most influence pest establishment and investigate the potential impact of climate change on specific pest threats. The results will also be compared with standard approaches for pest prioritisation.

Previous research carried out by the Bio-Protection Centre team has been applied using data at a global scale. The benefits of this collaboration are the additional assessment of the utility of the methods and validation of the approaches developed by Dr Worner's team over small geographic areas, giving greater resolution. A particularly important aspect to this collaboration is that Dr Paini brings the valuable combination of ecological knowledge and excellent computer skills. This research will add new components to the risk assessment toolbox for biosecurity agencies and managers in both New Zealand and Australia.

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Exploiting the host finding behaviour of thrips

How do thrips find their dinner? How do they respond to plant colour and odour cues from crops? Can thrips directly follow odour paths upwind to a host plant?

These are the sort of questions being considered by Kenneth Webster, who has commenced a PhD project on thrips' host-finding behaviour. Thrips are some of the most important insect pests in greenhouses and field crops, where they transmit viruses, cause crop damage and contaminate export produce.

"By understanding the way thrips come to alight on their host plants, we hope to increase growers' knowledge about how to use traps and lures for these insects more effectively," says Kenneth.

"We know thrips are migrating on air currents; at some point it is likely that their behaviour switches so that they are stimulated to locate host plants. My research is designed to identify the sequence of steps that allow thrips to locate and successfully land on a host."

The project will build on research already gathered and published by Kenneth's supervisors who include Dr David Teulon (Crop & Food Research), Associate Professor Bruce Chapman (Lincoln University) and Drs Willem Jan De Kogel and Rob van Tol (Plant Research International, Netherlands).

Funding for the project is from the Bio-Protection Centre and Plant Research International. The co-operative nature of the project will see Kenneth spending research time both in New Zealand and the Netherlands.

Up to three commonly available thrips species will be used: New Zealand flower thrips, onion thrips and western flower thrips. The first two are commonly found in the field in New Zealand, while onion and western flower thrips are also found in greenhouses here and in the Netherlands.

Perhaps one of the most challenging aspects of the project is finding the right sticky trap to use in field research. Already Kenneth is on the way to developing a large prototype which should yield new information. These traps will have central colour and odour cues which will help to distinguish the importance of each to the target pest. Also under development are custom sticky traps for testing thrips response to odour without visual interference.

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Dr David Teulon and Kenneth Webster examine field trap insect samples.

Kenneth traps insects beside his large field thrips trap.

Dr Rob van Tol, Wageningen.

Prominent visitors to the Bio-Protection Centre

The Centre has hosted several prominent people and research collaborators from New Zealand and overseas during recent months. Some key visitors were:

Dr Jeom Soon Kim, plant pathologist, National Institute of Highland Agriculture, Republic of Korea
Mr Ji Hong Cho, potato breeder, National Institute of Highland Agriculture, Republic of Korea
Dr Dan Funck Jensen, plant pathologist (biocontrol), Department for Plant Biology, Royal Veterinary and Agricultural University, Denmark
Prof Richard Sikora, soil biologist (nematology), Bonn University, Germany
Dr Ueli Merz, plant pathologist, Swiss Federal Institute of Technology, Switzerland
Dr Matthew Thomas, entomologist, CSIRO Entomology, Australia
Dr Martin Grabert, Director, COST, European Science Foundation, Belgium
Ms Melae Langbein, NZ Ministry of Research Science & Technology, Belgium
Dr Sang Ki Rhee, President, Korea Research Institute of Bioscience & Biotechnology, Republic of Korea
Dr Sang-Soo Kwak, Director - Environmental Biotechnology, Korea Research Institute of Bioscience & Biotechnology, Republic of Korea
Prof Eun Woo Park, plant pathologist, Seoul National University, Republic of Korea
Rt Hon Jim Anderton, Minister for Biosecurity, Minister of Agriculture & Forestry
Prof John Porter, agroecologist, University of Copenhagen, Denmark
Prof Tony Shelton, entomologist, Cornell University, USA

Rt Hon Jim Anderton (Minister of Agriculture, Minister of Biosecurity) discusses operation of the NZ Biotron.

Dr Soeren Navntoft, insect ecologist, University of Copenhagen, Denmark
Dr Dean Paini, insect ecologist, Co-operative Research Centre in National Plant Biosecurity, Australia
Dr Yong-Uk Shin, Director, Fruit Research Division, National Horticultural Research Institute, Republic of Korea
Dr Seung-Ryong Cheong, Director, Horticulture Environment Division, National Horticultural Research Institute, Republic of Korea
Dr Edward Page, Extension Agent, Colorado State University, USA
Ms Laura Collins, Extension Officer, Teachers' Refresher Course Committee, Wellington
Mr Bruce Archibald, Deputy Minister, Agriculture, Food & Rural Affairs, Canada
Mr Paul Meibusch, Grains Research & Development Corporation, Australia
Mr Ken Kirkpatrick, Policy Advisor, Department of the Prime Minister & Cabinet, Wellington

Assoc Prof Graham F Harris (1950-2006)

The sudden death of Graham Harris of the Open Polytechnic of New Zealand has been a severe loss for New Zealand ethnobotany and for the Mātauranga Māori Theme in the Bio-Protection Centre. Graham was an expert on Māori potatoes and was a recipient of a Slow Food Award in 2001 for his efforts to collect, conserve and outline the history of early New Zealand potato cultivars. In October 2006 he travelled to the latest Slow Food Conference in Turino, Italy. He was also a member of the Linnaean Society of London, and had recently completed a seminal paper, "Te Paraiti: the 1905-1906 potato blight epidemic in New Zealand and its effects on Māori communities".

Graham was instrumental in producing the first distance education course in ethnobotany in New Zealand. The Plants and People course is an elective in the Open Polytechnic of New Zealand's Environment major for the BApplSc degree, introducing students to ethnobotany, with focus on Māori plant use and lore. He also initiated the introduction of a Māori Art and Design Programme, teaching traditional crafts of carving and weaving, in collaboration with local Māori groups. He assisted Māori groups as an advisor on many plant-related matters and property rights issues.

Graham's research interests ranged from modern horticulture to the history of pre-European food plants, including kūmara, bracken fern, and taro. He had extensive knowledge of early post-contact Māori agriculture and the uses of New Zealand indigenous plants, publishing widely on these subjects. His Bio-Protection Centre projects included kūmara production and storage using traditional cultivars, bracken fern rhizome properties and effects of historical plant disease epidemics.

Assoc Prof Graham Harris and wild taro near Chiang Mai, Thailand, June 2006.

Through the Bio-Protection Centre, the Society for Economic Botany and other institutions, Graham had established extensive international networks of ethnobotany contacts. The annual Society for Economic Botany meetings were a highlight of his activities, including the 2006 meeting where researchers participated in a wild taro hunt in the hills around Chiang Mai. (See photo).

Graham is survived by his wife Lexie, son Delaney, daughter Ricci and three grandchildren.

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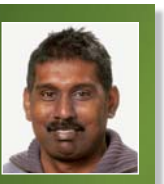
Bio-protection Centre Postgraduate Students

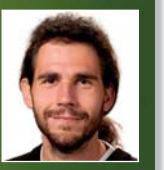
In this and future issues of Bio-Protection, profiles of postgraduate students and their projects are given for students associated with the Bio-Protection Centre.



Jeyaseelan (Seelan) Baskarathevan is from Sri Lanka. He completed a Masterate in Plant Science at Wageningen University, The Netherlands. His PhD project is "Identification and genetic diversity of *Botryosphaeria* pathogen species prevalent in New Zealand vineyards".
[Supervisor Dr Hayley Ridgway, Associate Supervisor Dr Marlene Jaspers]

Carolyn Bleach completed her Bachelor of Viticulture and Oenology at Lincoln University. Her PhD topic is "Management of Cylindrocarpon black foot disease of grapevines", on a Technology in Industry Fellowship.
[Supervisor Dr Marlene Japers, Associate Supervisor Dr Eirian Jones, Industry Mentor Mart Verstappen (Corban's Viticulture)]

Celine Blond is from the National Superior School of Agronomy, Rennes, France where she completed a Masterate. Her PhD project is "To examine the fate and dynamics of fungal inoculum in soil".
[Supervisor Dr Hayley Ridgway, Associate Supervisor Assoc Prof Bruce Chapman, External Supervisors Drs Michael Brownbridge and Travis Glare (AgResearch)]

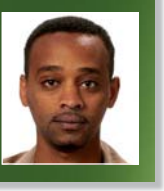


Pierre Hohmann studied biotechnology at the University of Applied Sciences, Bingen, Germany. His PhD project is "Ecological studies of *Trichoderma* bio-inoculants in the soil ecosystem of *Pinus radiata*".
[Supervisor Dr Eirian Jones, Associate Supervisor Prof Alison Stewart, external advisor Dr Robert Hill (Bio-Discovery Ltd)]

Milena Mitic completed a BSc at Belgrade University. Her PhD project will investigate the role of Ca++ signalling in the symbiotic interaction between *Epichloë festucae* and perennial ryegrass. She will be supported by a studentship from a Marsden grant.
[Supervisor Prof Barry Scott, Co-supervisor Dr Jasna Rakonjac]

Sophia Orre is from Finland & completed her undergraduate degree in Sweden. Her PhD project is "Attract & reward for ecological engineering of biological control", funded by an Education NZ PhD Scholarship. She is collaborating with Prof David James (Washington State University) & Prof Geoff Gurr (Charles Sturt University).
[Supervisor is Prof Steve Wratten, Associate Supervisor Dr Mattias Jonsson]

Kenneth Webster completed his BSc (Hons) at the Australia National University. His PhD project is "Exploiting the host-finding behaviour of thrips: underlying principles".
[Supervisors Assoc Prof Bruce Chapman, Dr David Teulon (Crop & Food Research), external Co-supervisors Drs Rob van Tol and Willem Jan de Kogel (Plant Research International, The Netherlands), Associate Supervisor Dr Roddy Hale]



Yonas Workneh is from Ethiopia and he completed his MSc degree at the University of Ghent, Belgium. His PhD project is "Influence of soil biotic factors on the ecology of a *Trichoderma* biological control agent".
[Supervisor Prof Alison Stewart, Associate Supervisor Dr Kirstin McLean, External Advisor Dr Sarah Dodd (Landcare Research)]