



Universiteit Utrecht



Bio-Protection
Bioprotection science for New Zealand

Plant & Food
RESEARCH

RANGAHAU AHUMĀRA KAI

A close-up photograph of several green leaves. One leaf in the foreground has a distinct hole eaten into it, illustrating the concept of induced resistance in plants.

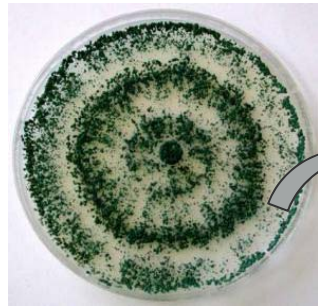
Induced Resistance

Tony Reglinski, Joe Taylor, Grant Northcott, Mike Spiers, Annette Ah Chee.
Nicole Rodenburg
Robert Hill

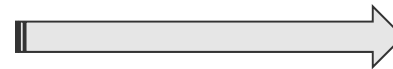
Effect of Trichoderma spp. on seedling growth

Trichoderma

- LU132
- LU140
- LU584
- LU633



Monitor change in height over 6 weeks



Destructive harvest



Trichoderma spores were applied as root drench when seedlings were 4-months old

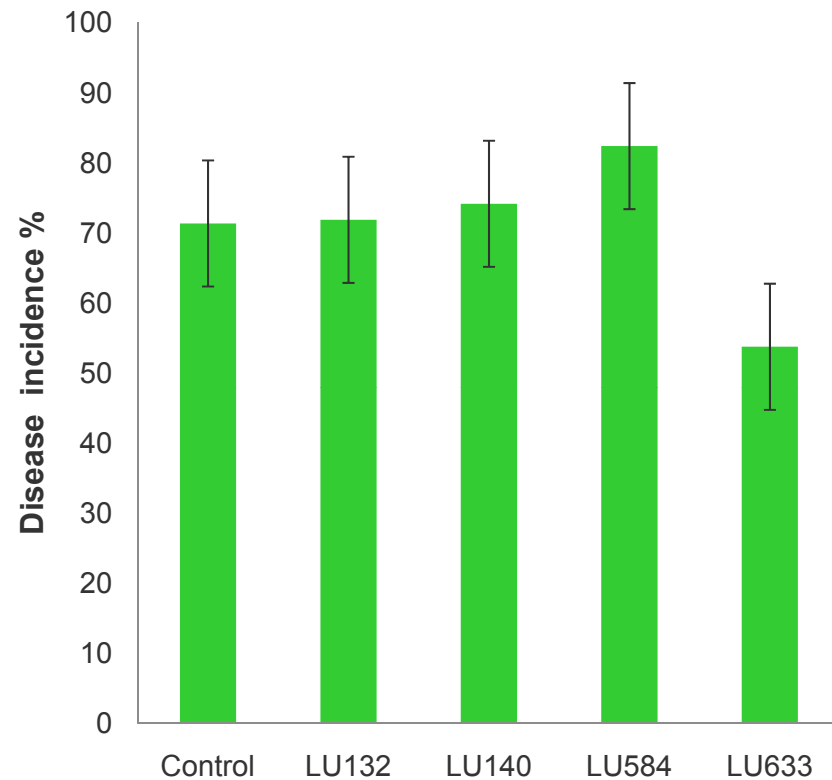
| | <i>Increase in height, cm</i> | <i>Stem diameter, cm</i> | <i>Stem dry weight, mg</i> | <i>Needle dry weight, mg</i> | <i>Root dry weight, mg</i> |
|---------------------|-------------------------------|--------------------------|----------------------------|------------------------------|----------------------------|
| Control | 5.28 ± 0.27 a | 1.74 ± 0.07 a | 86.2 ± 8.9 a | 361 ± 32 a | 68.8 ± 8.9 a |
| LU132 | 5.43 ± 0.24 a | 1.86 ± 0.05 ab | 101.0 ± 6.2 ab | 409 ± 26 a | 87.2 ± 6.7 ab |
| LU633 | 6.10 ± 0.19 a | 1.96 ± 0.06 b | 108.5 ± 5.5 b | 433 ± 23 a | 94.3 ± 5.7 b |
| LU140 | 5.60 ± 0.27 a | 2.00 ± 0.06 b | 98.0 ± 8.1 ab | 398 ± 29 a | 84.8 ± 6.6 ab |
| LU584 | 5.82 ± 0.28 a | 1.95 ± 0.07 b | 120.0 ± 9.6 b | 475 ± 38 a | 103.1 ± 8.4 b |
| F ratio (df) | 1.75 (4,94) | 2.96 (4,94) | 2.61 (4,69) | 1.92 (4,69) | 2.98 (4,69) |
| F prob | 0.148 | 0.025 | 0.043 | 0.11 | 0.025 |

Induced Resistance to *Diplodia pinea*

- *Trichoderma spp.* were applied as a root drench to potted seedlings two weeks before stem inoculation with *Diplodia pinea*.
- Disease incidence was measured four weeks later.
- LU633 reduced dieback by >20%



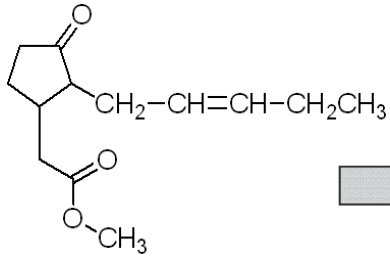
Diplodia pinea



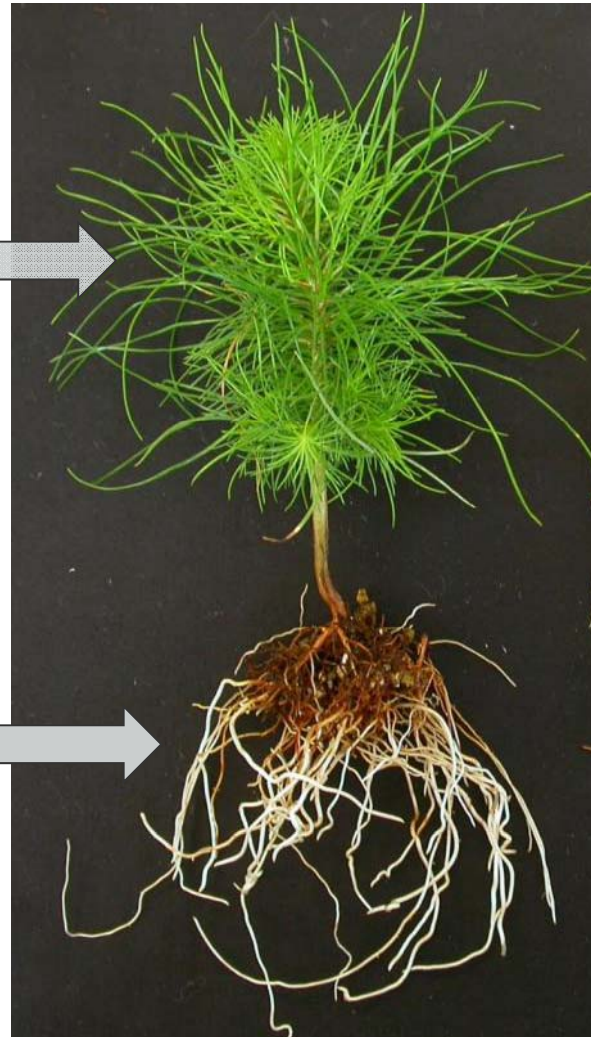
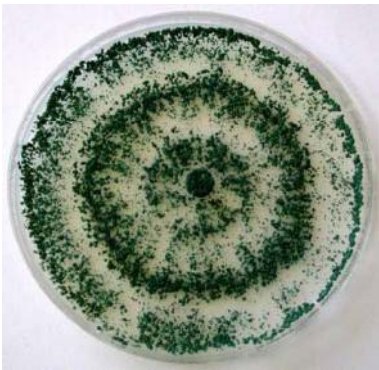
Data are the averages of four repeat trials
($F_{2,295} = 12.5$, $p = 0.013$, $LSD = 17.8$).

Treatment

Methyl jasmonate



Trichoderma spp



Plant response

1. Enhanced resistance to challenge inoculation with *Diplodia pinea*.
2. Induction of defence mechanisms
 - Terpenoids (e.g. α & β pinene) and phenolics (e.g. pinosylvin).
 - Pathogenesis-related proteins e.g. Peroxidase.

Terpenes

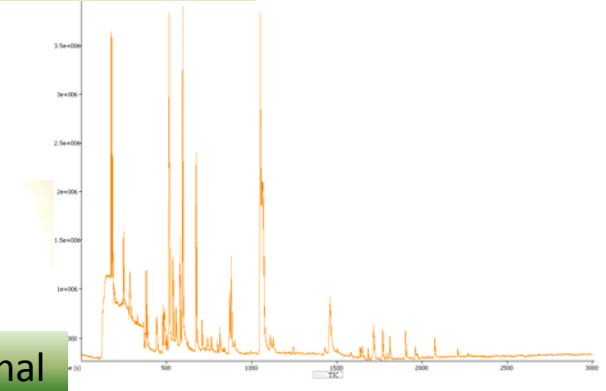
- Mono-, di-, and sesquiterpenes are common constituents of resin in conifers.
- Important in defence against pathogens and pests.
- Seals wound sites.
- Directly inhibitory to pathogens & pests



Terpenes

- Mono-, di-, and sesquiterpenes are common constituents of resin in conifers.
- Important in defence against pathogens and pests.
- Seals wound sites.
- Directly inhibitory to pathogens & pests
- communication

Interplant communication
"talking trees"

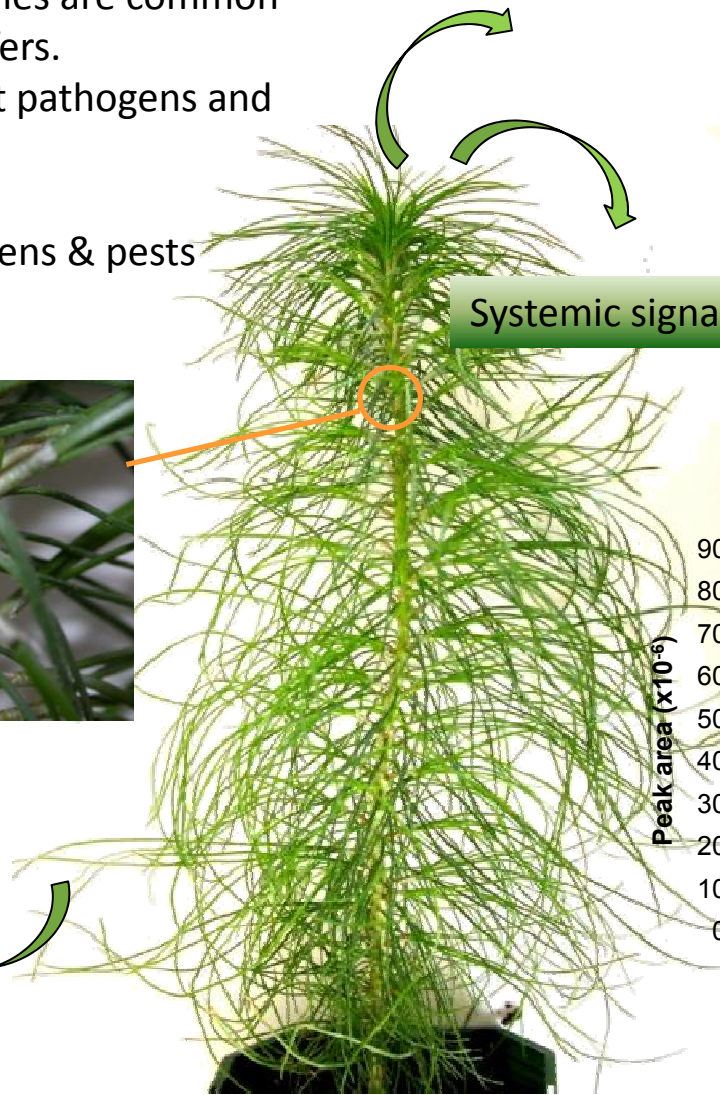
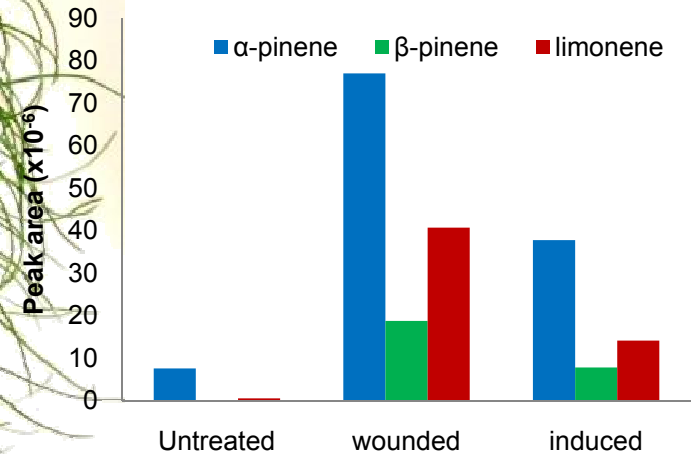


Systemic signal



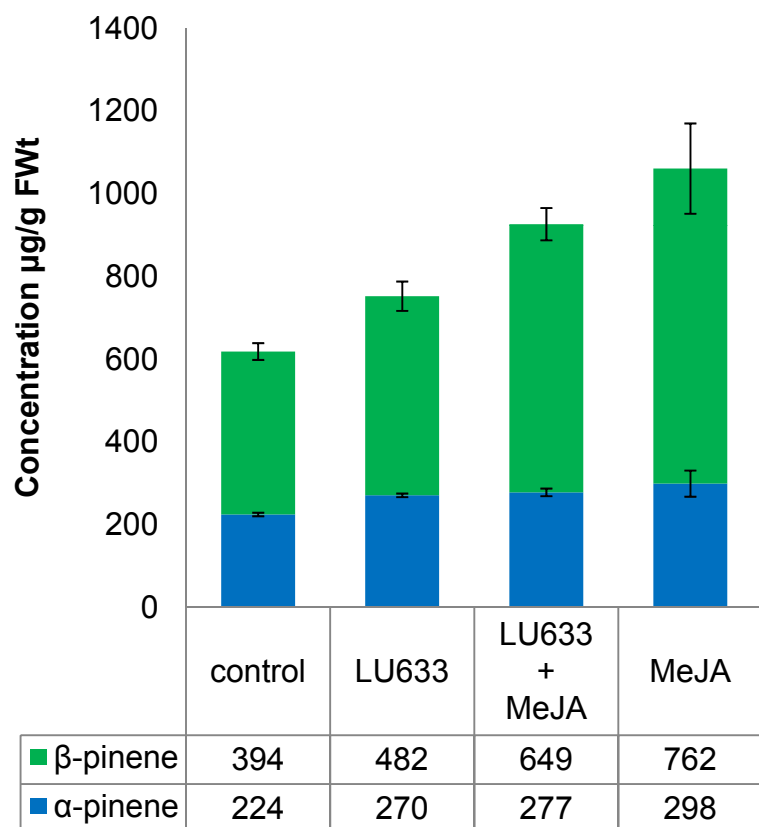
recruitment of
insect predators

Headspace analysis of wounded
and induced seedlings

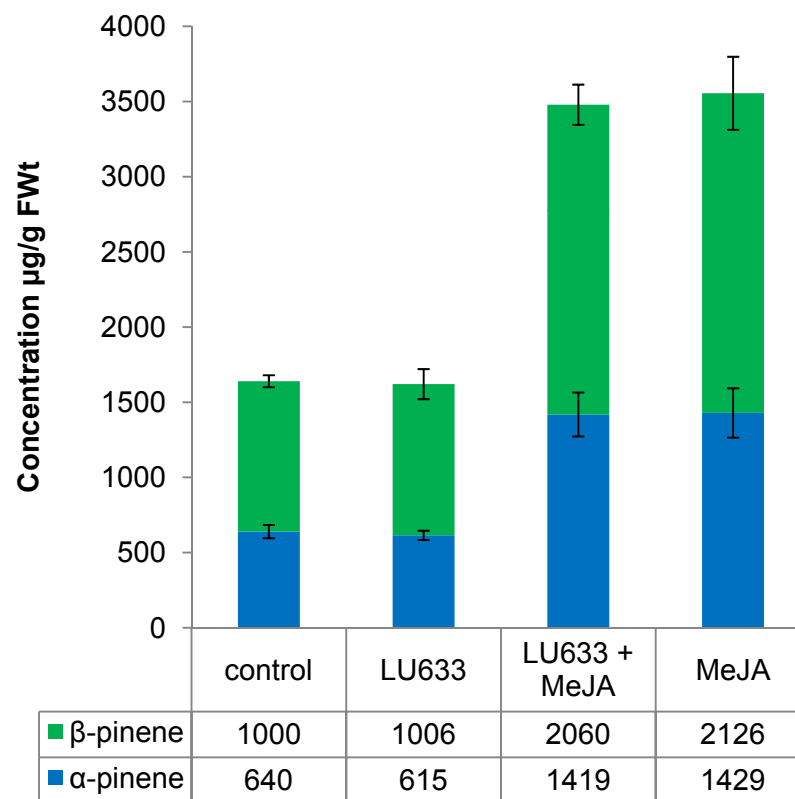


Accumulation of α -, β -pinene in stems and needles

Needles



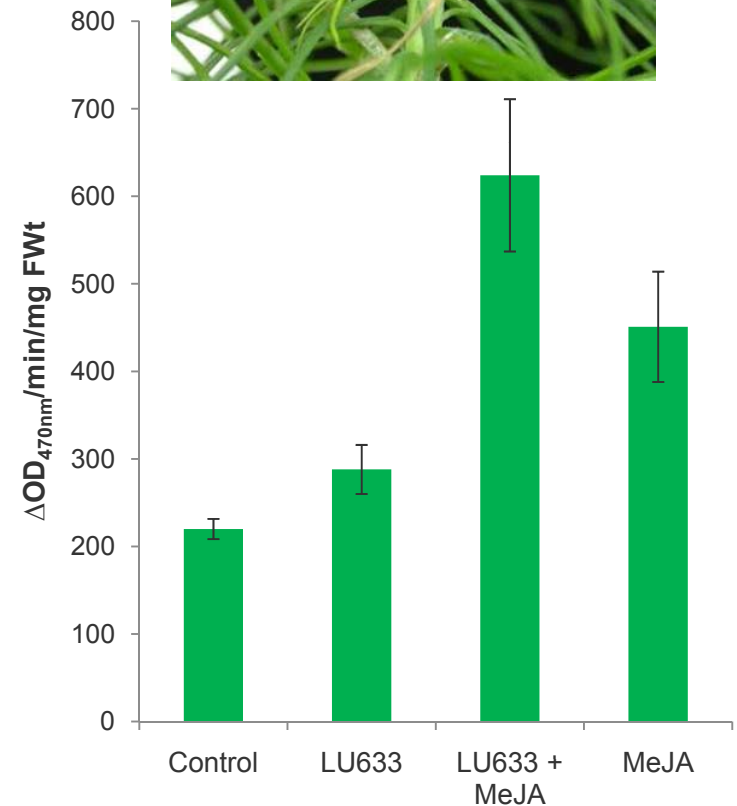
Stems



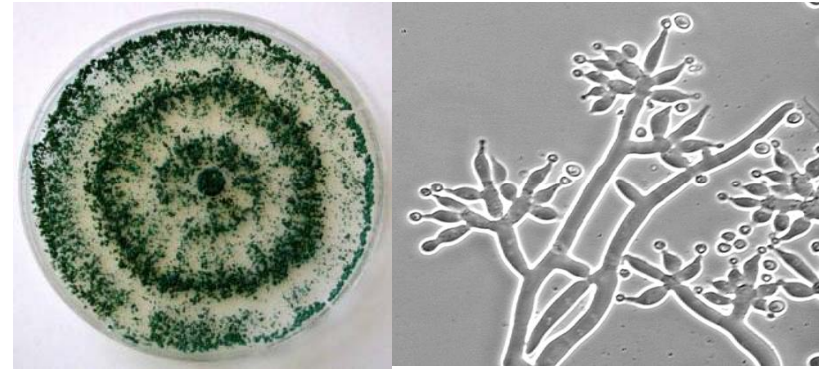
Class III Plant Peroxidase (POX)(EC 1. 11. 1. 7)

Involved in a broad range of defence processes;

- lignin and suberin formation.
 - cross-linking of cell wall components.
 - synthesis of phytoalexins.
 - hypersensitive response .
-
- POX activity significantly increased in the stems two weeks after treatment.
 - POX was significantly greater in seedlings treated with LU633+MeJA than those treated with MeJA alone.
 - Trichoderma may 'sensitise' seedlings to enable a more rapid and intense response to subsequent attack by pathogens & pests.



Summary



- Trichoderma isolate LU633 promoted growth enhanced resistance against *Diplodia pinea* in radiata pine seedlings.
- Seedling root biomass increased by 40–50%, stem biomass by >25%, and stem diameter by 12%.
- Treated seedling were more resistant to diplodia dieback.
- Peroxidase activity was greater in seedlings treated with Trichoderma+MeJA than those treated with MeJA alone.
- Trichoderma may ‘condition’ seedlings to enable a more intense defence response to pathogens & pests.

Thanks

SHORT COMMUNICATION

Trichoderma atroviride promotes growth and enhances systemic resistance to *Diplodia pinea* in radiata pine (*Pinus radiata*) seedlings

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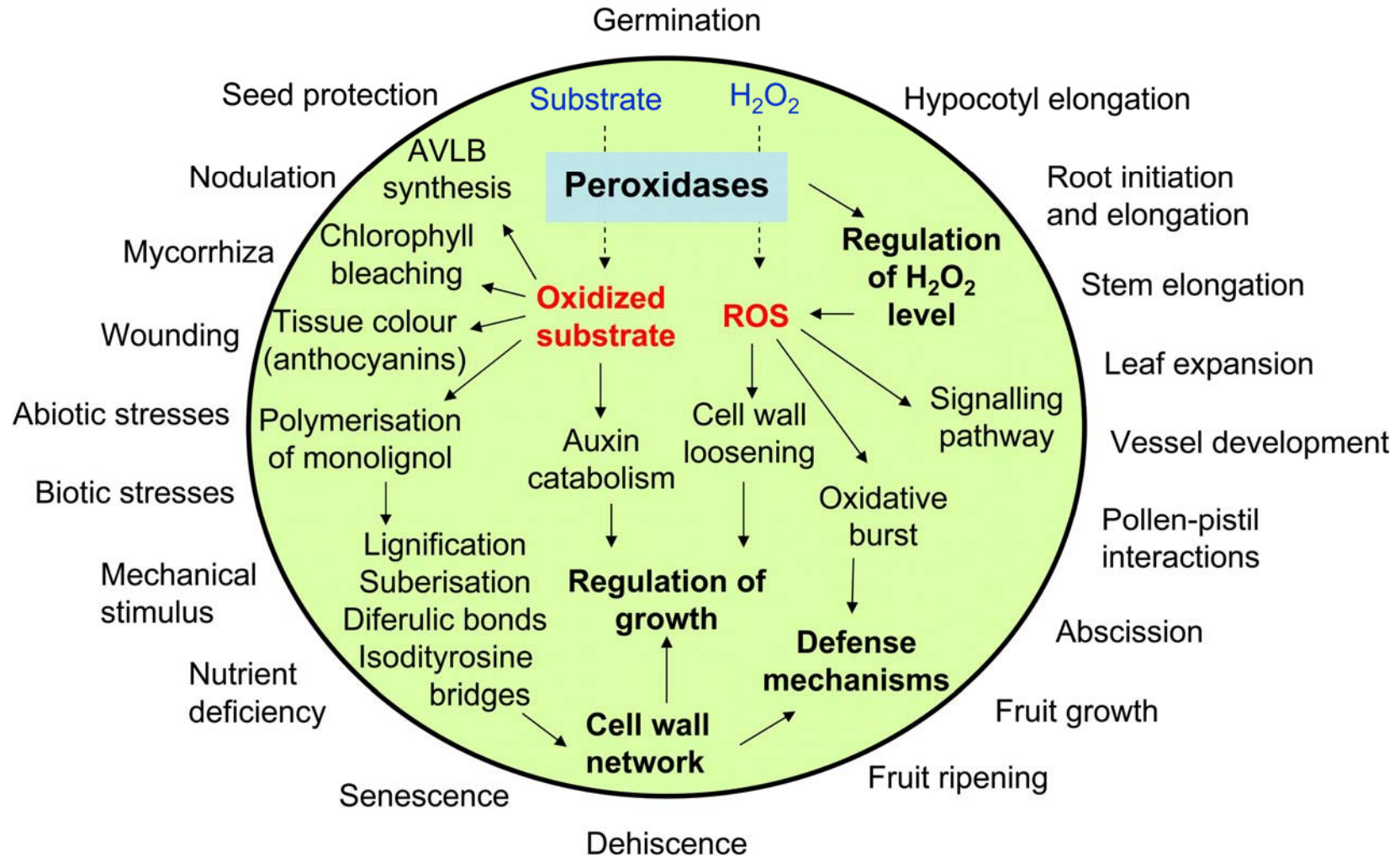
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Summary

Root drench application of *Trichoderma atroviride* isolates R32, R33, R40 and R84 promoted the growth of potted radiata pine seedlings. After 6 weeks, seedlings treated with R33 and R84 had thicker stems and greater stem and root biomass ($p < 0.05$) than untreated controls. Treatment with R32 increased seedling root biomass whilst R40 increased stem diameter. None of the isolates affected seedling height. One isolate, R33, induced systemic resistance to stem inoculation with *Diplodia pinea* and reduced dieback incidence by 20% compared with untreated controls. To our knowledge, this is the first report of systemic induced resistance by *Trichoderma* in a pine species. Furthermore, seedlings that were treated with R33 (root drench) plus foliar application of methyl jasmonate (MeJA) expressed elevated peroxidase activity in their stems 2 weeks later, compared with seedlings treated only with MeJA. Because R33 itself did not affect peroxidase activity, this may be indicative of treatment synergy or defence potentiation by R33. Curiously, R33 + MeJA induced terpenoids but suppressed phenylalanine ammonia-lyase activity suggesting possible trade-offs between phenolic and terpenoid defence pathways in the treated seedlings.

The diverse functions and roles of class III peroxidases (AVLB=α-3',4'-anhydrovinblastine).



Cosio C , Dunand C J. *Exp. Bot.* 2008;60:391-408