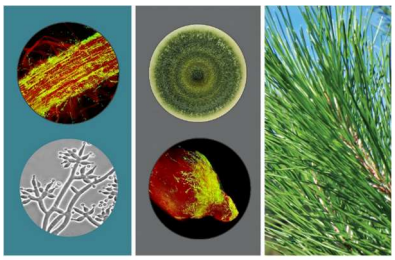
Bioprotection - enhancing growth and health Research Programme



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RESEARCH SUMMARY

# *Trichoderma* bioprotection for foliar diseases of radiata pine

Biocontrol may be an option for suppression of foliar diseases that cost the New Zealand forestry industry over NZ$150 million per annum in lost production (Hill, 2016). To alleviate losses caused by existing diseases and to reduce potential impacts of biosecurity threats, ongoing work is being conducted to establish a long-term symbiotic relationship between *Pinus radiata* and other forestry tree species, and native endomycorrhizal fungi *Trichoderma. Trichoderma* is found in all soils and can enter plant roots and enhance the speed and strength of the plant's response to diseases.

In this research programme, hundreds of *Trichoderma* strains were isolated from exceptionally healthy, strongly growing radiata pine and non-forest plants. Laboratory, nursery and plantation trials identified strains that promoted growth and reduced the incidence of *Dothistroma septosporum* (Dothistroma needle blight), *Colletotrichum acutatum* (terminal crook disease) or *Sphaeropsis sapinea* (diplodia canker). Two *Trichoderma* strain mixtures, PR6 and PR3a, were selected and tested against an untreated control in six important forestry regions. The mixtures were applied as a seed-coating or to cuttings as a soil drench and stock was grown in commercial nurseries for 12 months before field planting in fourteen plantation trials.

## *Trichoderma* promoted growth in young trees:

This research programme has shown that nursery inoculation with PR6 and PR3a mixtures is an important management tool for radiata pine tree cultivation. Both inoculations were equally effective at significantly enhancing young tree growth in a wide range of growing conditions. *Trichoderma* significantly ($P<0.01$) increased stand volume by a mean of 13.2% in the eight 2018 trials, and tree height ($P<0.05$) by a mean of 9.0% in the five 2021 trials, compared to untreated controls (Table 1, Whelan, 2024).

**Table 1:** Effect of *Trichoderma* treatments PR6 and PR3a on mean radiata pine survival (%), height (m), diameter at breast height (DBH, mm), stand volume ($m^3.ha^{-1}$), including expressed as a **percentage increase** compared to the control **(in brackets),** in eight and five plantation trials established in 2018 and 2021 respectively.

| Treatment | 2018 trials (year four) [a] | | | | 2021 trials (year two) [a] | |
|---|---|---|---|---|---|---|
| | Survival (%) [b] | Height (m) | DBH (mm) | Stand Volume ($m^3.ha^{-1}$) [c] | Survival (%) | Height (cm) |
| PR6 | 94.3 ns | 4.70 (7.1) *** | 76.5 (7.0) ** | 14.5 (12.3) ** | 97.2 ns | 148.2 (10.3) * |
| PR3a | 95.0 * | 4.69 (6.8) *** | 77.0 (7.7) ** | 14.7 (14.1) ** | 96.1 ns | 144.9 (7.9) * |
| Control | 92.6 | 4.39 | 71.5 | 12.9 | 95.4 | 134.3 |

[a] trials were established in Northland, Gisborne, Bay of Plenty/Waikato and Nelson in 2018 and Canterbury and Otago in 2021 using the same stock within the 2018 trials and the same stock within the 2021 trials except one trial.

[b] significantly different from the Control at $P<0.05$ (*), $P<0.01$ (**) and $P<0.001$ (***). Not significantly different (ns).

[c] stand volume was estimated by summing the under-bark stem volume of the trees within the plot (Kimberley and Beets 2007) and adjusting to a per-hectare basis based on the size of the plot.

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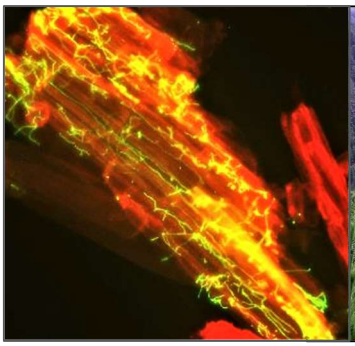
### *Trichoderma* increased the size uniformity of tree stems:

*Trichoderma* treatments increased the size uniformity of four-year-old tree stems by a mean of 9.6%, compared to the controls (Whelan, 2022). In some trials, the *Trichoderma*-treated plots had fewer trees with small stem volumes and more trees in the middle-size classes. These mixtures are therefore recommended as practical and effective tools for foresters who want to reduce production or harvest costs and produce timber of more uniform size. The number or type of thinning and pruning operations, better estimation of harvest dates and less waste of small-diameter stems could be the result of nursery-applied *Trichoderma.* This technology is relevant to both intensive or low-cost, extensive management regimes and will ultimately lead to more efficient and sustainable use of forest resources.

### *Trichoderma* suppressed foliar disease in young trees:

Foliar disease epidemics of *Phytophthora pluvialis* (red needle cast) and *D. septosporum* developed in six trials during 2021 and 2022. The two *Trichoderma* inoculations suppressed foliar diseases by up to 63% (Whelan, 2023) but the epidemics were not severe (≤13% severity). The wet and warm conditions of 2023 encouraged further pathogen development in four of the trials (mean disease severity of 42% measured between August and November 2023) with *Trichoderma* treatments effective at reducing *P. pluvialis* by a mean of 28% ($P<0.01$) and *D. septosporum* by 17% ($P<0.01$) compared to the untreated plots (Whelan, 2024). Although *Trichoderma* treatments did not eliminate the pathogen, the disease suppression offers an opportunity for delayed or fewer agrichemical sprays required to control these diseases.



*Trichoderma* hyphae in a pine root

Nelson plantation trial

*Dothistroma septosporum* infection

### *Trichoderma* was compatible with nursery agrichemicals:

This research determined that the PR6 and PR3a *Trichoderma* strains could be successfully integrated into radiata pine production systems. The sensitivity of eight strains (that make up the PR6 and PR3a mixtures) to fifty-one agrichemicals was tested in laboratory and greenhouse conditions. In the laboratory, the strains were sensitive to 16% of the agrichemicals. However, once *Trichoderma* was established in greenhouse radiata pine roots, colonisation levels were not affected by a single agrichemical application at recommended rates. *Trichoderma* root persistence was also studied in numerous commercial nursery trials. Importantly, significantly higher root levels were found at harvest (12 to 18 months after *Trichoderma* application) compared to untreated stock, resulting in stock well inoculated for field planting. Recommendations for using bioinoculants in nurseries that use agrichemicals can be found in Whelan (2021).

### Where to next?

The availability of forestry-specific *Trichoderma* mixtures may lead to increased productivity (including rapid carbon sequestration), sustainability and economic gain for the New Zealand Forest industry. The business case for the commercialisation of one mixture is currently being developed.

### References: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