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A fruiting body of Scleroderma cepa *(diameter 3cm).*

Can we increase revegetation success by inoculating plants with fungi and root nodule bacteria?

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Reforestation of degraded lands can be difficult and expensive. The production and planting of nursery-raised seedlings, especially, requires substantial labour and funds. Direct seeding may provide a low cost alternative for forest reforestation, however establishment and early growth of direct-seeded recruits remains a challenge. Priming seeds with beneficial organisms and other treatments may be useful in this regard.

Thea *et al*. (2011) tested whether priming tuart (*Eucalyptus gomphocephala*) and orange wattle (*Acacia saligna*) seeds improved their germination and growth. These plants are important species in the revegetation of tuart woodlands in southwest WA.

Methods & Results

Trials were established in tuart woodland near Yalgorup National Park, south of Mandurah. The region experiences a Mediterranean climate with hot, dry summers and cool, wet winters (June to August) with average annual rainfall of ~900 mm, and is predominantly depauperate sands of the Spearwood Dune System. The sites had previously been grazed and had no native understorey species present.

Two field experiments were established:

Trial 1 investigated the effect of a liquid innoculum of four local mycorrhizal (ECM) fungi species (Figure 1) and inorganic fertiliser on establishment and growth of tuart planted as seedlings or sown directly as seed. Treatment 1 tested the effects of mycorrhizal fungi alone, Treatment 2 tested the effects of mycorrhizal fungi plus a 10g inorganic fertiliser tablet (composition: 20% N, 4.4% P, 8.2% K, micronutrients). The control (Treatment 3) was untreated plants.

After one year, 81% of the nursery-raised tuart seedlings had survived compared to only 8% of seedlings establishing from direct seeding. Nursery-raised seedlings were more than double the height of those from direct seeding. However we did not find any significant effects of the treatments on tuart establishment or growth (Figure 2).

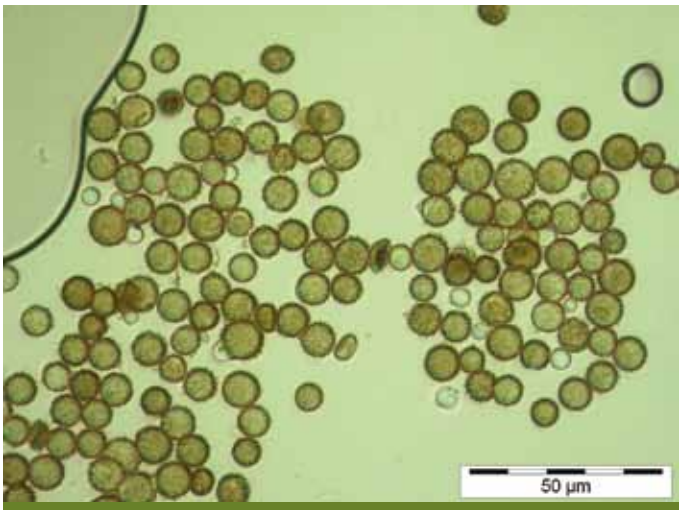

*Figure 1 Thousands of mycorrhizal fungi species exist. A mycorrhiza (*Greek: 'fungus-roots'*) is a mutualistic association between a fungus and the roots of a vascular plant: the plant provides the fungus with carbohydrates, while the plant benefits from the mycelium's higher absorptive capacity for water and minerals. A mixture of four local mycorrhizal fungi (9 × 10^6 spores; equal mix of* Scleroderma cepa, Pisolithus marmoratus, Laccaria lateritia *and* Amanita eucalypti*) was used in liquid form to inoculate tuart seeds and seedlings in this study. This image shows the microscopic spores from the fruiting body of* Pisolithus *sp.*

Trial 2 examined the effects of N_2-fixing bacteria (presented as a suspension of crushed N_2-fixing bacteria root nodules collected from young orange wattle trees), mycorrhizal fungi (in this case commercial mycorrhizal inoculum) and inorganic fertiliser on establishment and growth of orange wattle.

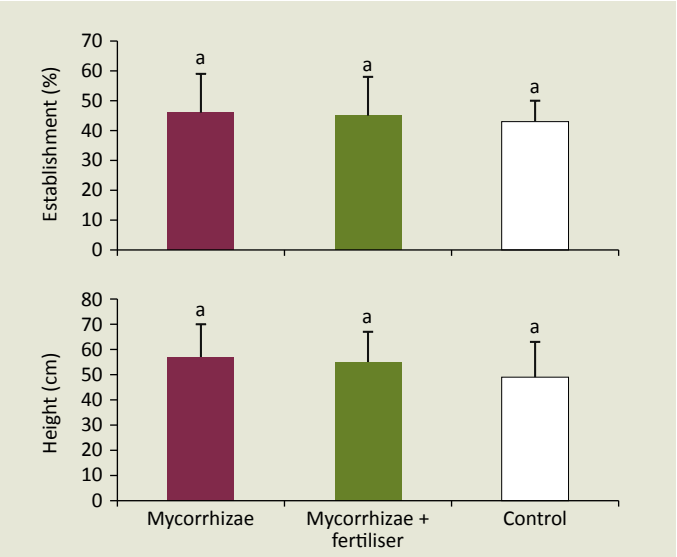

*Figure 2 Response of tuart (*Eucalyptus gomphocephala*; directly sown or planted as seedlings) to mycorrhizal fungi and inorganic fertiliser treatments after one year. Values are means (± S.E.) of 3 replicates for each treatment tested. In a column, letters link means that were not significantly different at α = 0.05.*

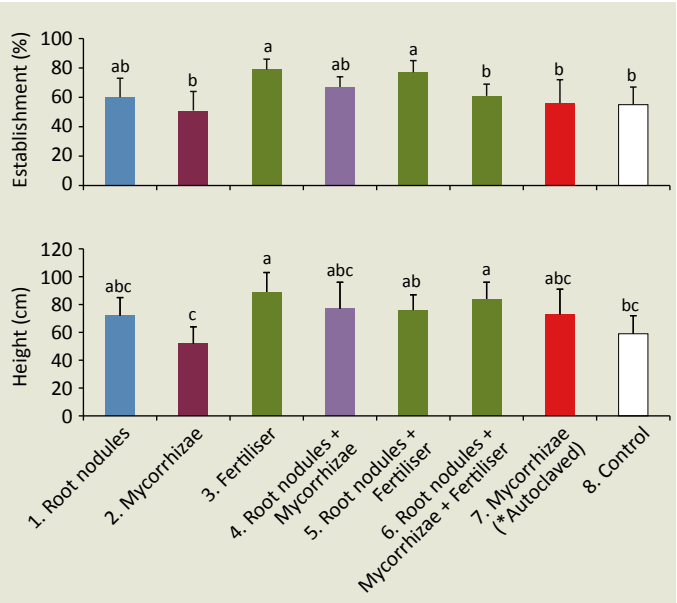

Figure 3 Response of orange wattle Acacia saligna *(directly sown or planted as seedlings) to the presence of N_2-fixing bacteria (crushed root nodules), mycorrhizal fungi (commercial mycorrhizal inoculum) and inorganic fertiliser treatments after one year. * indicates the commercial mycorrhizal inoculum was autoclaved prior to treatment of plant material, which would kill the fungi. Values are means (± S.E.) of 3 replicates for each treatment tested. In a column, letters link means that were not significantly different at α = 0.05.*

Establishment and growth of nursery-raised orange wattle seedlings were twice those of plants from seeding. In this species, the treatments tested did influence establishment and growth of plants (Figure 3). At one year, establishment and growth were improved by application of inorganic fertiliser (with or without a nodule suspension: Treatments 3, 5 and 6) resulting in improved seedling establishment and seedling growth (by 51%, 29% and 42% respectively) over the control. The microorganism treatments, however, did not result in significant improvement in establishment or growth, with the least growth evident for plant material treated with the commercial mycorrhizal inoculum.

Conclusions & Recommendations

There was no evidence that the application of mycorrhizal fungi promoted establishment or growth of tuart or orange wattle. This may be due to the added fungi not colonising host plants or being effective in promoting nutrient uptake and growth, or else there were already sufficient propagules of native mycorrhizal fungi present in the soil to make additional application ineffective.

Establishment of nursery-raised seedlings was superior to direct seeding, with twice the numbers of orange wattle plants established when planted as seedlings rather than sown as seeds. For tuart, establishment through planting of seedlings was an order of magnitude higher. The significant differences in establishment may be explained in part by the rapid drying of the soil profile as the dry season progresses, and differing capacity of the plant to allocate resources for root growth into the soil profile to access water.

In conclusion, this study has shown that the use of seedlings is more effective than sowing seed in degraded tuart woodlands, even when attempting to reintroduce key colonising species. The microorganism treatments did not result in significant improvement in establishment or growth of the plants monitored, which suggests that the application of these treatments is unwarranted in revegetation projects where soil biota are likely to still be intact.

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References

1. Thea, S., Ruthrof, K. X. and Dell, B. (2011) Seed and seedling responses to inoculation with mycorrhizal fungi and root nodule bacteria: implications for restoration of degraded Mediterranean-type Tuart woodlands. *Ecological Management and Restoration* 12: 157-160.