

**Bioprotection -  
enhancing growth  
and health** Research  
Programme



**Bio-Protection**  
*Bioprotection science for New Zealand*

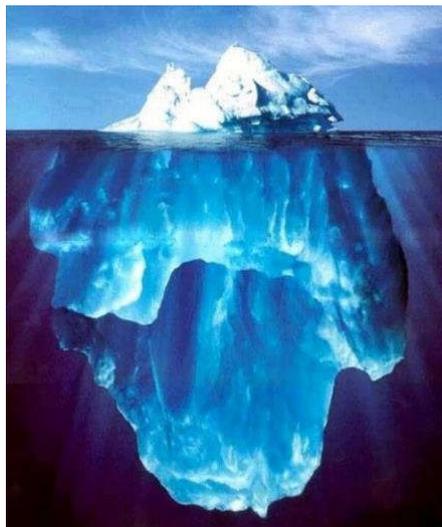
## Bio-Protection Successes

Dr Helen Whelan  
18 October 2017

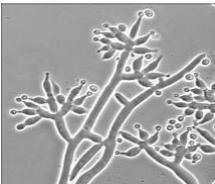
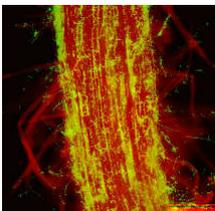
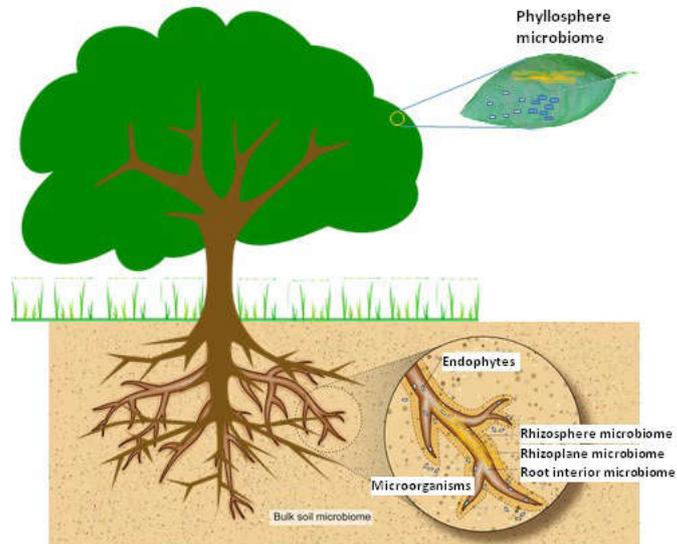
supported by  
**forestgrowers**  
commodity levy



### Above and below the surface



## The microbiome



## *Trichoderma* root endophytes

- Evolved natural system
- Easy to grow and multiply
- Stable and persistent
- Plant growth promotion – enhanced photosynthesis, hormone production
- Plant defence activation – systemic induced resistance
- Antibiosis and mycoparasitism
- Increased tolerance to abiotic stress – e.g. drought, salt
- Reduced fertiliser requirement



### Trichoderma root endophyte project: Planted Forest Zone, Sarawak, Malaysia (2008 to present)

Increase in productivity (>60%) leading to change in nursery practice.  
*Trichoderma* is the new standard operating practice (no fungicides).

## Field trials – 12 months old

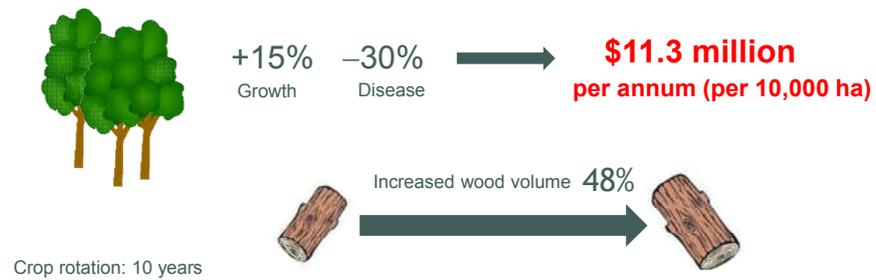


## SE Asia forestry

### NURSERY – new operating practice



### PLANTATION



## NZ Forestry: Bioprotection for foliar diseases and disorders of *Pinus radiata*

### Goal

To use beneficial *Trichoderma* root endophytic fungi,  
to control foliar pathogens of *Pinus radiata* by  
enhancing plant growth and disease resistance in  
forest nurseries and plantations

Funded through the New Zealand Forest Owners Association

### Economics

#### Seedlings:

Assuming a 10% improvement in establishment from bioprotection formulation  
≈ \$2m increased profit for nurseryman  
≈ \$4m (with projected increase)

#### Cuttings:

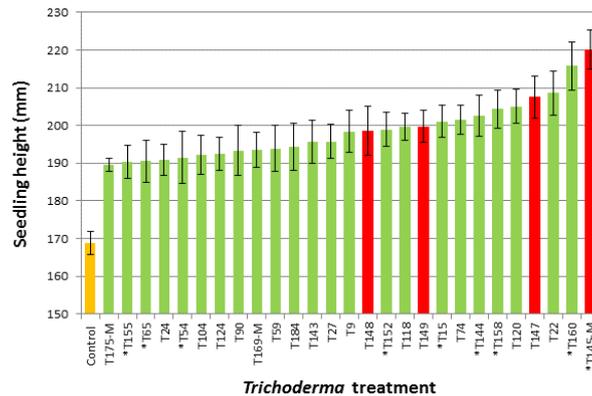
Assuming a 25% improvement (70–95%)  
→ an extra 250,000 per 1m cuttings set  
→ \$1m per 10m cuttings  
→ \$5m per 50m cuttings (projected increase)



Note: This does not include the value from reduced use of fungicides

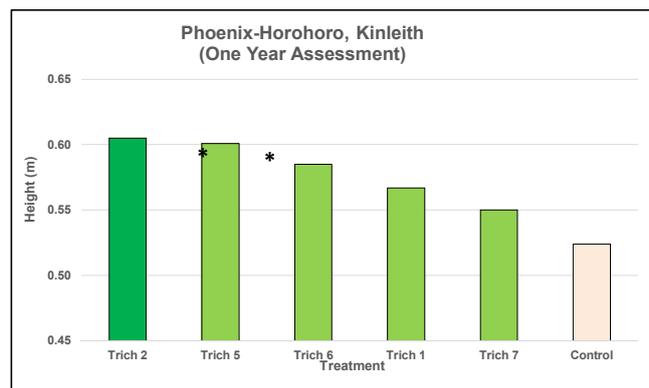
## Seedling growth promotion: nursery trials for best *Trichoderma* treatments

Hundreds of *Trichoderma* isolates were tested in containerised nursery trials in 2012 and 2013 to determine the most effective *Trichoderma* treatments for increasing growth and health of *P. radiata* seedlings

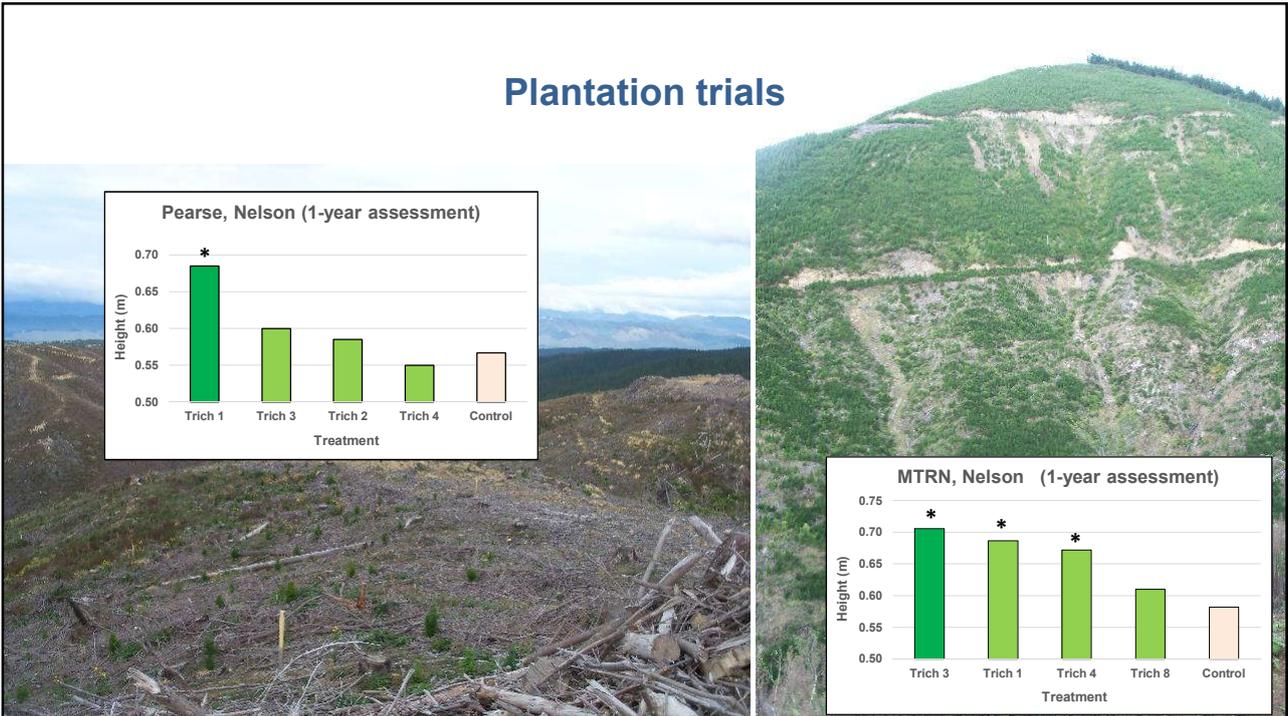


## New Zealand plantation trials with *Trichoderma*

- Nursery seedlings treated with the best *Trichoderma* treatments were planted in 19 small plantation trials between 2013 and 2015 in 7 main forestry locations from Nelson to Northland.
- Trichoderma* increased early tree growth (height and stem diameter) in many of the trial sites, particularly in sites with growth limitations.



## Plantation trials

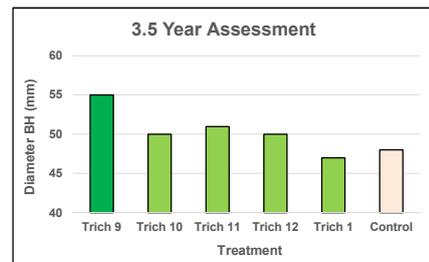
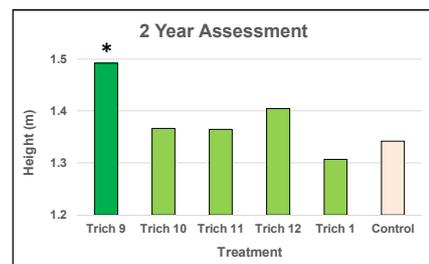


## Plantation trials

### XP KANG, Kaingaroa



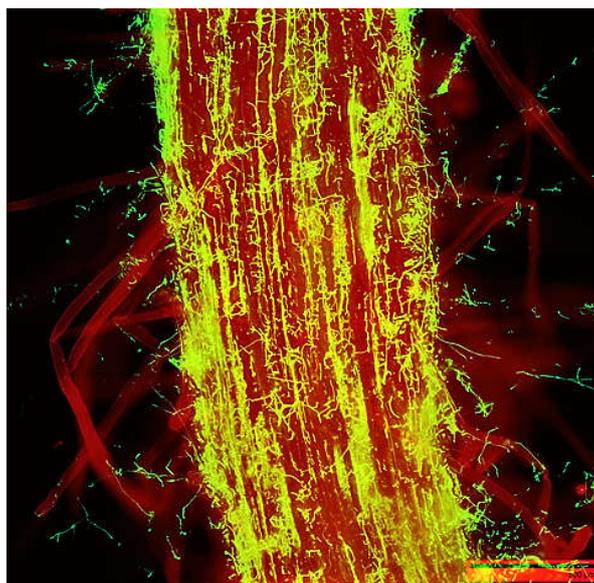
=> The best *Trichoderma* treatments were selected from these trials and will be validated in large plantation trials to be set up in winter 2018



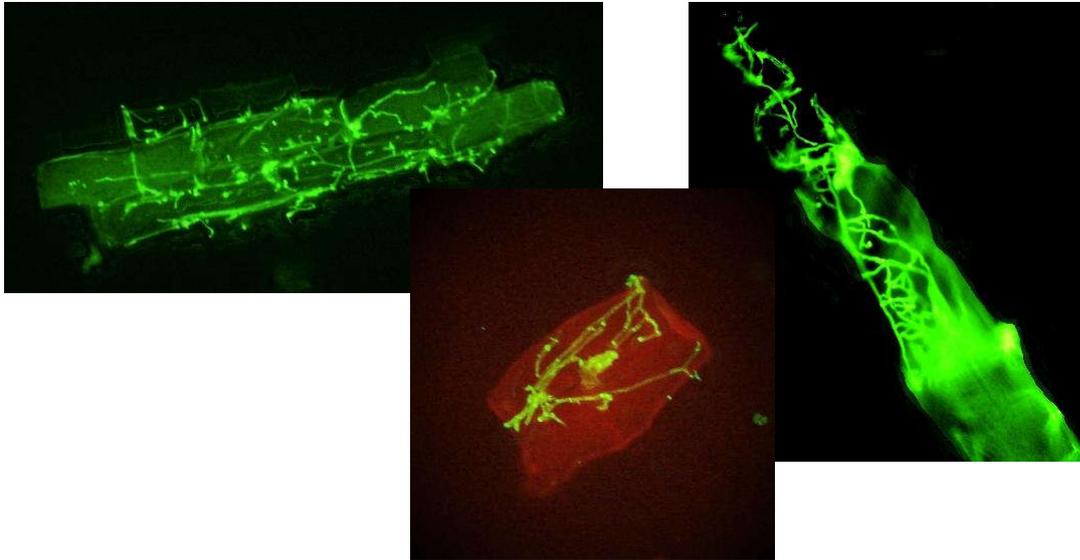
## Colonisation and persistence of applied *Trichoderma*

- *P. radiata* seedlings grown in the greenhouse (under controlled conditions). *Trichoderma* spore suspensions applied at planting.
- Colonisation and persistence of *Trichoderma* was measured by treating sterilised *P. radiata* roots with fluorescent dyes:
  - Wheat Germ Agglutinin–AF488 (generates a green image)
    - => binds to the fungal cell wall
  - Direct Red 80 (generates a red image)
    - => binds to the plant cell wall

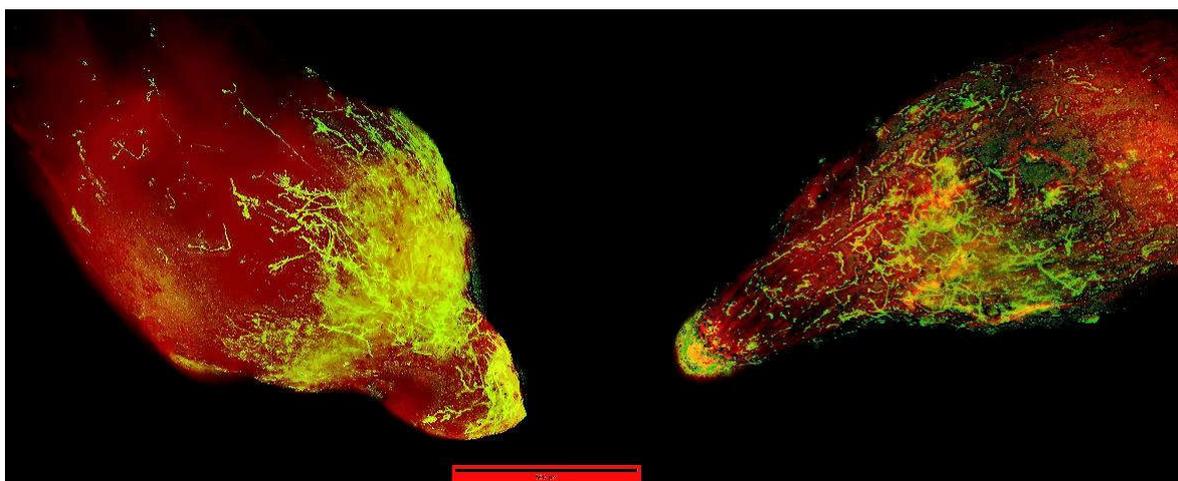
## *Trichoderma* colonisation of young roots



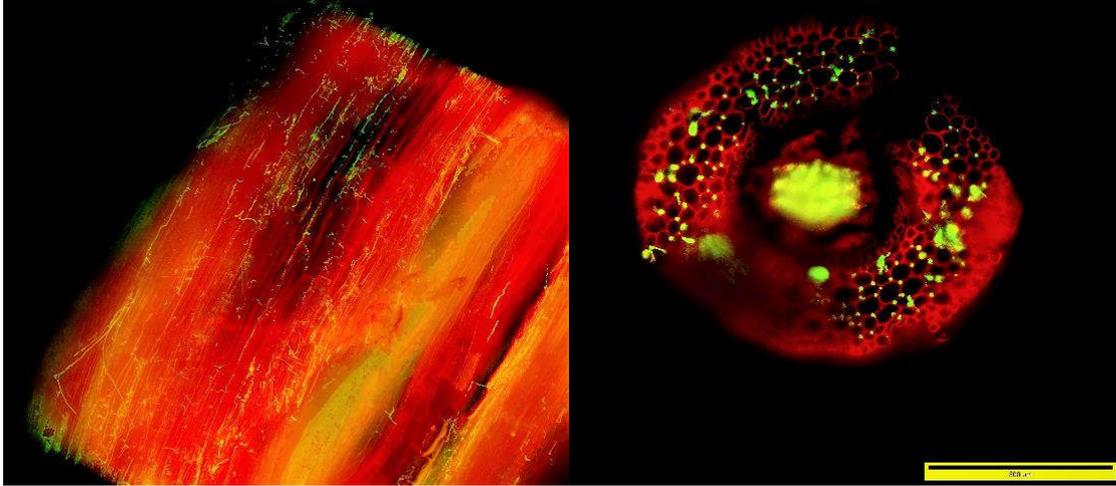
***Trichoderma* highly associated with individual cells**



**Sterilised root tips of 3-month-old seedlings**



## Cross-sections of young roots



## Persistence of *Trichoderma*?

- In the greenhouse trial = high levels of persistence.
- How well is the applied *Trichoderma* persisting in the plantation trees?
- In field trials, initial molecular studies in 2016 indicated that an isolate (LU633) applied in 2012 was still present in roots 4 years later.
- A large study is being undertaken this year to test additional root samples for persistence of applied LU633.

## Bio-Protection Research Centre, Lincoln University

### Current and future work

- Eight large *P. radiata* field trials (about 10 hectares each) are being set up in 2018 to validate the best *Trichoderma* treatments to date.
- Assess the feasibility of treating established trees with *Trichoderma* to mitigate disease problems.
- Isolate and characterise cold- and warm-tolerant *Trichoderma* isolates for use in colder and warmer regions of New Zealand.
- Assess the potential for *Trichoderma* treatments to control cypress canker.
- Assess the potential for *Trichoderma* treatments to improve growth and control Swiss Needle Cast in Douglas fir.

### Conclusions

- Endophytic root *Trichoderma* can make a major contribution to plant growth and health in the nursery and the plantation.
- The chance of finding outstanding *Trichoderma* isolates is improved when isolates are obtained from within very healthy plant roots.
- Many endophytic root *Trichoderma* appear not to be plant specific.

## Conclusions

- The best treatments increased *P. radiata* tree height by up to 20% compared to untreated controls in plantation trials.
- Persistence of these treatments is currently being monitored.
- Immense value of working with growers, nurseries and forestry companies.

## Future benefits



Reduced chemicals in nurseries



Healthier forests and faster growth

\$50M+/year



Protection against pests/pathogens not yet here

Priceless!

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Programme



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[www.fgr.nz](http://www.fgr.nz)

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