NZASE science research

Controlling kauri dieback

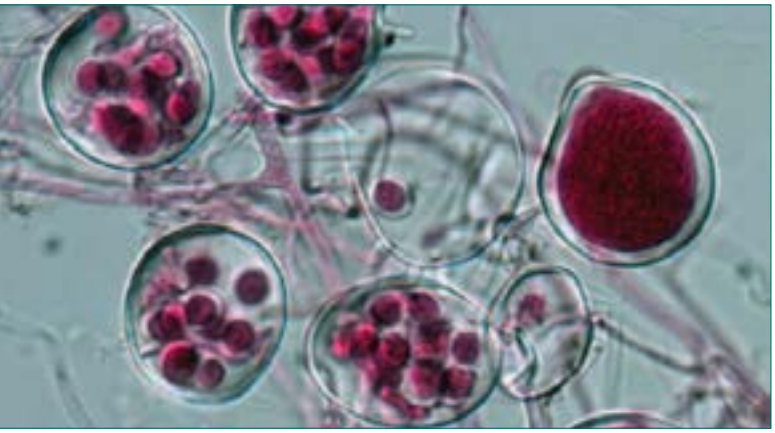
This disease is spreading insidiously in our northern kauri forests, killing our slow-growing icon, *Agathis australis*. Progress in finding out about the pathogen has been slow and the reports are complex. NZASE Science Communicator Mike Stone clarifies the science behind the control of kauri dieback.

Background

Kauri dieback is caused by *Phytophthora agathidicida* (Agathis killer). This water mould lives in the soil,infecting and destroying kauri roots and damaging conducting tissues.

This slowly starves the kauri of water and nutrients, causing lesions on the base of the trunk, yellowing leaves, thinning canopy and dead branches. By the time the first symptoms become visible in the crown, the fine root system may be already very damaged.

This mould produces different types of spores, including zoospores and oospores. Infection begins when a swimming zoospore attaches to a young kauri root tip, finding it by chemotaxis. It penetrates the epidermis, growing into the root and rotting the tissues as it goes. The pathogen moves up into the base of the trunk, where it feeds on the cork cambium. Oospores develop inside the root and are released into the soil when roots decompose. Oospores form sporangia which release more zoospores, ready to spread the infection when water floods the soil.



Sporangia filled with zoospores, stained with acid fuchsin .Photo: E.P. Paderes, Manaaki Whenua Landcare Research.

Photo: Nga Rakau Taketake: Saving our iconic trees from kauri dieback and myrtle rust.

Control of kauri dieback needs to be targeted to the soil around the roots. Currently dieback is controlled by injecting the trunk with phosphite (phosphorous acid).However, its application takes many hours, making it difficult to treat a forest. So biological control and rongoā methods are also being explored.

However, Stan Bellgard, scientist with Biosense, says we have to be very selective about how we manage this disease as we're working in the conservation estate, being careful about the chemicals we use and their effect on organisms such as kauri symbionts.

Treatment with phosphite

Phosphite is a common horticultural fungicide specific to Phytophthora, biodegradable with low toxicity. A phosphite treatment was trialled in 2012 using Agrifos®600 in syringes, which were pushed into drilled holes in the kauri trunk and left there to be absorbed into the tree.

Between 7.5 and 20 percent phosphite solution protected seedlings from *P. agathidicida* attack, and healed lesions in infected trees. However, at the higher concentration there was some evidence of toxicity - leaves went yellow, then brown and fell off.

To improve the use of phosphite, scientists tested about 1,000 treated and control healthy and diseased trees in the Waitakere Ranges, Dargaville, Kerikeri and near Waipoua forest. A citizen science project with about 50

Dr Ian Horner injecting kauri trees with phosphite. Photo: Plant & Food Research.

landowners and 800 kauri also provided data.

These experiments and data, each over two to three years, showed that phosphite injections are effective on young, slender kauri rickers, regardless of season, time of day or weather conditions. Lower concentrations (down to 4%) and low doses (20mL every 40cm) reduced lesions with no evidence of toxicity.

Spraying the trunk was also trialled, and two applications two years apart healed most lesions. However, on larger, older trees, a four percent phosphite solution injected every 40cm did not heal lesions over 2.5 years and some trees died.

"Phosphite is a tool to stop its spread, not a cure", says Dr Ian Horner of Plant & Food. "It buys us time to find a solution". Kauri seeds are being screened to identify resistance to Phytophthora, which may offer hope.

Rongoā

The Kauri Dieback Management Programme charter includes a policy that ensures that all intellectual property derived from indigenous communities shall remain the property of those indigenous peoples. Several wānanga with rongoā experts discussed potential rongoa options that may help control dieback.

Rongoā recommended for testing included: Sperm whale* products – especially oil; seaweed and ash; and bio-controls such as manuka, rahurahu, and harakeke extracts. These experts also said that a rongoā regime should follow the maramataka, to keep within the rhythms of Papatuanuku.

As wānanga visits to local kauri forests showed poor regeneration of new growth due to animal pests, experts also recommended the planting of kauri seedlings and new pest eradication programs.

A rongoā biocide programme, Ngā Rākau Taketake – Saving our Iconic Trees, has been funded, and aims to accelerate work already being done.

Biological control

This method uses a living organism (biocide) to control *Phytophthora* – it can kill the pathogen, and also reduce its activities and ability to spread.

The research for a biocide for *P. agathidicida* has centred on decomposer competitors, plant symbionts and parasites. A handful of bacteria and fungi have become the focus because they are easy to culture in synthetic media and readily produce spores. The Auckland Botanic Gardens studied two groups of biocontrol agents: mycorrhizal fungi and Trichoderma.

Mycorrhizal fungi are symbionts living inside or on the roots of plants. Kauri naturally have many native mycorrhizal fungi in their root cortex. Trials showed that inoculating the tree with mycorrhiza improved kauri growth.

Trichoderma species are aggressive parasites of other fungi found on living and dead kauri roots. Experiments showed that adding *Trichoderma atroviride* to the soil improved the growth of diseased

Kauri dieback lesion at the base of the trunk in 2014; this tree has since died. Photo: Dr S.E. Bellgard.

**The relationship between the sperm whale and the kauri is significant to Māori. The sperm whale once walked on land until he decided to go out to the ocean. Tangaroa, the ocean god, set the boundary between the ocean and land, isolating the sperm whale in the ocean from his brother the kauri.*

Thinning of the kauri canopy in the Waitakere Ranges due to kauri dieback. Photo: Dr R.E. Beever.

kauri and reduced the number of spores produced by Phytophthora.

These biocontrols have yet to be demonstrated in a forest, where risks would need to be carefully evaluated.

"People are a major vector for kauri dieback - in the Waitakere Ranges, 70 percent of the infection is on the track network," says Dr Horner. "So use wash stations and respect track closures and rāhui. It's quite upsetting to be doing trials and see how many people ignore signs and walk around barriers."

References

S.E. Bellgard, et al. (2018). Species profile. *Forest Phytophthoras of the world*.

R.E. Bradshaw, et al. (2020). *Phytophthora agathidicida*: Research progress, culturalperspectives and knowledge gaps in the control and management of kauri dieback in New Zealand. *Plant Pathology, 69*, 3–16.

I. Horner. (2018). Phosphite toxicity and impact: An investigation of seasonal variability in injection uptake. Plant & Food Research.

I. Horner. (2018). Trunk sprays and lower phosphite injection rates for kauri dieback control. Plant & Food Research.

I. Horner. (2019). Phosphite large tree treatment trials. Plant & Food Research.

S.E. Bellgard, C. Smith & C.M. Probst. (2019). Biological control of *Phytophthora agathidicida*: Desktop literature review. Biosecurity NZ.

T. Shortland (No date). Rongoā improving the health of kauri forests.

Jung, T. (2005). Life cycle and pathological importance of the genus *Phytophthora*. Phytophthora Research & Consultancy.

Cleaning dirt and mud off shoes and spraying with a two percent solution of SteriGENE® before entering forests helps to stop kauri dieback disease from spreading. Photo: Des Williams, DoC.

Useful resources

Connected, 2017: L4 Kauri Dieback

Kauri dieback: Death in the ngahere. *Project Mātauranga*. [Bilingual video with transcript]

KauriKonnect newsletter, Kauri Dieback Programme.

Ngā Kupu

Maramataka - Māori lunar calendar
Parāoa – Sperm whale
Pirau – Infected
Puruhekaheka – Mould
Pūwero – Syringe
Rahurahu - Bracken
Rongoā – Traditional treatments, Māori medicine
Tīwai – Trunk
Wana – Seedling
Weri – Rootlet

From Paekupu and Te Aka Maori Dictionary