Growing confidence in forestry's future Research Programme

SCION FORESTS ▪ PRODUCTS ▪ INNOVATION

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Technical Note

The Accelerator Trial series – update on progress to June 2019

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Summary: All six Accelerator Trial sites have been installed, and various initial treatments and post-planting treatments have been applied. In this technical note we detail some early results from the first three trials and describe the rationale for future treatments at all sites. A strategy for ongoing engagement with the forestry sector to maintain and manage these trials is outlined. (Refs: GCFF TN-015 and GCFF FN-022)

Introduction

The Accelerator Trials have been established to support the forestry sector's target of sustainably increasing the productivity of New Zealand's forest estate under a range of current and future limitations[1]. This is to be achieved at each of six trial sites (Fig. 1) through detailed assessments of growth and health followed by the application of specific interventions.

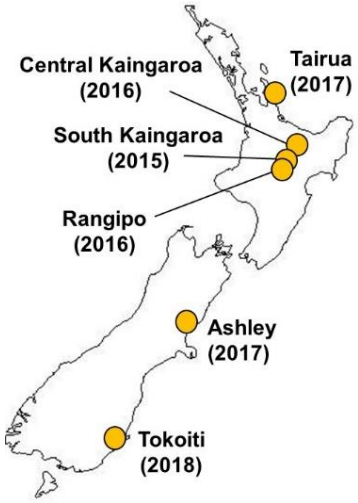

Figure 1 Location of the six Accelerator Trials and year of establishment.

These efforts are supported by past and ongoing research into tree nutritional status, indices of soil fertility, silviculture, and genetics, which have altered biomass, nutrient uptake, tree water use, and stand productivity across a range of sites and initial conditions.

This trial series is the flagship project of the GCFF programme, with ongoing management interventions at the sites planned to extend throughout the life of the planted radiata pine rotation (Fig. 2). This also provides the additional benefit of generating full rotation data sets, critical to demonstrating the long-term sustainability of the treatments.

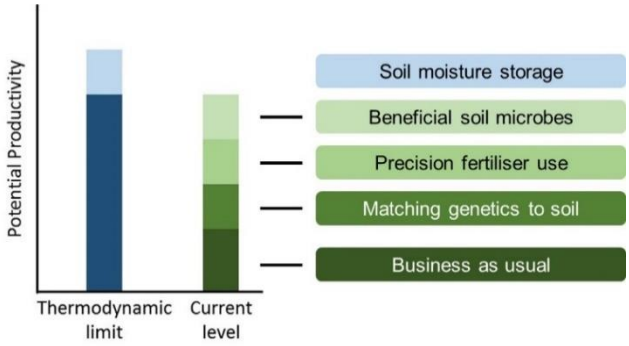

Figure 2 Incremental applications of productivity-enhancing treatments to a hypothetical site to attain the thermodynamic potential, defined by light and temperature.

In this technical note, we present results from the first three sites, outline the treatments and research to be explored at each site, and identify a process for the ongoing management of the sites.

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Basic Trial Design

The Accelerator trials are established following a split plot design, using a single plot for treatment that contains 12 subplots, each populated with the different planting stock types. Conceptual arrangement of subplots within plots across the trial space is provided in GCFF Tech Note 0XX[2]. The stock types used in the trials (Table 1) were selected for the variety of traits they possessed, in order to identify the most suitable tree genetics for the various sites, and to find genotypes that would respond most positively to future site treatments. Although it was not possible to utilise the exact same material for all sites due to changes in availability through time, the overall range of traits was able to be maintained for each year.

Stock Code	High DBH	High MOE	High density	Low density	Dothistroma resistant	Drought tolerant	Sites present
15	✓	✓	✓		✓	✓	All sites
19	✓	✓		✓			All sites
24	✓	✓	✓			✓	1,2,3,4,5
25	✓	✓	✓				1,2,3
30	✓	✓		✓			1,2,3
31					✓	✓	1,2,3
37	✓	✓		✓			1,2,3,4,5
38	✓	✓	✓		✓		1,4,5,6
43	✓	✓		✓			All sites
48	✓	✓	✓				All sites
50	✓						4,5,6
60	✓	✓	✓		✓		2,3,4,5,6
66	✓	✓		✓			6
74	✓						4,5,6
77	✓	✓					6
A x C hybrid						✓	All sites
GF19							All sites

Table 1 The traits of the stock types used in the Accelerator trials and their distribution across the trial sites.

Southern Kaingaroa Trial (2015)

Treatments to Date

The site has received two post-planting treatments – a replicated set of plots were dosed with biuret at 12.5 kg nitrogen ha^{-1} (completed in early 2018) and another set of plots were treated with urea at 50 kg nitrogen ha^{-1} (applied in late 2018). In both cases chemicals were applied by hand. Blanket copper spray to treat dothistroma needle blight was also applied across all plots in late 2018 and early 2019. Management of regenerating non-crop radiata pine has also taken place on a regular basis, but the need for this is abating as the crop trees mature.

Results to Date

As of the 2018 measurement, only the effects of the biuret treatment can be determined. Biuret produced several statistically significant outcomes, including increased height and diameter growth, and, prior to copper treatment, reduced damage from dothistroma (Fig. 3). Stock type also exerted a considerable influence, influencing growth rates, tolerance to dothistroma and the extent of beneficial activity in the soil microbial community immediately around the tree.

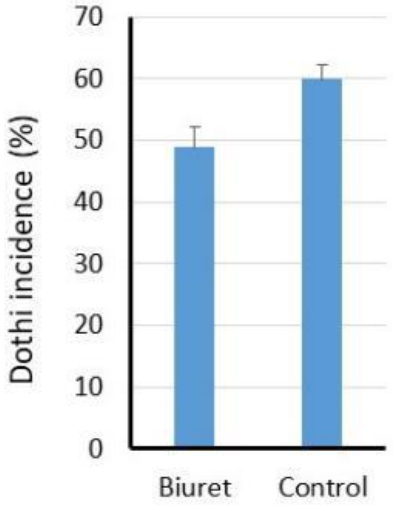

Figure 3 Significant reduction in the extent of needle damage from dothistroma following the application of biuret.

Future Treatments

Based on modelling with NuBalM, this trial will receive further urea doses as needed. Discussion at a workshop in August 2018 determined application of other elements will occur based on regular foliar sampling. Copper spraying will continue as needed, and further biuret testing is also likely to explore the disease control potential in more detail..

Central Kaingaroa Trial (2016)

Treatments to Date

To increase organic matter content and nitrogen in the soil, a lupin sowing treatment was applied at this site in April 2019. This treatment was discussed and developed at the August 2018 stakeholder meeting. A step-out trial to further explore the effect of herbivory and the timing of lupin seed dispersal on germination and growth rates was also developed and installed; this work is ongoing. Copper sprays to treat dothistroma needle blight were applied in late 2018 and early 2019, and management of regenerating non-crop radiata pine is ongoing.

Results to Date

Although it is too early to identify an impact on the radiata or the soil, the lupin plants are establishing well within the trial area and appear to be subjected to minimal herbivory at this stage (Fig. 4).

Future Treatments

The growth of the lupins will continue to be monitored, and based on the impact that this has on soil status and the growth of the trees, further treatments will be applied. The uptake of phosphorus by legumes is an issue as this may affect tree nutrition, so will be assessed. Biuret is also likely to be applied to explore the impact this has on the lupins in this context, as the weed control effect may be a useful mechanism to convert the lupins into soil organic matter at a specific time rather than waiting for shading to gradually induce lupin mortality. Copper spraying will continue as needed, and the impact this has on the developing lupin understorey will be explored.

Figure 4 Successful germination and vigorous growth of a lupin understory in the treated areas of the Central Kaingaroa Trial

Rangipo Trial (2016)

Treatments to Date

This ex-pasture site was established with plots at 833 and 1282 sph to provide a stocking treatment, and a disc cultivation treatment was also applied to half of the trial area. In addition, considerable soil and weed growth sampling has been done at this site to quantify the effects of the initial treatments. This has been done through ground based assessments of density and mass, but the site has also been used as a test case for various remote sensing platforms to assess height growth and weed density (Fig. 5). Blanket copper spraying for dothistroma took place in early 2019, with assessment of the effects of the treatments on dothistroma incidence occurring before this date.

Results to Date

Cultivation significantly promoted weed growth compared to the undisturbed area of the trial (Fig. 5).

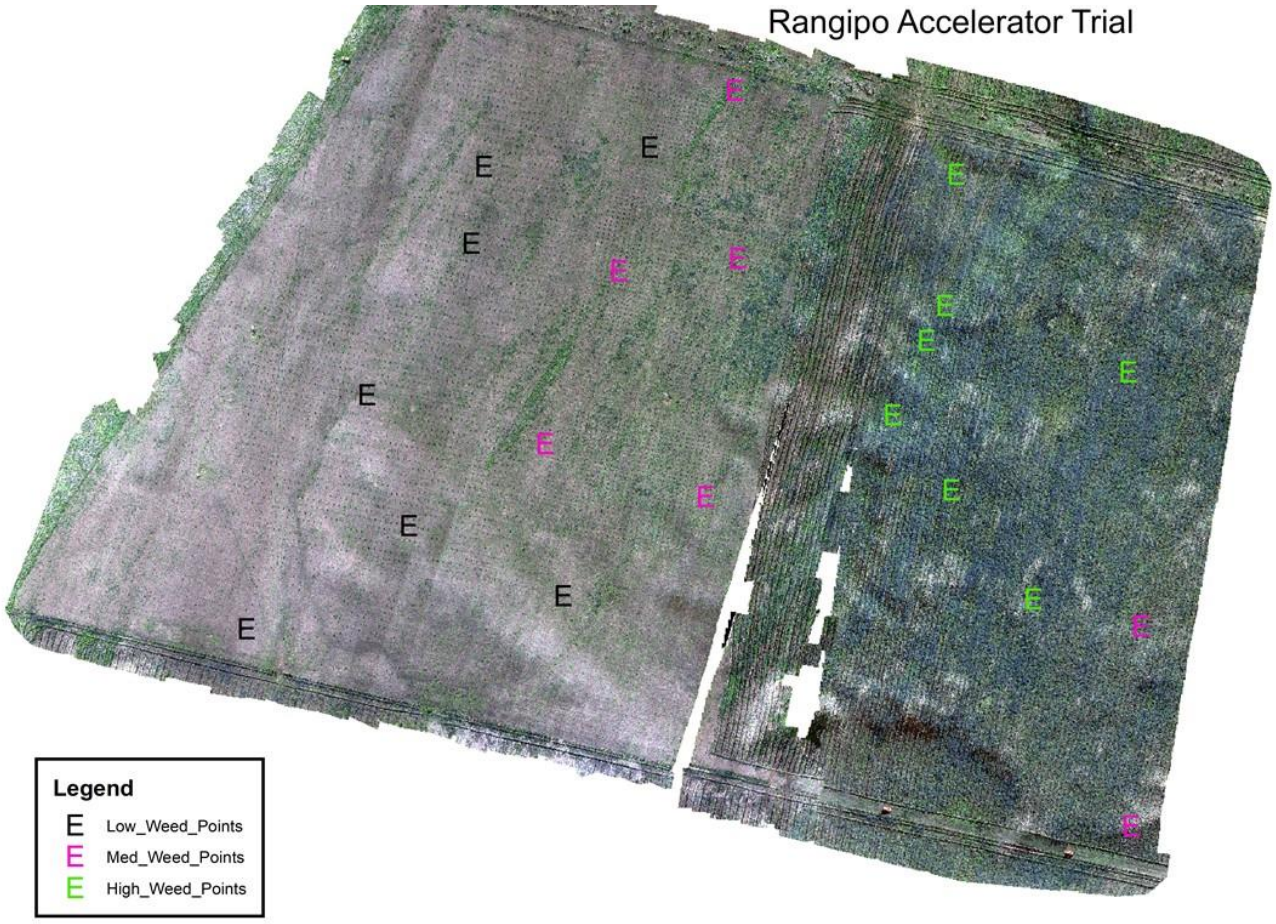

Figure 5 Weed density as indicated by analysis of remote sensing data. Weed destiny was increased by the application of cultivation prior to planting (right side of trial area).

The cultivation treatment, likely due to greater weed competition, also resulted in significantly reduced tree vigour, evidenced by reduced growth rates (Fig. 6) and greater incidence of dothistroma (47%).

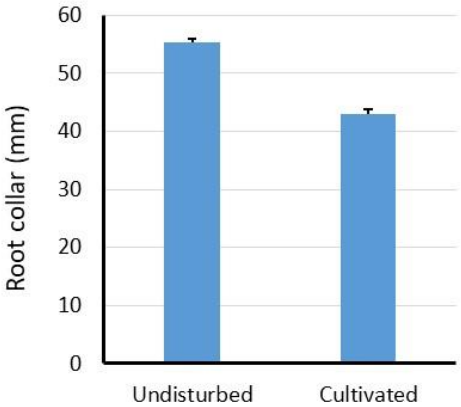

Figure 6 Significant reduction in tree growth with the cultivation treatment.

In addition, the greater stocking rate was also associated with a marginal increase in dothistroma incidence (9.8%). However, no deleterious effects on tree growth were observed with greater stocking.

Future Treatments

Soil and foliage at the site is being collected and will be used to inform future nutrient management decisions. Variations in microbial properties at the site have also been assessed based on molecular analysis and will be used to determine the extent of interventions, designed to alleviate any stress associated with greater stocking rates by encouraging the activity of plant growth promoting rhizobacteria, as has been accomplished at the Southern Kaingaroa trial site.

Ashley Trial (2017)

Treatments to Date
No specific treatments have been applied yet; these will occur in 2020. Treatments will focus on efficient methods to control gorse, which presents a major issue at sites of this kind. Deployment of biuret is a likely treatment. The management of regenerating radiata pine at this site has been ongoing.

Results to Date
The different stock types planted at this site display variable levels of suitability to this location, but the full extent of the differences will become apparent post-treatment application.

Future Treatments
Treatments to enhance stress tolerance will be the initial focus at this dry site. This will involve targeted weed control, but two additional pathways to affect stress tolerance have also been developed:

- The use of chemical treatment to decrease the sensitivity of the plant to moisture stress, enabling greater productivity to be maintained
- By enhancing the activity of soil bacteria that produce the enzyme 1-aminocyclopropane-1-carboxylate deaminase, which decreases *in planta* ethylene production, reducing the negative effects of moisture stress

Considerable progress has been made towards operationalising these treatments for deployment.

Tairua Trial (2017)

Treatments to Date
The specific limitation at this trial is phosphorus deficiency, which will likely begin to manifest in the next 2-3 years. This is driven by high phosphorus retention in the Allophanic soils at this location.

Results to Date
As at Ashley, the different stock types planted here display variable levels of performance, as expected.

Future Treatments
The initial treatments at this site will be determined by Dec 2019. This will be informed by implementing the phosphorus module within NuBalM[3] to identify the timing and extent of demand, factoring in the ongoing supply of phosphorus from the remaining slash at the site. Two opportunities under consideration are:

- Direct application through foliar fertiliser use
- Capture of phosphorus into organic forms through the sowing of legumes for later release through decomposition.

Further data to support these concepts is becoming available from existing trials, while a review is also being conducted to explore past trial results. Prior to any treatment application, further consultation with industry will also be pursued.

Tokoiti Trial (2018)

Treatments to Date
This site was selected as it is projected to be significantly affected by reduced moisture availability within the life of the next rotation due to climate change. To address this, a cultivation treatment was applied at three levels during site preparation to attempt to increase soil moisture storage capacity:

- Whole tree harvesting followed by windrowing (control)
- Whole tree harvesting followed by grinding of the harvest residue and cultivation of the mulch into the soil to a depth of 500 mm
- Stem only tree harvesting followed by grinding of the harvest residue and cultivation of the mulch into the soil to a depth of 500 mm

Soil sampling was undertaken to assess the impact of these treatments on various properties, but the visual impact was stark (Fig. 7).

Figure 7 Extent of slash remaining on the soil surface in the control treatment plots (left) compared to the grinding/cultivation treatment plots (right)

Results to Date
No growth data are available yet, but soil samples have been collected and microbial data from the site are currently being analysed to assess the impact of the cultivation treatments on relevant properties.

Future Treatments
Stress tolerance treatments will be applied to the Tokoiti site in future, informed by the findings from the Ashley trial, where water stress is already the dominant limitation to productivity. It is also planned to install a network of soil moisture sensors in this location, to identify any critical points in soil moisture storage in relation to atmospheric conditions, treatments and tree performance.

Use in the development of remote sensing technologies

All six sites have been characterised through remote data capture from drone overflights. Given the intense level of on-ground monitoring, the opportunity has been taken to test and refine several systems to translate the remote data into various practical measurements, including soil properties based on visual metrics, weed density (as at Rangipo), tree counting systems and tree height estimation. This work is ongoing, and will provide considerable additional value.

Ongoing engagement with stakeholders regarding treatment plans

It is recognised that the Accelerator trials represent a substantial investment by Scion, the FGLT and the companies hosting the individual trials. As such, the Scion scientists leading this project will continue to engage with stakeholders regarding potential treatments and the results of past interventions. The first such meeting was held in August 2018, with another meeting to be held in the near future.

Acknowledgements

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References

1. New Zealand Forestry Owners Association, *New Zealand Forestry Science and Innovation Plan 2012*. NZ Forest Owners Association, Wellington (2012).
2. Smaill, S.J., Garrett, L.G. *The Accelerator Trial series – update on progress to June 2019*. GCFF File Note GCFF FN-022. (2018).
3. Smaill, S.J., Hock, B.K., Clinton, P.W. *A nutrient balance model (NuBalM) to predict biomass and nitrogen pools in* Pinus radiata *forests*. Forest Ecology and Management ***262***, pp. 270-277. (2011).