Growing confidence in forestry's future Research Programme

SCION FORESTS ▪ PRODUCTS ▪ INNOVATION

Date: June 2018
Reference: GCFF-T023

File Note

The Accelerator Trial series – update on progress to June 2018

Authors: Simeon Smaill and Loretta Garrett

Corresponding author: Simeon Smaill (simeon.smaill@scionresearch.com)

Summary: Five of the six planned Accelerator Trial sites have now been established, with a sixth site currently being installed. In this file note we detail the rationale for the inclusion of these sites, and describe the initial treatments that have already been applied or are in planning stages. A strategy to engage with the forestry sector to identify further treatments is outlined. (Ref: GCFF TN-015)

Introduction

The Accelerator Trials have been established to support the Forestry sector target of sustainably increasing the annual export earnings of New Zealand's forest estate to $12 billion by 2022[1].

This trial series has been developed under the "Growing Confidence in Forestry's Future" (GCFF) research programme[2], and is designed to identify the key current and future limitations to productivity at specific sites, and then sequentially overcome these limitations through the application of targeted interventions based on state of the art science.

This science is supported by past 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 research suggests that stand productivity can be approximately doubled through combining site fertility improvements with the use of superior genotypes grown at a final crop stocking level that fully utilises the carrying capacity of the site.

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. This also provides the additional benefit of generating full rotation data sets, which are critical to demonstrating the long term sustainability of the treatments. The various treatments to be tested are beyond "business as usual".

In this file note the progress made towards establishing each trial site is reported, including characterisation of site properties and suitable productivity enhancement treatments.

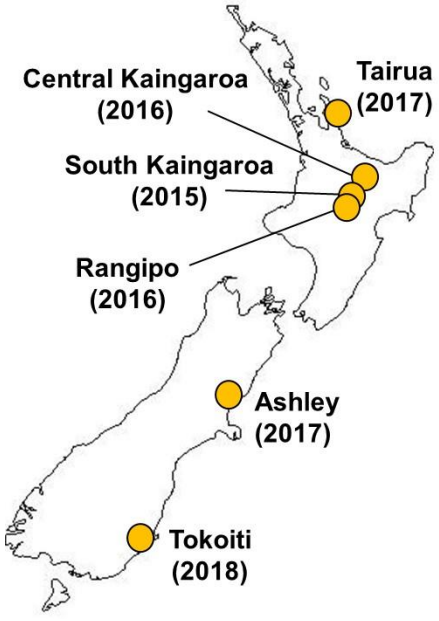

Figure 1 Location of the six Accelerator Trials and year of establishment

supported by forestgrowers commodity levy

FOREST GROWERS RESEARCH

This programme is also funded by Scion and the Ministry of Business, Innovation and Employment, New Zealand.

Basic Trial Concepts

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 stock types. These stock types were selected based on the traits they possessed in order to identify the most suitable tree genetics for the various sites, and to also find genotypes that would respond most positively to the future site treatments. These traits are:

- High DBH
- High MOE
- High density
- Low density
- Dothistroma resistance
- Drought tolerance

A stable combination of these traits has been provided through ten selection of 10 clones, an Attenuata x Radiata (Cedross) pine hybrid, and a GF19 seedling. Note that given the dominance of radiata pine in the New Zealand planted estate, only this species was chosen for use in the trials. A conceptual overview of trial layout is shown in Figure 2; this approach reduces the risk of cross-contamination between treatments.

Analysis suggests that New Zealand planted forest have historically been understocked[3], which has negatively affected productivity. In the Accelerator Trials, stocking rates will be informed by the latest research conducted to assess carrying capacity, Wood quality will be assessed, including the effects of tree stock type and the effects of the site management treatments such as nutrient additions. This is a necessary component of the trial work given the known potential for fertiliser amendment to diminish wood quality[4]. Key areas of additional research will be examining how the stock type and site management treatments affect the activity of soil microbial communities, and the environmental outcome of the treatments. These concerns directly relates to issues around the maintenance of licence to operate, and the ability of the site to continue to support planted forests over multiple rotations[5]. The following sections detail the characterisation and treatment work done at each site, as well as plans for future treatments that will be developed in partnership with industry.

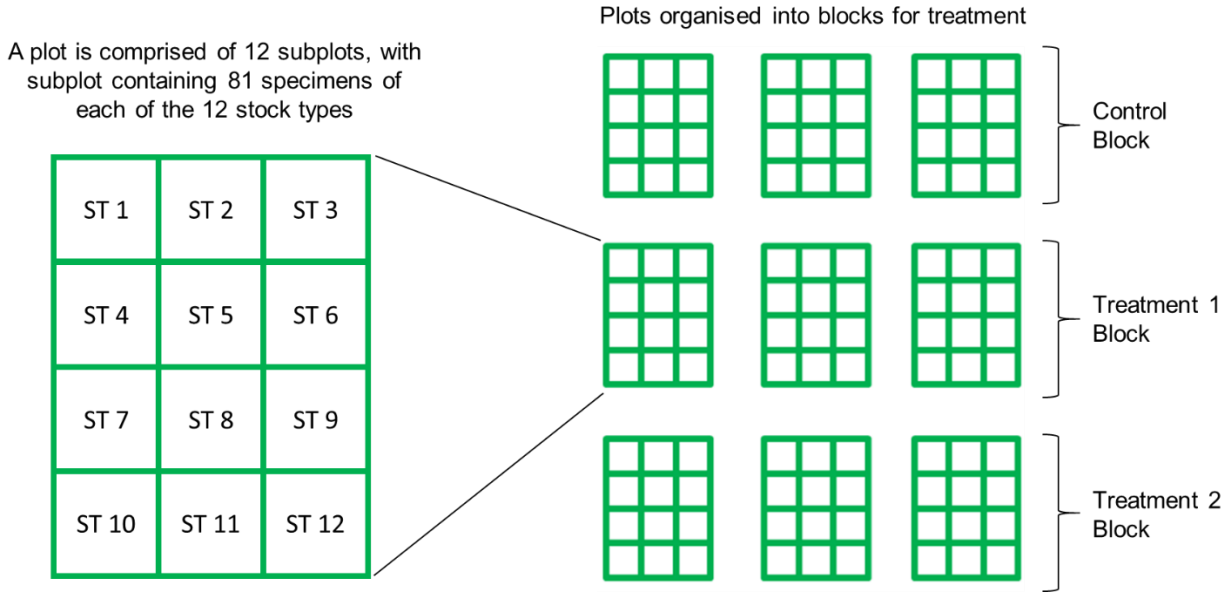

Figure 2 Layout of the subplot, plots and blocks in the Accelerator trials.

Southern Kaingaroa Trial

Selection Basis

This site was selected due to the inability of previous rotations to generate a pool of available N in the organic cycle. The site has a reserve of available N in the mineral soil, but this is largely unavailable for plant uptake.

Treatment Plan

A productivity gain target of 32% was established. This value was generated by referring to the national 300 Index surface layer, then adding an additional 20% gain based on past experience with enhanced fertility. The nitrogen addition required to achieve this target was determined to be 500 kg ha^{-1} nitrogen across the life of the rotation, as calculated by NuBalM. Initial treatments will be:

- Biuret – applied to deliver nitrogen but also to stimulate access to the inaccessible N present at the site
- Urea – applied at selected intervals across the life of the trial to ensure maximum plant uptake

Control plots will also provide information regarding the relative N uptake efficiency of the different stock types planted at the site.

Central Kaingaroa Trial

Selection Basis
The soils at this site are similar to the Southern Kaingaroa site, but the site itself is considerably warmer and therefore should support higher productivity if limitations are removed. The site was selected to test methods for increasing soil organic carbon, thereby increasing the ability of the site to store nutrients in the organic cycle.

Treatment Plan
Weed management is the focus of initial treatments at this site. The concept is to utilise weeds to capture nutrients that may be lost post-harvest, while also building a new input of organic carbon to the soil. The first attempt at this treatment was to compare blanket and spot spraying treatments, however the implementation of this treatment failed due to operational issues. A new plan involving the use of selected understory species, including legumes, will be developed in partnership with industry for application in late 2018.

Rangipo Trial

Selection Basis
This was selected to provide an opportunity to optimise forest productivity on an ex-farm site. The site has considerably greater soil carbon and nutrient pools than conventional forest sites with no past farming legacy effects.

Treatment Plan
At this site a pre-planting treatment was applied by ripping and mounding half of the site, following standard establishment practice, while the other half of the site was left uncultivated.

Figure 3 Illustration of the difference in cultivation techniques applied to the Rangipo trial site

Furthermore, at planting two stocking rates were used: 833 sha and 1282 sha. The greater stocking rate was established to explore the carrying capacity of the site, as it was considered that the conventional stocking rate may not fully utilise the soil resources at the site. Future treatments will be developed based on the data provided from ongoing monitoring at this site.

Ashley Trial

Selection Basis
This site was due to low available soil moisture, resulting in limitations to plant growth. The site is also resource limited, and therefore addressing this issue will become a focus of future treatments.

Treatment Plan
Treatments to enhancing stress tolerance will be the first focus for the site. The deployment of multiple genotypes is the foundation treatment applied to this site as this will enable the identification of stock with enhanced water stress tolerance. Further treatments to enhance stress tolerance will be applied following two pathways:

- Through the use of a chemical treatment (aminoethoxyvinylglycine) that decreases 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

Tairua Trial

Selection Basis
This site was selected as it is low in plant available P due to the high P retentive soil. This property is characteristic of Allophonic soils, and restricts the productivity of these forests as added P is readily adsorbed to the soils and is rapidly made unavailable for plant uptake.

Treatment Plan
Saturating Allophanic forests soils with mineral P is not a viable solution. The initial treatments that will be deployed at this site will focus on:

- Feeding the tree through targeted application of P to the organic cycling pool, bypassing mineral soil. Direct application of P to foliar tissue will also be considered.
- Through reducing the ability of the mineral soil to retain P through the application of semi-complementary cations.

Tokoiti Trial

Selection Basis
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. The first rotation at this ex-farm site performed well, but without intervention will likely underperform in future.

Treatment Plan
Treatments to increase the organic carbon content and rooting depth in the soil at this site have been applied to enhance water storage capacity. Treatments are:

- Whole tree harvesting followed by windrowing
- 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

Post-planting, stress tolerance treatments will also be applied, based on the findings from the Ashley trial at which water stress is already the dominant limitation to productivity.

Next steps

Several of the treatments outlined here are still to be confirmed, and therefore engagement with industry is critical to further develop these ideas and ensure their relevance. The nature and extent of these future treatments will be discussed at the upcoming Q4 2017/2018 TST meeting.

It is also worth reiterating that treatment application to these sites will be a regular event, based on responses to past treatments, current performance and the availability of new relevant interventions. This is conceptually illustrated below:

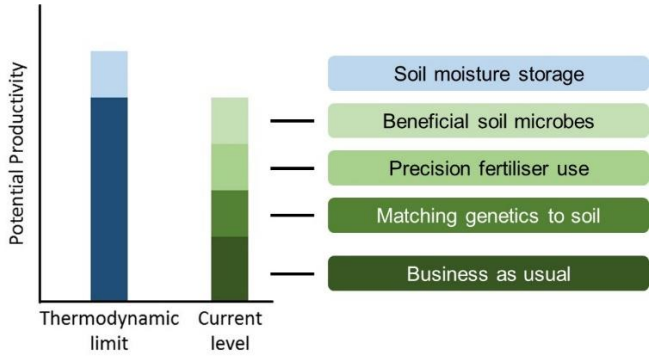

Figure 4 Ongoing applications of productivity enhancing treatments to a hypothetical site in order to attain the thermodynamic potential, as defined by light and temperature.

Acknowledgements

Funding for this research came from the "Growing Confidence in Forestry's Future" research programme (C04X1306), which is jointly funded by the Ministry of Business Information and Employment (MBIE) and the Forest Growers Levy Trust, with the support of the NZ Forest Owners Association (FOA) and the NZ Farm Forestry Association (FFA).

References

1. New Zealand Forestry Owners Association, *New Zealand Forestry Science and Innovation Plan 2012*. NZ Forest Owners Association, Wellington (2012).
2. Scion, *Doubling forest productivity sustainably*. Scion Connections ***11***, pp. 1-3. (2014).
3. Moore, J., Clinton, P.W. *Enhancing the productivity of radiata pine forestry within environmental limits*. New Zealand Journal of Forestry ***60***, pp. 35-41. (2015).
4. May, B., Smethurst P., Carlyle, C., Mendham, D., Bruce, J., Baillie, C. *Review of fertiliser use in Australian forestry.* Forest and Wood Products Australila, Project No: RC072-0708:96. (2008).
5. Smaill, S.J., Garrett, L.G. *Multi-rotation impacts of increased organic matter removal in planted forests*. Journal of Soil Science and Plant Nutrition ***16***, pp. 287-293. (2016).