Healthy trees, healthy future
Enabling technologies to combat *Phytophthora* diseases

News

SCION

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Introduction

Wow! It's April 2019 already, meaning we have six months to go on the HTHF programme. The science team is working frantically on all fronts as we near the finish line of the programme with so many of the programme's achievements coming to the fore, enabling new areas of research and seeding new programmes of work.

In May we will farewell Mirea Gomez-Gallego who submitted her PhD just before Christmas and will defend this in May. Mireia's PhD studies have investigated the epidemiology and impact of *Phytophthora pluvialis* and red needle cast on radiata pine and Douglas-fir in New Zealand and Oregon. Incredibly, Mireia is on track to publish six (or more) papers directly from her PhD and has co-authored two review papers looking at disease management and impacts in association with climate change. Her work has established a foundation for much of the proposed follow on work on needle diseases within the proposed Resilient Forests programme and we are looking forward to continuing to collaborate with Mireia on the physiological impacts of pathogen infection as she takes up a post-doc in Sweden.

The key highlight of the last six months has been a hugely successful collection of kauri seed from across kauri-lands. From 7 February to 29 March mana whenua groups from Northland to the eastern Bay of Plenty assisted climbers into their ngahere to collect seed from their taonga kauri stands. This has been one of the biggest kauri seed collections involving 14 mana whenua, Scion, Manaaki Whenua Landcare Research and professional tree climbing company BioSense.

The mana whenua groups involved included Omahuta, Ngamanawa Inc, Te Roroa, Te Rarawa, Patuharakeke, Tau Iho I Te Po, Te Rawhiti, Ngāti Huarere Ki Whangapoua, Te Uri o Hikihiki, Ngāti Hine, Ngāti Rehia, Te Uri O Hau, Kawerau a Maki and others. For these mana whenua to have the foresight and ability to be a part of this piece of work is terrific and we appreciate their time commitment, passion and hard work leading to this collection being a success.

Our thanks also go to the climbing team led by Fredrik Hjelm and the whole BioSense crew with assistance from Chantal Probst, Stephanie Morton, Zane McGrath, Chris Winks and Dr Stan Bellgard from Manaaki Whenua Landcare Research, who were all just amazing. The coordination of collection teams, mana whenua engagement, cultural, safety, and hygiene protocols ensuring no soil, water or organic matter is transferred between sites, was a mammoth effort. We have received many expressions of thanks for their proficiency, expertise, care and ability to safely take mana whenua up to experience the life in the top of a kauri tree.

Back at Scion the work continues with Gordon Tieman, Catherine Banham and Colin Faulds leading the team to see that the seed is dried, quantified, stored and sown appropriately. With the collection being from over 650 trees what a fantastic resource to help the future of our taonga.

Regards,
Dr Nari Williams

Members of the climbing team from BioSense and Manaaki Whenua Landcare Research.

Congratulations!

Molecular forest pathologist Rebecca McDougal won the Contribution to a Science Team award at the Forest Growers Research conference. It was acknowledged that in her work Rebecca is constantly innovative and either develops or implements new molecular techniques to better understand the pathogens that are affecting our forests. We're very proud of Rebecca and feel the award is well deserved.

Did *Phytophthora kernoviae* originate in Gondwanaland?

The genetic diversity of *Phytophthora kernoviae* from both New Zealand and Chile, combined with signs that native plants in both countries co-evolved with the organism, suggest a possible Gondwanan origin.

An international research team that included Scion's Preeti Panda, Nari Williams and Rebecca McDougal have sequenced the genomes of *Phytophthora* oomycete isolates from Chile and compared them with *P. kernoviae* isolates from New Zealand and the United Kingdom. *Phytophthora kernoviae* was first described in the UK in 2003 causing cankers and foliage lesions. Subsequently, it was discovered in New Zealand where it is not considered to be a major pathogen of native plants. Recently, its presence in Chile was reported; a country that shares common ancient Gondwanaland flora with New Zealand.

The genome sequencing of six Chilean oomycete isolates found three of the samples were indeed *P. kernoviae*, two were very closely related to *P. kernoviae* and one was thought to be a member of *Nothophytophthora*, a newly described oomycete genus.

The three Chilean *P. kernoviae* samples were genetically diverse and dissimilar to the New Zealand samples. The New Zealand isolates were also genetically diverse. In contrast, the UK samples were all very similar to each other, and fell within the diversity found in New Zealand.

The authors believe this pattern is consistent with the Chilean and New Zealand populations both descending from an ancient Gondwanan population. Further genotyping of isolates from both countries would be necessary to confirm this hypothesis.

Studholme, D. J., Panda, P., Sanfuentes Von Stowasser, E., González, M., Hill, R., Sambles, C., ... & McDougal, R. L. (2018). Genome sequencing of oomycete isolates from Chile supports the New Zealand origin of *Phytophthora kernoviae* and makes available the first *Nothophytophthora* sp. genome. *Molecular plant pathology*. https://doi.org/10.1111/mpp.12765

Searching for red needle cast disease resistance

One of the long term goals in the fight against red needle cast (RNC) of radiata pine, caused by *Phytophthora pluvialis*, is breeding for disease resistance. Minimising dependence on chemical control for needle diseases is important in ensuring the continued success and resilience of radiata pine planted forests. With a much shorter history of RNC in New Zealand compared with other foliar diseases, such as dothistroma needle blight and cyclaneusma needle cast, opportunities to measure and understand the genetic resistance to this disease have so far been limited to a handful of genetic trials.

Inoculation of detached needles to identify clones of radiata pine with greater resistance to RNC. Top: inoculation; middle: incubation; bottom: resulting lesions counted and measured.

Using a screening technique where detached needles are exposed to the pathogen, the Healthy Trees, Healthy Future programme has screened around 400 representatives of a Radiata Pine Breeding Company (RPBC) elite population. Development of greater numbers of larger needle lesions indicated susceptibility, while development of no, or few lesions of small size, indicated greater resistance to RNC.

We observed a broad range in the response of this population to infection, with some clones that were clearly susceptible and others that were clearly more resistant. These differences also appeared to be heritable, which supports what we have seen to date in genetic field trials, and tells us that improving resistance through breeding is possible.

There are limitations with lab-based assays, and development of some sophisticated statistical models was required to analyse the data generated using this screening tool. Continued work is required to better understand the sources of variation observed in these experiments. We look forward to opportunities to validate these results against field data from the RPBC's regional trials. Using such lab-based screening methods remains a viable option to assess resistance to RNC when no information is available for a population.

Natalie Graham, Scion

Graham NJ, Suontama M, Pleasants T, Li Y, Bader MKF, Klápště J, Dungey HS, Williams NM, 2018. Assessing the genetic variation of tolerance to red needle cast on a *Pinus radiata* breeding population. *Tree Genetics & Genomes* 14: 55. https://doi.org/10.1007/s11295-018-1266-9

First published in Forest Health News No. 283.

Infection of fine roots of radiata pine by *Phytophthora pluvialis*

Recently published research from Scion's Forest Pathology group shows that *Phytophthora pluvialis*, cause of red needle cast (RNC), is capable of infecting fine roots of radiata pine (Scott, et al., 2019). This was not a surprising finding given that several aerially dispersed species of *Phytophthora* (that damage aboveground plant tissues) are known to infect and survive in the roots of their hosts. In controlled artificial inoculation experiments, infection by *P. pluvialis* led to death of fine roots and root tips at comparable levels to that caused by *Phytophthora cinnamomi*, a well-known root pathogen of several plant species. Results of this research have important implications for our understanding of the spread, survival and impact of *P. pluvialis*. A lack of aboveground symptoms on root infected pine may allow spread of the pathogen on apparently healthy seedlings and rooted cuttings. Due to more stable belowground conditions, infection of

roots may also allow *P. pluvialis* to survive unfavourable environmental periods and have important implications for understanding disease epidemiology. Loss of fine roots may also significantly reduce growth of pine in nurseries and plantations. More research is needed to investigate the influence of root infection on these factors.

Stuart Fraser, Scion

Scott PM, Taylor P, Williams N (2019). Contrasting the infection and survival of *Phytophthora pluvialis* and *Phytophthora cinnamomi* in *Pinus radiata* roots. *Australasian Plant Pathology*. https://doi:10.1007/s13313-019-0619-7

First published in Forest Health News No. 287.

Significant kauri seed collection complete

One of the biggest kauri seed collections to be undertaken in decades has just been completed across the upper North Island of New Zealand, in an effort to identify trees that are resistant to kauri dieback disease.

Kauri dieback is a plant disease caused by the fungus-like pathogen *Phytophthora agathidicida*. The pathogen has killed many precious kauri trees, which are endemic to New Zealand and a taonga (treasure) to Māori. Kauri are considered a dinosaur among trees, growing to over 50 m tall, with trunk girths up to 16 m, and living for over 2000 years.

The seed collection is part of the Scion-led Healthy Trees, Heathy Future (HTHF) programme focused on researching and combating several *Phytophthora* species, including *Phytophthora agathidicida* aka kauri dieback.

The coordinated collection saw 14 mana whenua (Māori) groups working with researchers from Scion, Manaaki Whenua Landcare Research and professional tree climbers from BioSense to collect seed from kauri in northern Northland to Tauranga in the eastern Bay of Plenty.

Mana whenua groups involved include Omahuta, Ngamanawa Inc, Te Roroa, Te Rarawa, Patuharakeke, Tau Iho I Te Po, Te Rawhiti, Ngāti Huarere Ki Whangapoua, Te Uri o Hikihiki, Ngāti Hine, Ngāti Rehia, Te Uri O Hau, Kawerau ā Maki and others.

Kauri seed is enclosed in cones that mature between February and April. Maturation is earliest in northern New Zealand and then moves south.

Tree climbers used special gear to climb into the tree canopy to harvest cones. It is vital that the cones are collected while still on the tree so collectors can record which tree they came from, and can go back to gather more if the specimen is identified as being resistant. Cones have been sent to Scion in Rotorua where some of the seed will be raised in a specially commissioned kauri polyhouse within the Scion research nursery where strict hygiene precautions ensure it stays free of kauri dieback. Seed not used this year will be placed into a seed bank for mana whenua to use in research or restoration.

This is the fourth year of seed collections in the HTHF programme and was the biggest collection undertaken so far. This year, the team collected seed from 500+ trees across kauri lands to establish a resource for future research, screening and propagation programmes.

Programme leader Dr Nari Williams explains, “By taking seed from mature trees, we’re hoping to get a better understanding of the range of genetic resistance present. This is one part of understanding why and how some trees succumb to dieback and others remain apparently disease-free.”

When the seedlings are 15 months of age, they are sent to Manaaki Whenua Landcare Research laboratories in Auckland where they are screened for resistance to kauri dieback. The plants are flooded with water containing *Phytophthora agathidicida* to encourage infection. Researchers monitor them closely to see how the disease takes hold and how long they survive after infection. The plants are also analysed to see what chemical reactions are triggered, hoping to find one that may be effective at neutralising the disease.

“Although early days, it’s starting to get really exciting. The team at Manaaki Whenua Landcare Research led by Dr Stan Bellgard and Dr Chantal Probst have started to see a range of responses to how the plants succumb to infection. There is a big difference between understanding what happens in the glasshouse and how vulnerable trees are within the forest, but it gives us hope for the future of kauri,” says Dr Williams.

The team from BioSense, led by Fredrik Hjelm, coordinated the collection teams, mana whenua engagement, cultural, health and safety and hygiene protocols, and the shipping of the cones. They ensured that groups collecting the cones used strict protocols to ensure no soil, water or organic matter is transferred between sites.

Funding for the kauri stream of the HTHF programme is provided by the New Zealand Ministry for Business, Innovation and Employment and the Kauri Dieback Programme. Collaborators include Massey University, Manaaki Whenua Landcare Research, Plant and Food Research and the Auckland University of Technology. The programme wraps up in September 2019 after six successful years, but the researchers hope to continue the work in partnership with mana whenua.

Conferences

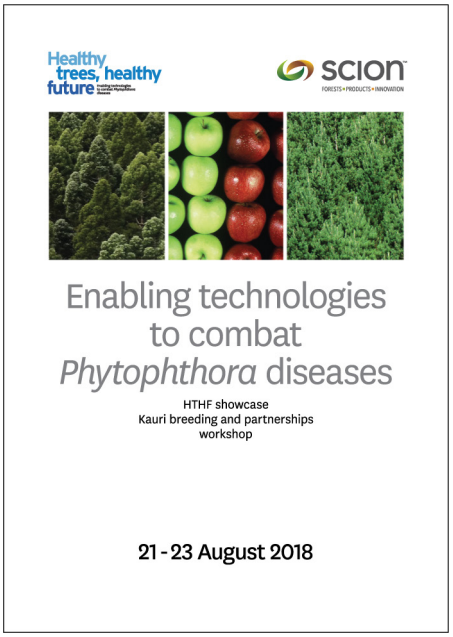
- **71st NZ Plant Protection Society Annual Conference** in Nelson, August 2018

  Renelle O'Neill presented her research on the validation of automated qPCR for pathogen detection and quantification.

- **HTHF Enabling Technologies to Combat *Phytophthora* Diseases** in Rotorua, August 2018

  All the posters and presentations from this showcase have been collated into a booklet.

  Email vicky.hodder@scionresearch.com if you would like your own copy.



Renelle O'Neill with her poster on a high-throughput protocol for the detection of pathogens with qPCR.

Renelle's poster showed that a collaboration with robotic diagnostic services provider, Slipstream Automation, could provide a high-throughput diagnostic alternative for research trials, which previously relied on laborious plating and isolation for pathogen detection. This valuable tool has great potential in increasing the capacity of large research trial analysis, as well as detection sensitivity and analysis timeframes.

To learn more about this programme

Contact Dr Nari Williams at nari.williams@scionresearch.com
Visit our website www.healthytrees.co.nz

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