One Billion Trees Programme
Helping New Zealanders plant the right trees, in the right place, at the right time

Te Uru Rākau New Zealand Forest Service

How does soil moisture affect native tree seedling survival and growth?

How will our native tree species cope with shorter- and longer-term moisture stress?

Aotearoa New Zealand's climate is changing, with some parts of the country expected to become much drier or experience more frequent and intense drought events. One question is: how will our native tree seedlings tolerate these drier conditions, especially for species commonly used for native afforestation?

This fact sheet has information to help you think about drought stress, particularly in terms of the importance of watering during the establishment of native seedlings in the greenhouse and soil moisture when planting seedlings out into the field in different locations.

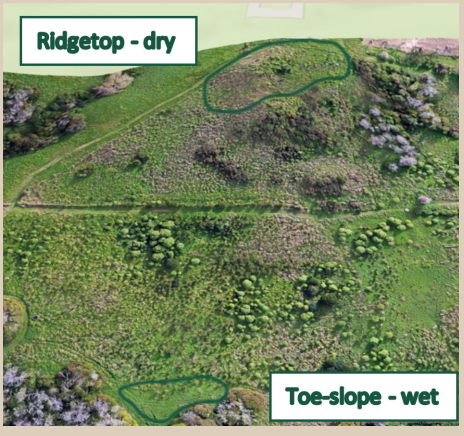
This Auckland University of Technology (AUT) study investigated water availability impacts on the survival and growth of four common native restoration species: kānuka, karamū, māhoe, and whau. The research involved two phases:

Phase 1: Seedlings were watered in a greenhouse at three controlled rates to understand how different watering regimes might affect the performance of these different species:

- low watering: 18 min per day every five days
- medium watering: 18 min per day every three days
- high watering: 18 min per day every day over three months.

Phase 2: A subset of these same seedlings was planted out into the AUT Living Laboratories restoration site at Te Pourewa, Auckland and monitored over a year. Half of the seedlings were planted in a dry, ridgetop location and half in a wet, lower-slope location.

The purpose of this phase was to explore how seedlings, subjected to different levels of water stress in the nursery, could then cope with different soil moisture conditions when planted in the field. This type of information is useful for understanding species' tolerances to ongoing stress.



Not all native tree species are the same

- Aotearoa's native tree species have different tolerances to stressful conditions.
- These tolerances affect how seedlings allocate nutrients and water, above- and below-ground, for survival and growth.
- Knowing about species' tolerances to low moisture conditions can guide us on how to optimise seedling establishment in the nursery and once planted in field conditions.

Responses to moisture stress – takeaways from the experiments

There is not a lot of published scientific information about the tolerances of native seedlings. Moisture experiments improve understanding of how seedlings respond to water availability and help fill information gaps for different native species.

Species		What information do we have?	Tolerance to low moisture: What did we learn?
Karamū *Coprosma robusta*		• Common large shrub restoration species. • Robust leaves. • Moderately fast growing. • Thought to be hardy to a range of moisture conditions once mature. • But seedlings considered sensitive to ongoing low-moisture conditions.	• Highly tolerant to low moisture conditions. • High survival and growth, both in the nursery and in the field, in all conditions.
Mānuka *Leptospermum scoparium*		• Widespread, early coloniser small tree. • Small, thick needle-like leaves. • Considered highly tolerant to dry field conditions.	• Moderately tolerant to moisture stress in nursery and field. • Coped with moisture stress by dropping leaves (dieback). • Survival was high.
Māhoe *Melicytus ramiflorus*		• Moderately-fast-growing sub-canopy tree. • Fleshy, relatively thin leaves. • Considered tolerant to a range of moisture conditions. • Seedling shown to be drought sensitive.	• Moderately intolerant to moisture stress. • Moderate survival in nursery and after field planting. • Low growth performance overall.
Whau *Entelea arborescens*		• Very fast-growing. • Large, fleshy leaves. • Early-colonising, small tree on disturbed sites. • Seedlings considered intolerant of very dry or very wet soil conditions, particularly before root system has developed.	• Very low tolerance to moisture and transplanting stress. • Minimal growth throughout experiment, for both roots and aboveground components. • Nearly 100% mortality in the field planting phase.

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Considerations in the greenhouse

- Repotting can stress young seedlings of some species, causing poor ongoing growth performance.
- Our results suggest it's beneficial to water seedlings at least every three days for 15 to 20 minutes and, ideally, every day for 15 to 20 minutes.

Considerations for planting native tree seedlings

- Get good quality nursery stock where plants were well watered throughout their life. Even short periods of drought stress in the nursery can have noticeable effects on growth and survival even a year on.
- Think carefully about the timing of planting and conditions of the site, including the climate, soil, weed density, and topographic variability.
- Environmental moisture conditions can change over small distances, for example between downslope or upslope conditions.
- Upper slope positions are likely to be drier, where more drought-resistance species might be more successful.
- Alternatively a lower-slope, wetter environment, would be suitable for species with greater stress tolerance versatility.

About this fact sheet

This fact sheet was produced by the AUT Living Laboratories Forest Restoration Research and Education Programme team. It is based on the technical report called "Seedling responses of four native angiosperm species to experimental moisture conditions: A two-phase, greenhouse and out-planting experiment", commissioned by the One Billion Trees Programme, Te Uru Rākau – New Zealand Forest Service.

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Want more information?

Read the full technical report called "Seedling responses of four native angiosperm species to experimental moisture conditions: A two-phase, greenhouse and out-planting experiment". The technical report is on the **One Billion Trees Programme science projects page on the MPI website**

Read other One Billion Trees fact sheets on the **Resources section on the Canopy website**

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