Plant Health and Environment Laboratory annual report

The Plant Health and Environment Laboratory (PHEL) of Biosecurity New Zealand, Ministry for Primary Industries (MPI) is New Zealand's national plant health reference laboratory, responsible for identifying organisms of biosecurity concern and confirming all suspected new plant pests, diseases and invasive plants found in New Zealand. We help to protect New Zealand's primary industries and the environment from exotic organisms and reassure our trading partners that New Zealand is free from unwanted pests and diseases. This report gives an overview of PHEL activities from 1 July 2023 to 30 June 2024.

About us

PHEL has two well-equipped laboratory facilities located in Auckland and Christchurch, and New Zealand's only level 3B post-entry quarantine (PEQ) greenhouses at two locations in Auckland. PHEL is accredited to the ISO 17025 standard (General requirements for the competence of testing and calibration laboratories) by International Accreditation New Zealand (IANZ) and has fixed and flexible scope accreditation for PCR testing and morphological identification of fungi, invertebrates and plants. Our staff are highly skilled and include 27 technical personnel who are accredited to sign off laboratory test results.

We have physical containment level 2 (PC2) and level 3 (PC3 – invertebrate rearing) laboratories, a level 3B PEQ greenhouse and level 3 tissue culture facilities. The laboratories have highly specialised and advanced equipment including a transmission electron microscope (TEM) and high-throughput sequencing (HTS) platforms. PHEL also actively curates numerous reference and data collections, including important exotic invertebrates, plant virus and herbarium collections.

Our services

Diagnostics

PHEL provides a range of diagnostic services to identify bacteria, fungi, insects, mites, nematodes, oomycetes, phytoplasmas, liberibacters, viroids, viruses and unwanted plants.

In 2023/24 PHEL processed 4,946 submissions (each usually consisting of multiple samples) and completed 96,261 tests (**Table 1**). We provided a range of diagnostic techniques including microscopy (stereo, compound and TEM), molecular testing (end-point and real-time PCR, loop-mediated isothermal amplification, Sanger and HTS sequence analysis), as well as serological (e.g., ELISA) and biochemical tests to screen and identify suspected unwanted organisms (**Figure 1**).

Figure 1: Plant Health and Environment Laboratory staff processing samples for bee mite surveillance diagnostics (left); inspecting plants at the post-entry quarantine greenhouse (middle); and testing suspected infected plant material using molecular diagnostics (right)

Table 1: Summary of diagnostic testing carried out at Plant Health and Environment Laboratory from 1 July 2023 to 30 June 2024

Purpose of testing	**Description**	**Number of tests**
Border diagnostics	Testing samples of suspect exotic pests and diseases found during the inspection of imported goods and produce at the border and pre-border (including post-entry quarantine)	25,152
Domestic testing	A tailored plant disease testing service to support industry needs for clean planting material	3,347
Export pre-clearance	Testing to ensure that products leaving New Zealand meet the import requirements of our trading partners	319
Post-border diagnostics	Testing samples from recently imported material to determine if the pest or disease could have been introduced from overseas	819
Response diagnostics	Providing diagnostic services during a biosecurity incursion. In 2023–2024 these included potato spindle tuber viroid, and subterranean termite (*Coptotermes acinaciformis*)	2,476
Surveillance and investigation testing	Testing samples from various surveillance programmes including general surveillance, high-risk sites, forest biosecurity, fruit fly, arbovirus, bee mite and national invasive ant; scale on black currents, brown marmorated stink bug trapping and public awareness of stink bugs	63,593
Other	Providing diagnostic services for overseas cost-recovered testing, overseas insect collections and proficiency testing programmes	555

Pest and disease notifications

Each year PHEL receives notifications of suspect new-to-New Zealand pests and diseases. Notifications are reported through the exotic pest and disease hotline (0800 80 99 66) or online (https://report.mpi.govt.nz/pest/).

In 2023/24 PHEL processed about 2,200 notifications, with the months of January to March being the busiest (**Figure 2**). Suspect brown marmorated stink bug notifications made up a large proportion of these notifications (32 percent). The remainder of the notifications were mostly of native or established organisms, with some leading to incursion investigations.

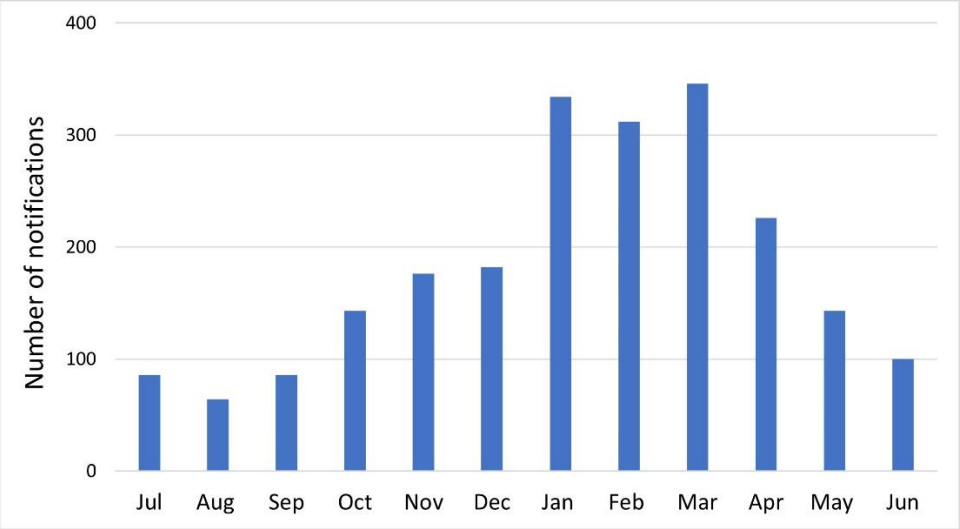

Figure 2: Number of suspect exotic pest and disease notifications processed by Plant Health and Environment Laboratory 2023/24

Plant post-entry quarantine

PHEL is currently the sole provider of level 3B PEQ services in New Zealand. This stringent level of quarantine is required for high-risk, high-value imported plant germplasm such as berry crops, kiwifruit and grapevines. PEQ ensures that the material is free from unwanted pests and pathogens before being released. Plants undergo a series of tests and regular inspections to screen for regulated pests and diseases.

In 2023/24 we handled 80 imported cultivars in our PEQ level 3B greenhouse. These included apple, apricot, avocado, blackberry, blueberry, cherry, grapevine, kiwifruit, kumara, lemon, peach, raspberry, strawberry and sweet orange. Thirty cultivars were released, and the remainder are due for release in 2024/25. Imports arrived from Australia, France, Israel, Italy, Japan, Korea, the Netherlands, South Africa and the United States.

Technical advice

Our scientists often work with stakeholders to provide technical and scientific advice. We advise on border interceptions, organism biology, phenology and taxonomy, and reply to media queries. We also review diagnostic protocols, manuscripts, external project reports, risk assessments, pest lists

and import health standards, as well as the robustness of science in MPI-funded projects. Since July 2023, PHEL has received and processed 474 requests, mostly from other MPI teams, local government bodies, Government Industry Agreement partners, growers and importers.

Our facilities

New greenhouse facility in Auckland

PHEL's new level 3B greenhouse facility build at the Mount Albert Research Centre in Auckland was completed in February 2024 (**Figure 3**). Following completion, the facility underwent biological commissioning to ensure that the 12 new greenhouse units are suitable for plant growth and the associated systems meet the requirements outlined in the standards. The greenhouses are expected to receive the first imported plants in September 2024.

The addition of the 12 new level 3B greenhouses will nearly double MPI's capacity to process imported plant material and provide more opportunities for industry to introduce new plant varieties from overseas. PHEL has also introduced a new PEQ space booking and prioritisation policy that provides greater transparency about how greenhouse space is allocated and gives importers new options to secure the PEQ space they need.

Figure 3: An aerial view of the new level 3B post-entry quarantine greenhouse facility in Mount Albert, Auckland (left); and plants in one of the 12 units that were used for biological commissioning (right)

Plant Health and Environment Capability (PHEC) Programme

The PHEC programme is progressing the design of a new Plant Health and Environment Laboratory and greenhouses to replace our existing facility in Auckland. Our staff have been heavily involved in the design as it has progressed through concept, preliminary and developed design phases. The final detailed design phase will begin in the third quarter of 2024.

The new PHEL (**Figure 4**) will be located at the same site as our newly completed greenhouses at Mount Albert Research Centre in Auckland, and early site preparation has begun.

Figure 4: Artist's impression of the new Auckland Plant Health and Environment Laboratory in Mount Albert, Auckland (subject to change), showing the entry, office and laboratory areas (left to right)

Quality assurance

Our quality system and culture underpin PHEL's effectiveness and credibility to deliver high-quality and timely diagnostics and meeting stakeholders' requirements and expectations. Our systems, work processes and test performance are assessed annually through internal and external audits that help to introduce business improvements and ensure that we comply with the testing standard ISO 17025:2018. Following the latest external audits in 2023, PHEL continues to maintain its ISO 17025:2018 accreditation and MPI facility certification for the Auckland and Christchurch laboratories.

In 2023/24, 11 new PCR assays were added to the list of PHEL's IANZ-accredited assays under the flexible scope (1.70). This has increased the number of our IANZ-accredited PCR assays to 44. We also conducted a two-day internal auditor training workshop at PHEL to develop staff auditing skills and increase the pool of internal auditors.

We also received an authorisation from the Ministry of Health to test cannabis material for the presence of plant pathogens. This approval helps to test for and investigate suspect plant diseases in imported or domestically grown cannabis plant samples.

Over the last year, PHEL introduced a virtual dashboard for tracking our performance. The dashboard helps visualise and track key metrics which assist with developing improvement strategies where needed.

National and international networks

PHEL maintains an extensive national and international network of contacts that ensures access to reference material, technical advice and scientific collaborations. PHEL scientists are well connected with Crown research institutes and universities in New Zealand through contributing to collaborative projects, delivering invited presentations and interacting with professional associations.

PHEL represents MPI in the Better Border Biosecurity (B3) programme and contributed to several projects in the past year. We were actively involved in 12 projects related to diagnostics, risk assessment and pathway risk management and contributed as stakeholders to these projects.

PHEL staff collaborate with many overseas quarantine laboratories involved in national plant protection work including the United States Department of Agriculture (USDA), the French Agency for Food, Environmental and Occupational Health and Safety (ANSES), the United Kingdom's Department for Environment, Food & Rural Affairs (DEFRA), the Australian Department of Agriculture, Fisheries and Forestry (DAFF), the Canadian Food Inspection Agency (CFIA) and Fera Science, United Kingdom, as well as a number of universities and research institutes. We also represent New Zealand on international plant protection bodies providing leadership in biosecurity diagnostics.

Table 2 highlights some of the active collaborations in 2023/24 and their significance.

Table 2: Plant Health and Environment Laboratory's most significant international collaborations and their major outcomes in 2023/24

Collaboration partner	**Activities**	**Outcomes in 2023/24**
International Plant Protection Convention (IPPC)	Development and review of diagnostic protocols and reviews of International Standards for Phytosanitary Measures	Co-authored the draft diagnostic protocol for the identification of *Amaranthus palmeri*. Two protocols that PHEL scientists contributed to (DP 32 *Ceratitis,* fruit fly; DP33 *Mononychellus tanajoa,* cassava mite) have been adopted. Contributed to the development of *Xylella fastidiosa*, *Ips* spp., and *Anastrepha* diagnostic protocols.
Subcommittee on Plant Health Diagnostics	Observer status in committee. Writing, validating and peer-reviewing diagnostic protocols	Participated in the High-Throughput Sequencing (HTS) and Novel Technologies Working Group.
Quadrilateral (Quads) Scientific Collaboration in Plant Biosecurity (New Zealand, Australia, United States, Canada)*	Contributed to four working groups: - Molecular diagnostics - Managing regulatory issues arising from new diagnostic technology - Antimicrobial resistance (AMR) and plant health: review of current evidence and gaps - Quads seed health	Discussed and compared HTS protocols, analysing the data from the HTS ring testing. Evaluated the evidence on AMR in plant health and identified research gaps on the role of plant protection practices in AMR emergence and spread. Partners shared seed extraction and testing protocols, quality controls, interception data, emerging risks and regulatory changes.

European Network for Phytosanitary Research Co-ordination (Euphresco)	Participation in 15 projects	Four projects have been closed and 11 are in progress. New diagnostic methods, tools and experience explored with other diagnostic laboratories.
Northwestern University, USA; Maseno University, Kenya; National Crops Resources Research Institute, Uganda	PLANT-dx 2.0 – Rapid, simple and scalable plant pathogen detection (Bill and Melinda Gates Foundation-funded project)	Developing and validating a rapid HTS based methodology to determine the viral plant disease diversity and distribution.

* The United Kingdom is joining the different working groups in 2024. A new name for this scientific collaboration is being finalised.

Innovation and preparedness

At PHEL, we strive to constantly improve our preparedness for emerging biosecurity threats by researching novel diagnostic tools, adopting the best equipment, technology and methods in biosecurity diagnostics and surveillance, and continuously improving laboratory and data management efficiencies. This is achieved through in-house initiatives, external collaborative projects and the operational research projects funded by MPI.

High-throughput sequencing

High-throughput sequencing (HTS), also known as Next Generation Sequencing (NGS), is one of the most significant advances in recent molecular diagnostics, becoming a powerful technology for the identification of pests and diseases globally. PHEL diagnosticians use HTS to find multiple pathogens in a single sample, to differentiate between closely related plant pathogens and to detect unknown pathogens.

We are routinely using Illumina MiSeq and Oxford Nanopore Technology (ONT) MinION platforms and have recently focused on developing bioinformatic capability through staff training programmes. We are also working on improving the quality control around these technologies to facilitate the increasing demand for the use of HTS in our diagnostics. This year, PHEL applied for the accreditation of two established HTS assays: one for detecting and identifying viral/viroid pathogens in symptomatic plant tissue, and one for identifying bacterial isolates.

MPI's Plant Imports team has accepted the use of HTS protocols as part of imported nursery stock screening for *Fragaria* species (strawberry). We are expanding this work to validate the method for other high-value import commodities.

Operational research

PHEL carries out applied diagnostic preparedness research projects, mostly supported by internal MPI Operational Research funding. Their aim is to explore and implement new methodologies to strengthen our diagnostic capacity. Over the past year, three projects have been completed:

- **eRNA greenhouse testing for viruses:** This one-year project developed an effective enrichment method of water samples and optimised a RT-qPCR assay for maximal detection sensitivity of pepino mosaic virus from greenhouse wastewater samples. The project

provided a proof of concept to implement commercial greenhouse wastewater testing for high-risk plant pathogens. This project was partially funded by industry.

- **Life after death: Tracking RNA to pinpoint death:** This project identified candidate biomarkers that can be potentially deployed to determine the viability and time of death in *Drosophila melanogaster* (as a model organism for other flies, including fruit flies), and to assess viability in *Nezara viridula* (as a model organism for other stink bugs, including brown marmorated stink bug). The project also developed a robust and scalable computational pipeline for miRNA discovery that can be used for future diagnostic approaches at PHEL to identify candidate biomarkers from multiple pest and pathogen species.
- **Optimisation of seed testing for sensitive detection of viruses and viroids:** This project improved pathogen detection efficiencies in seed testing by improving nucleic acid extraction methods to increase test sensitivity and allow greater seed bulking. Several multiplex-PCR assays for the detection of viruses and viroids in solanaceous and cucurbit seed species were also validated and optimised. These improvements reduced testing costs to seed importers. The project also completed a proof of concept for using HTS on an ONT MinION platform, with a tiling amplification enrichment to increase the detection sensitivity of cucumber green mottle mosaic virus in cucumber seeds. The results were comparable to RT-qPCR, showing that this modified HTS technique can be used to validate RT-qPCR detections of low viral titres.

The projects currently in progress are:

- **Improving diagnostic capability and readiness for plant pathogens:** This project develops real-time PCR tests for rapid and sensitive detection of six significant fungal and bacterial plant pathogens. Two assays were developed and/or validated in the past year. Work is in progress to complete the final assay development for the wheat pathogen *Puccinia graminis* f. sp. *tritici* Ug99.
- **Improving microbial biosecurity diagnostics with novel genome sequencing technologies:** This project uses HTS to identify fungi and bacteria cultured from diagnostic samples. In the last year, multiplex PCRs to amplify sets of genes for fungi and bacteria were developed and the best bioinformatic tools for HTS data analysis were screened. A diagnostic bioinformatics pipeline has been developed for bacterial amplicons, and testing is in progress on a multiplex-PCR analysis pipeline developed for fungal diagnostics.
- **eDNA for biting midge surveillance diagnostics:** This project develops improved eDNA isolating and metabarcoding approaches for detecting bluetongue vectoring biting midges (*Culicoides* spp.) in surveillance samples, without the need of laborious microscopic screening. To date, suitable extraction protocols, metabarcoding assays and a bioinformatic pipeline for data analyse have been developed. The newly developed metabarcoding method can detect one individual in a mixture of 20,000 bycatch insects.
- **Enhancing high-risk fruit fly diagnostics:** This project focuses on acquiring enriched DNA barcode information for six unwanted fruit fly species, to develop and implement new qPCR assays for increased accuracy and efficiency. To date, 82 complete mitochondrial genomes have been sequenced and analysed for 18 fruit fly species from the Pacific islands. qPCR assays have been developed for six *Bactrocera* species and the development of multiplex assays is in progress.
- **Application of HTS in PEQ germplasm testing:** This project develops and validates HTS protocols for identifying non-culturable organisms (e.g. viruses, viroids, phytoplasmas) during imported nursery stock screening and PEQ testing. In the past year, protocols have been developed for using HTS for screening *Fragaria* (strawberry) nursery stock. Methodology application is currently being expanded to validate the method for other high-value import commodities (e.g. *Vitis*, *Prunus*).

- **Passive sampling to survey virus activity in production systems:** This new project builds on the results of the eRNA greenhouse testing for viruses project and aims to further develop and verify methods for water-based environmental surveillance of plant viruses. The project also develops methods that allow users to assess the risk associated with a detection (e.g., by developing a molecular-based viability test).

Laboratory Information Management System

The Laboratory Information Management System (LIMS) is used to process and store data associated with sample submissions. It provides an environment to support information workflow, eliminate errors, provide trustworthy results and promote the efficient input of data and output of information. In the past year, PHEL has upgraded to the latest version of the software (Labware V8) to improve its performance, enhanced automation of the specimen reception and laboratory processes for the MPI surveillance programmes, and implemented the application of new diagnostic test prices for border testing as part of a wider cost-recovery implementation plan.

Training

Enhanced Pacific Biosecurity Partnership Programme

The Ministry of Foreign Affairs and Trade (MFAT)-funded ' Enhanced Pacific Biosecurity Partnership Programme' has supported capability development in Fiji, Cook Islands, Samoa, Tonga and Vanuatu biosecurity systems since 2021. We engage with our counterparts across the Pacific and Australia, collaborate with Manaaki Whenua Landcare Research, and work with other MPI teams such as Biosecurity Surveillance & Incursion Investigation, Border Clearance Services and Plant Risk Assessment to reach the project goals. In addition, PHEL conducted a scoping visit to Tonga.

Over the past year, PHEL completed the following activities in the partner countries (**Figure 5**):

- delivered crop survey training for the Cook Islands Ministry of Agriculture (MOA) biosecurity, research and advisory staff;
- delivered first entomology and plant pathology training for Biosecurity Vanuatu plant health officers;
- set up a remote microscopy system in Biosecurity Vanuatu;
- delivered symptom recognition training for Biosecurity Vanuatu border clearance staff, assisting with pest or disease damage recognition on fresh produce to strengthen their border processes; and
- attended the Regional Early Warning System and Emergency Response Planning exercise in Fiji conducted by Biosecurity Authority Fiji and the Pacific Community. PHEL experts contributed as subject matter experts in surveillance for fruit flies, fall armyworm and little fire ant.

Our Pacific colleagues were also able to attend activities in New Zealand (**Figure 6**):

- officers from the Cook Islands and Vanuatu who received specific entomology training, focusing on improving their diagnostic skills;
- officers from the Cook Islands, Fiji, Tonga and Vanuatu attended introductory nematology training conducted by a nematology expert from Australia; and
- biosecurity officers from Tonga attended MPI quarantine inspector induction training in Auckland.

Figure 5: PHEL trainers and Vanuatu officers in Port Vila joining a remote microscopy diagnostics session(left); Biosecurity Vanuatu and PHEL staff at the symptom recognition training in Port Vila (right)


Figure 6: Biosecurity Vanuatu officer during entomology diagnostic training in New Zealand (left); Tonga biosecurity officers at their Ministry for Primary Industries' quarantine officer induction training graduation (right)

In-house professional development

PHEL's professional development opportunities programme aims to increase our staff capabilities, strengthen connections between disciplines and support diverse skill sets within PHEL. The sessions delivered last year included an introduction of the specimen reception processes at PHEL, an overview of MPI standards and a discussion around mental health first aid. PHEL also organised a training programme to enhance our people's HTS sample preparation and data analysis skills.

Figure 7: Sarah Han (Senior Technician, Post Entry Quarantine) delivering mental health first aid training to PHEL staff, a session arranged by the PHEL Professional Development Opportunities team

Outreach

PHEL and the Biosecurity Surveillance Incursion and Investigation Plant Health team continue to run joint outreach activities. Over the past year, the team has staffed booths at five career expos, hosted several groups of school students and teachers and the Te-Pu-A-Nga-Maara (rangatahi-led collective of taiao innovators and rangers) – providing presentations, onsite demonstrations, and tours of the laboratories. PHEL staff also gave talks and lectures at universities and polytechnics and represented MPI at fairs and other events, including the Northland Field Days. Through highlighting our role in protecting New Zealand's industries and biodiversity, and sharing our enthusiasm about biosecurity science, we aim to enhance collaboration and partnerships with diverse communities and inspire future biosecurity champions (**Figure 8**).

The team also contributes to and benefits from our Te Kākano Ako (the seed of learning) group activities which provide a safe, encouraging and inclusive space for staff to navigate cultural capability, thereby honouring Te Tiriti o Waitangi and becoming better Treaty partners. We continue to discuss, practise and incorporate te ao Māori, te Reo, pepeha, waiata and karakia into our work.

Figure 8: PHEL staff interacting with a young family at the Northland Field Days (left), and talking to university students at the Auckland University of Technology Career expo (right)

Responses

Potato spindle tuber viroid

Following the detection of potato spindle tuber viroid (PSTVd) in Nelson, a biosecurity response was initiated in November 2022. After introducing the control measures (e.g., movement control, depopulation, disposal and disinfection/decontamination of glasshouses), there have been no subsequent detections of PSTVd at the location, and the response was officially closed in February 2024. PSTVd has also not been detected from any other location. Therefore, PSTVd is considered to be eliminated from all known locations in New Zealand.

Our people

Director, Diagnostics, Readiness & Surveillance*	Fleur Francois, Veronica Herrera**
Plant Health & Environment Laboratory Manager	Lalith Kumarasinghe
Bacteriology and Botany	
Team Manager	Robert Taylor
Senior Scientists	Jeyaseelan Baskarathevan, Luciano Rigano, Michael Gemmell
Scientists	Carol Elliott, Ruth Griffin
Senior Technicians	Alison Penn, Kate Pitches**
Entomology	
Team Managers	Dave Voice, Sherly George
Principal Scientists	Disna Gunawardana, Dongmei Li, Qing Hai Fan
Senior Scientists	Asha Thomas, Ben Boyd, James Haw, Rebijith Balan
Scientists	Bede McCarthy, Hamaseh Aliakbarpour, Yan Chen, Anthony Gonzaga
Senior Technicians	Ben Wynne-Jones, Eloise Lancaster, Jiawei Shen, Joanna Mackisack, Elizabeth De Jong, Sally Ladbrook
Mycology and Nematology	
Team Manager	Wellcome Ho
Principal Scientist	Merje Toome
Senior Scientist	Katharina Hofer
Scientists	Karthikeyan Dharmaraj, Raja Thangavel, Jack Vasey**, Esha Arshad**
Senior Technician	Natalie Pettitt

Virology and Phytoplasmology	
Team Manager	Jeremy Thompson
Principal Scientists	Lia Liefting, Catia Delmiglio
Senior Scientists	David Waite, Joe Tang, Stella Veerakone, Subha Das, Subuhi Khan, Zoila Perez
Scientist	Sonia Lilly
Senior Technicians	Deepika Kanchiraopally, Michelle Kelly
Post-Entry Quarantine	
Team Manager	Sathish Puthigae (acting)
Principal Scientist	Abu Iqram
Senior Scientist	Kirsty McDermid
Scientist	Eloise Hollins**, Emma Milleza
Senior Technicians	Frances Graham**, Henri Lee Huddleston, Sarah Han
Assurance, Biosafety and Containment	
Team Manager	Sumathi Murugan
Senior Laboratory Technical Officer	Jane Martin
Senior Adviser Quality Assurance	Alina Antony
Senior Adviser Health & Safety, Containment	Benedict Uy
Senior Scientist	Maximilian Nepel
Scientist	Adam Colsell**
Senior Technician Laboratory Support	Brittany Scouller**, Deepa Dupaguntla
Diagnostic Readiness and Innovation	
Team Manager	Sathish Puthigae
Senior Scientist	Sreejith Padinjare Chakkatu**
Scientists	Georgia Breckell, Georgia Wakerley, Hester Roberts, Hui Wen Lee, Juncong Yan, Luciano Nunes Leite, Nathaly Lara Castellanos, Toan Hong**
Other Staff	
Principal Scientist	Brett Alexander
*Before July 2024, the Directorate was named Diagnostic and Surveillance Services. **These staff have left or moved to other roles within MPI since last year's report.	

Publications

Ehau-Taumaunu H, Williams N, Marsh A, Waipara N, Higgins C, Geering A, Mesarich C, **Rigano L**, Summerell B, Johnson G, Williamson P, MacDiarmid R (2024). Why a strategic shift in action is needed to recognise and empower indigenous plant pathology knowledge and research. *Australasian Plant Pathology* 57, 211–219.

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Biannual newsletter

PHEL produces a biannual newsletter, PHEL*osophies*. Access the latest issues (January 2024 and June 2024) at:

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