Heartwood in *Eucalyptus bosistoana* (2010 plantings)

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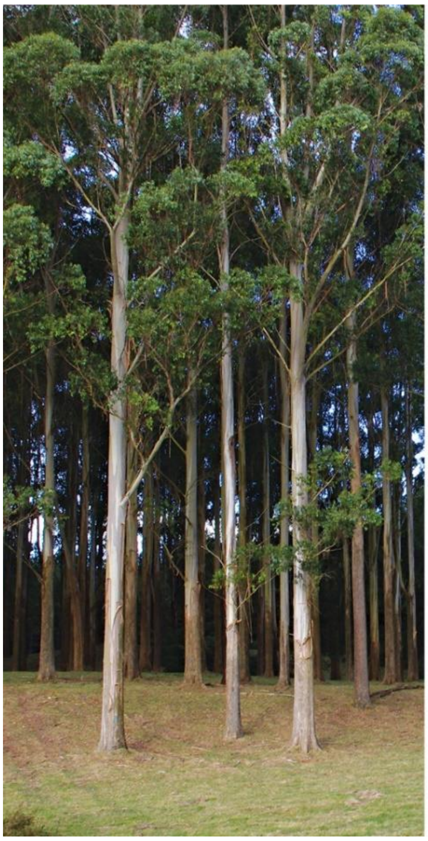

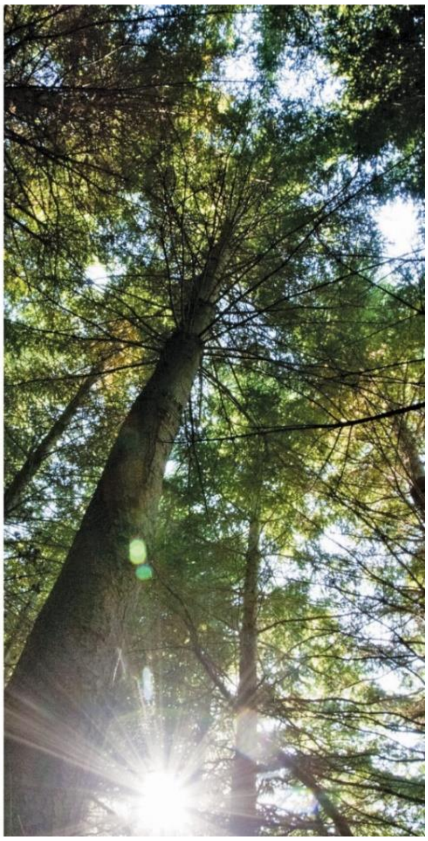

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INTRODUCTION

As mentioned previously, a target product of NZDFI is ground-durable timber. NZDFI has established a series of breeding trials to deliver growers healthy plants, which produce good amounts of quality timber. The key wood property is natural durability. Natural durability describes the resistance of wood to decay by fungi and insects. Only heartwood, which contains bioactive extractive compounds, has natural durability (AS5604, 2005).

Heartwood quantity

The heartwood diameter varies within a species. Heartwood quantity is partly under genetic control (Hillis, 1987). To maximise value of NZDFI plantations, trees which have a propensity to produce a large volume of heartwood should be selected in a breeding programme.

Heartwood quality

The measurement of natural durability is resource intensive (Harju and Venäläinen, 2006; Li and Altaner, 2016b). High resource demands prevent this trait from being included in breeding programmes. However, the heartwood extractives are a main factor providing natural durability (Hawley et al., 1924). Extractive content is highly variable within *E. bosistoana*, varying at least 10-fold between trees (Sharma et al., 2014; Van Lierde, 2013). As the extractive content can be efficiently measured, NZDFI is selecting genotypes of high extractive content to increase the amount of ground-durable timber in the future deployment population.

The objective of this work is to screen the 2010 *E. bosistoana* breeding population planted at Avery for heartwood quantity (diameter) and quality (extractive content).

METHODS

Material

The families established in the 2010 trials were a sub group from the northern inland region of this distribution. This group of *E. bosistoana* families have a phenotypically unique slender leaf form. These open-pollinated families were planted at 3 locations – Martin (North Canterbury), Craven Road, (Marlborough) and Avery (Marlborough). The results from coring the Martin and Craven Road sites has been discussed in a previous report (SWP-T028). The data for cores from the Avery site is presented in this report.

The Avery trial is a sets-in-reps, single tree plot design with 42 families and each family replicated up to 50 times across the site. There were 35 trees per plot and spacing is 2.4 m between rows and 1.8 m within the rows. There is a total of 50 blocks with a one row surround. The site is ex-pasture, and has an easterly aspect.

The Avery trial has not been thinned and pruned. The recent assessment (file note SWP-FN037) was completed in August 2017 at age 6.75 years. The diameter range was 30 mm – 78.4 mm with an average of 55 mm. Trees with a DBH less than 30 mm were recorded as too small. The data from this assessment guided the core sampling regime. All surviving trees above 30 mm in diameter were cored.

Sampling

A battery powered 14 mm inner-diameter increment corer was used to sample the trees. 1,106 trees representing 42 families were cored in total. The number of individuals for each family ranged from 8 to 49. Full diameter cores were taken at the bottom of the tree trunk (i.e. ~50 cm height) through the pith.

Heartwood quantity

Heartwood was highlighted by applying a pH indicator (methyl orange) to the core surface in the green state. Heartwood changed colour to pink while no colour change occurred when applied to sapwood (Figure 1). The total length of the core samples without bark as well as the length of the heartwood was measured with a ruler in the green state. Sapwood depth was calculated as the difference between the 2 measurements.

Figure 1: *E. bosistoana* cores stained with methyl orange. Heartwood is highlighted pink.

Extractive content

The surface of the cores was sanded (P 100) to expose clean wood before NIR spectra were collected with a fibre optics probe (Bruker) on the radial-tangential surface every 5 mm along the heartwood. The extractive content was predicted for each spectra using the previously developed model (Li and Altaner, 2016a). Heartwood extractive content (EC) for a tree was than calculated as weighted average (representing cross sectional area) of the individual spectra. An alternative measure would be the extractive content at a given radial position, e.g. close to the pith.

Data analysis

Data was analysed in R (Team, 2014).

SWP-T046 Heartwood assessment Eucalyptus bosistoana Avery_G3

RESULTS

Tree diameter

Core length (under-bark diameter at ~0.5 m height) and 2017 DBH measurements (over-bark diameter at breast height) of the trees were compared. Generally, a good correlation between the 2 measurements was found (Figure 2) and the correlation was similar to that found earlier in other trials (SWP-T028). Contributing to the differences between the measurements were:

- time as DBH assessment was done 6 month prior to coring,
- taper as measurements were conducted at different heights,
- bark thickness, as bark was removed from cores,
- occasional loss of material (1-10 mm sapwood) from the core ends due to breakage.

The latter is not relevant if all heartwood is recovered and ranking is based on heartwood diameter. It however, affected the accuracy of sapwood and core length data.

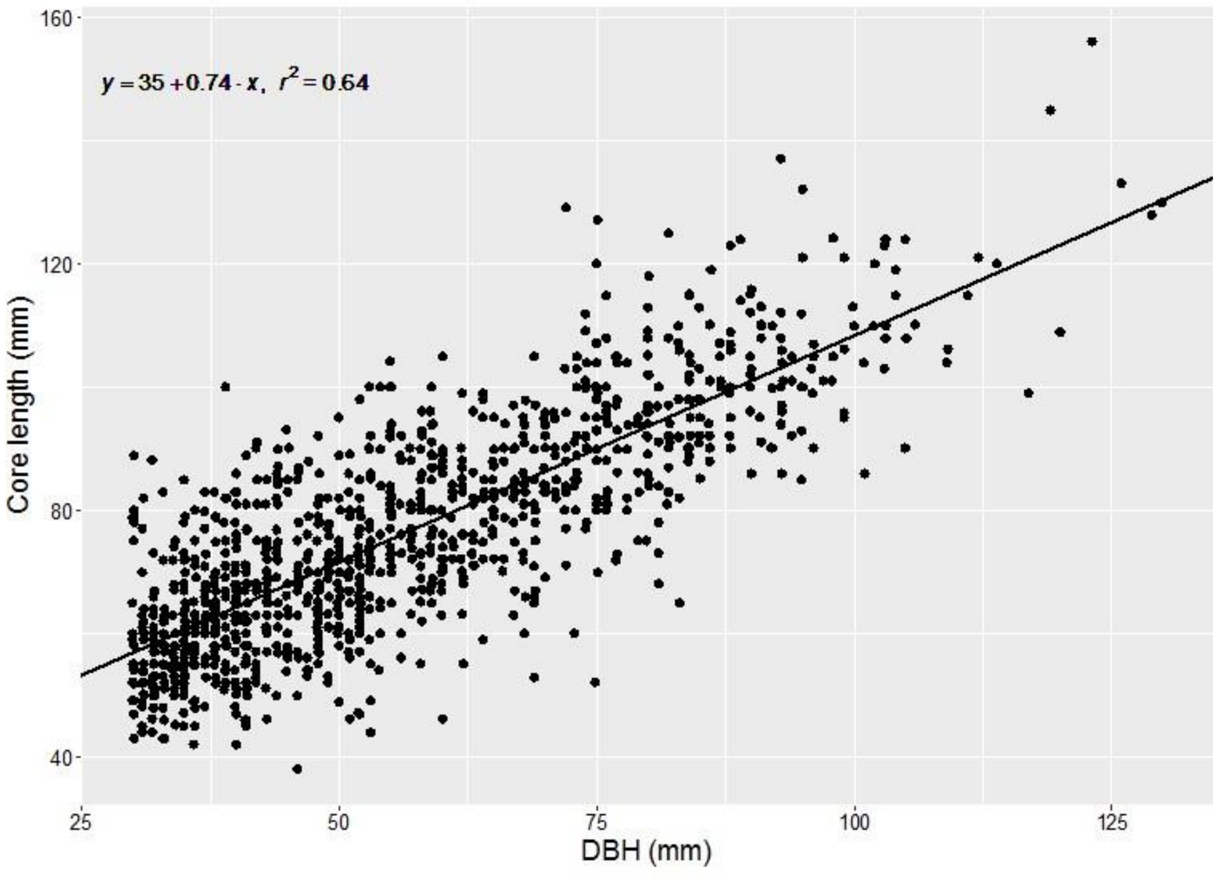

Figure 2: DBH (above-bark) in relation to core length (without bark) at the stem base for 7.5-year old *E. bosistoana* at Avery.

Wood cores

631 of the 1,106 *E. bosistoana* cores (57%) contained heartwood at age 7.5. The mean heartwood diameter was 14.91 mm with a coefficient of variation (CV) of 1.13 (Table 1). The average sapwood diameter was 61.69 mm with a lower degree of variation. The trees at Avery were the smallest and had the least heartwood compared to the Martin and Craven Road sites (SWP-T028). This is consistent the earlier assessment of the trial (SWP-FN037).

Table 1: Summary statistics of 7.5-year old *E. bosistoana* heartwood features grown in Avery site. CV = coefficient of variation, SD = standard deviation, CL= core length, HWD = heartwood diameter, SWD= sapwood diameter.

	Minimum (mm)	Maximum (mm)	Mean (mm)	CV	SD (mm)
CL (mm)	38	156	76.62	0.24	18.29
DBH (mm)	30	130	57.03	0.34	19.87
HWD (mm)	0	73	14.91	1.13	16.86
SWD (mm)	15	129	61.69	0.24	14.71

Core length and heartwood diameter

The heartwood diameter was correlated with core length (Figure 3). Larger trees generally have more heartwood. But large trees with little or no heartwood were also observed. This indicated that the largest trees do not necessarily produce the largest volume of the target product (heartwood). Again this was confirming the results of the other 2 trials (SWP-T028). If heartwood volume is under genetic control the value of the plantations can be increased through selection.

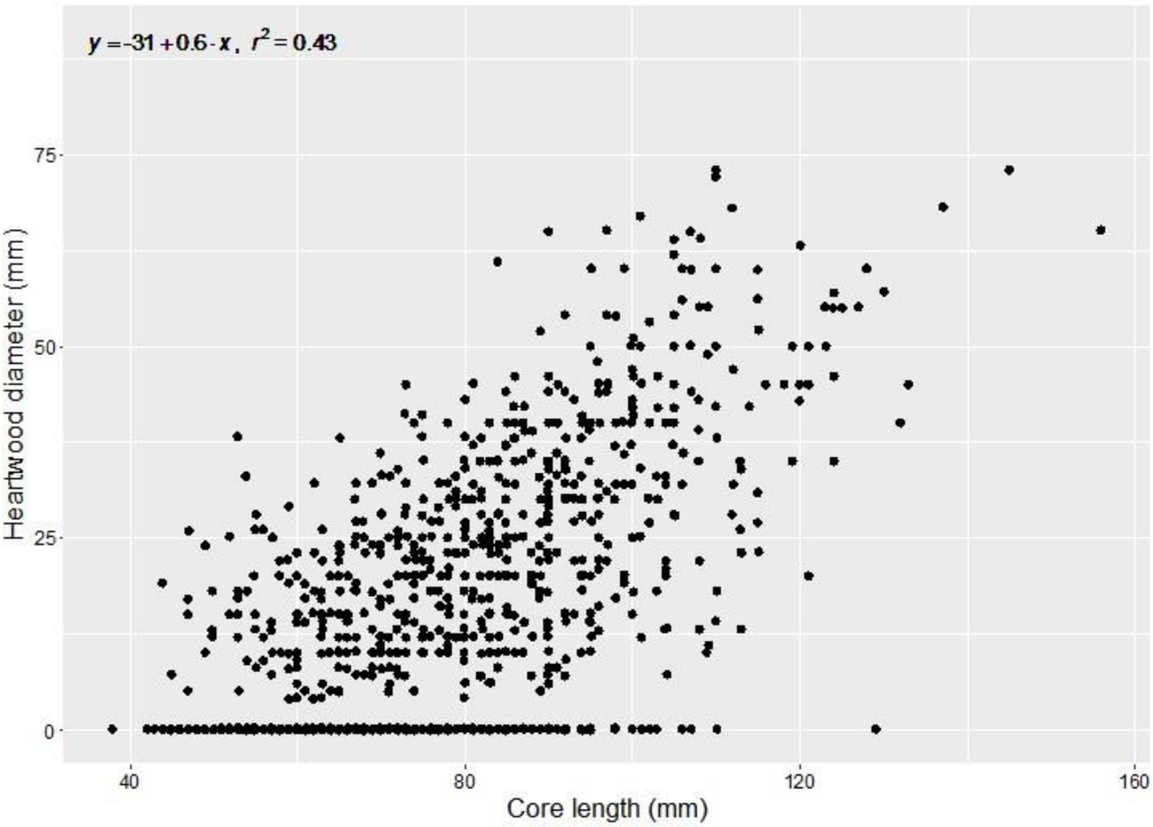

Figure 3: Heartwood diameter in relation to core length for 7.5-year old *E. bosistoana* at Avery.

Heartwood diameter and extractive content (EC)

Heartwood diameter and EC were not strongly correlated (Figure 4), i.e. trees with large quantities of heartwood do not necessarily have a high amount of extractives. Trees with high extractive content are more likely to have higher durability. It is important to note, that the EC showed a large variability, ranging from 0.55 to ~28% (Table 2). Again, this confirms earlier findings at Craven Road and Martin (SWP-T028). This large variability indicates a large variability in wood quality (natural durability). To produce a Class 1 durable product (AS5604, 2005) it is paramount to reduce this variability.

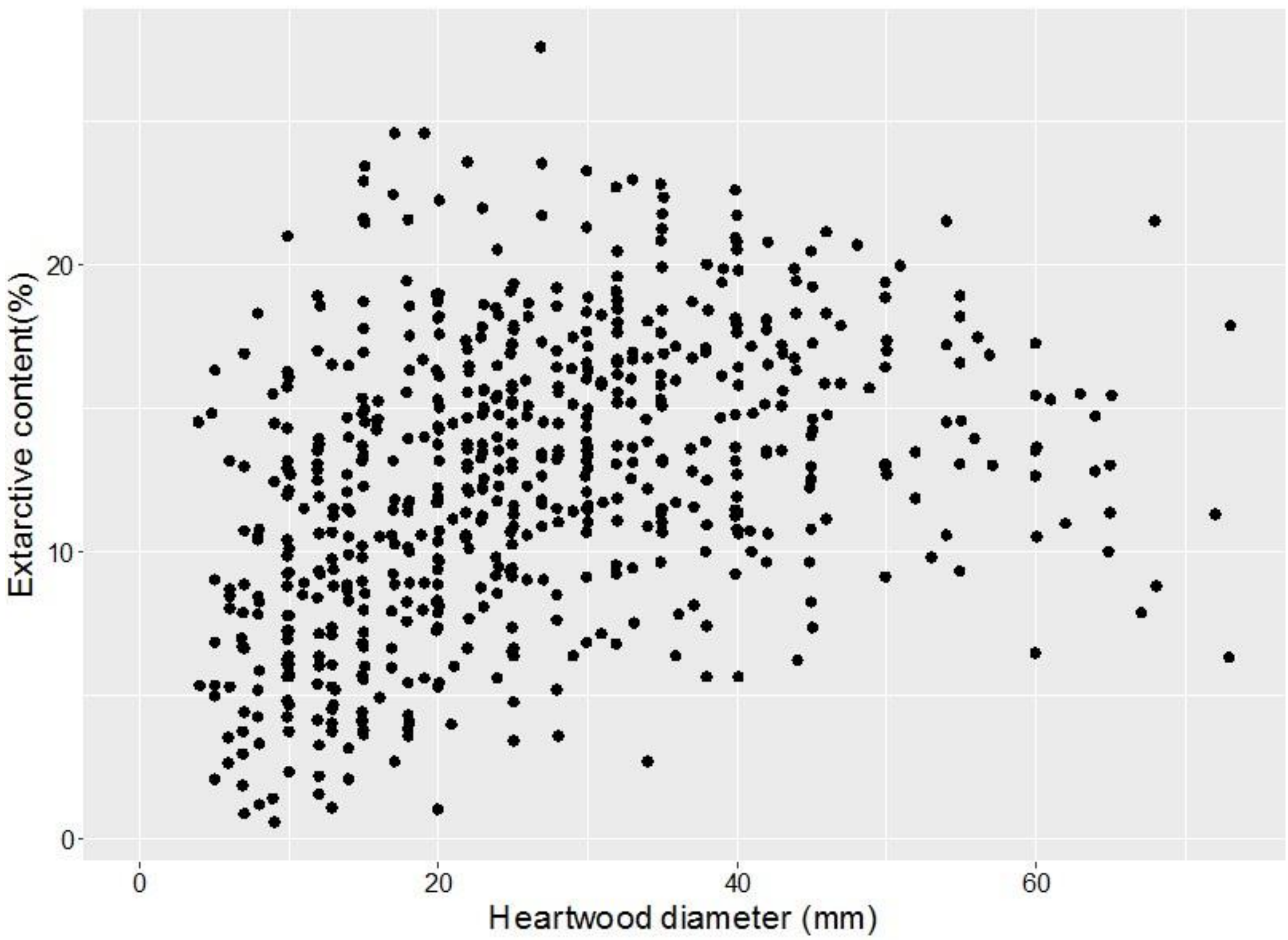

Figure 4: Heartwood diameter in relation to extractive content for 7.5-year old *E. bosistoana* at Avery.

It was interesting to note that the average predicted EC for the Avery site (12.5%) compared favourably with that at Martins (6.0%) (SWP-T028). Aligned work (SWP-T045) has shown that samples with high EC (NIR) exhibited low mass loss against brown and white rot fungi.

Table 2: Predicted extractive content (NIR) in 7.5-year old *E. bosistoana* heartwood grown at Avery.

	Minimum (mm)	Maximum (mm)	Mean (mm)	CV	SD (mm)
EC (%)	0.55	27.51	12.49	2.49	0.40

Family differences

Figure 5 shows the 42 assessed *E. bosistoana* families ranked for heartwood diameter at age 7.5 years at Avery. As for the other sites (SWP-T028), phenotypic variation in heartwood diameter was observed between the families. This indicated the possibility of genetic selection for heartwood volume. Similar statements can be made for extractive content (Figure 6).

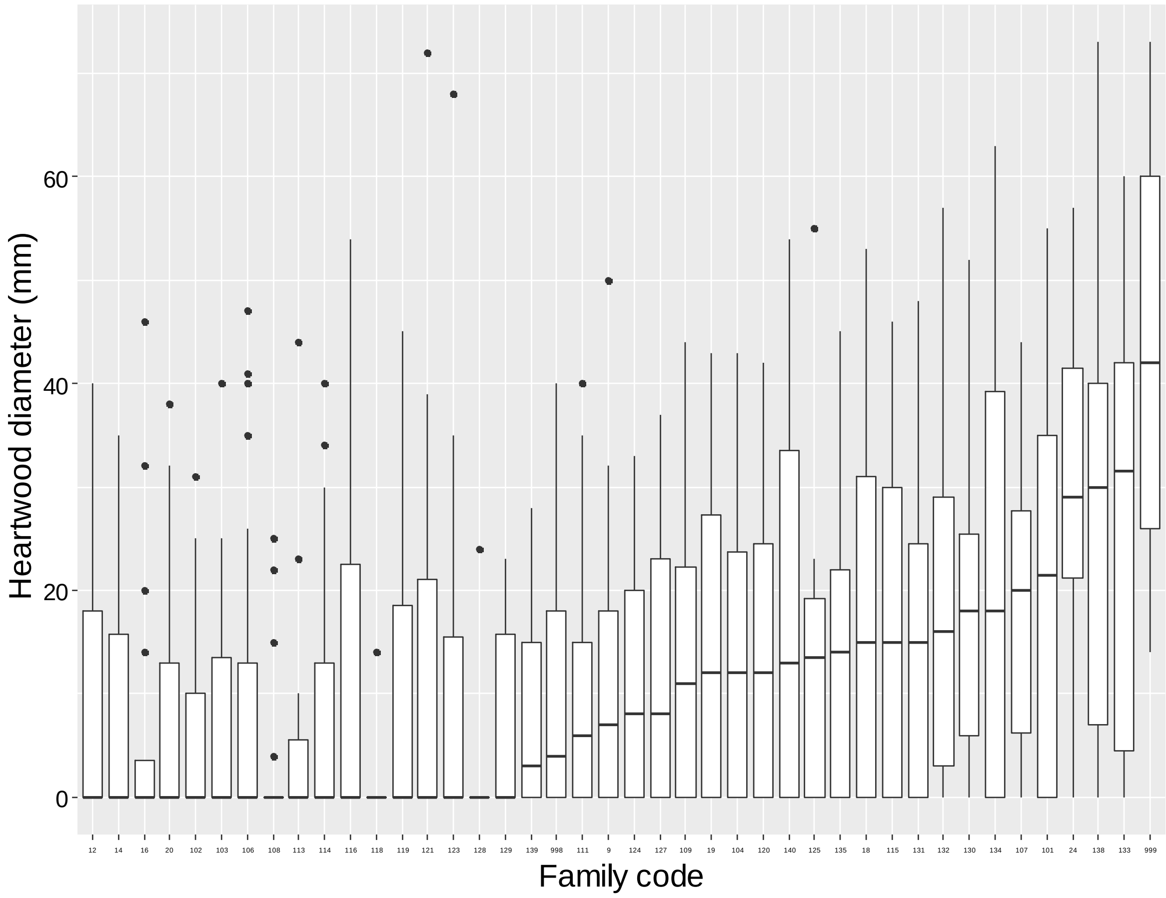

Figure 5: *E. bosistoana* families ranked for heartwood diameter at age 7.5 years at Avery.

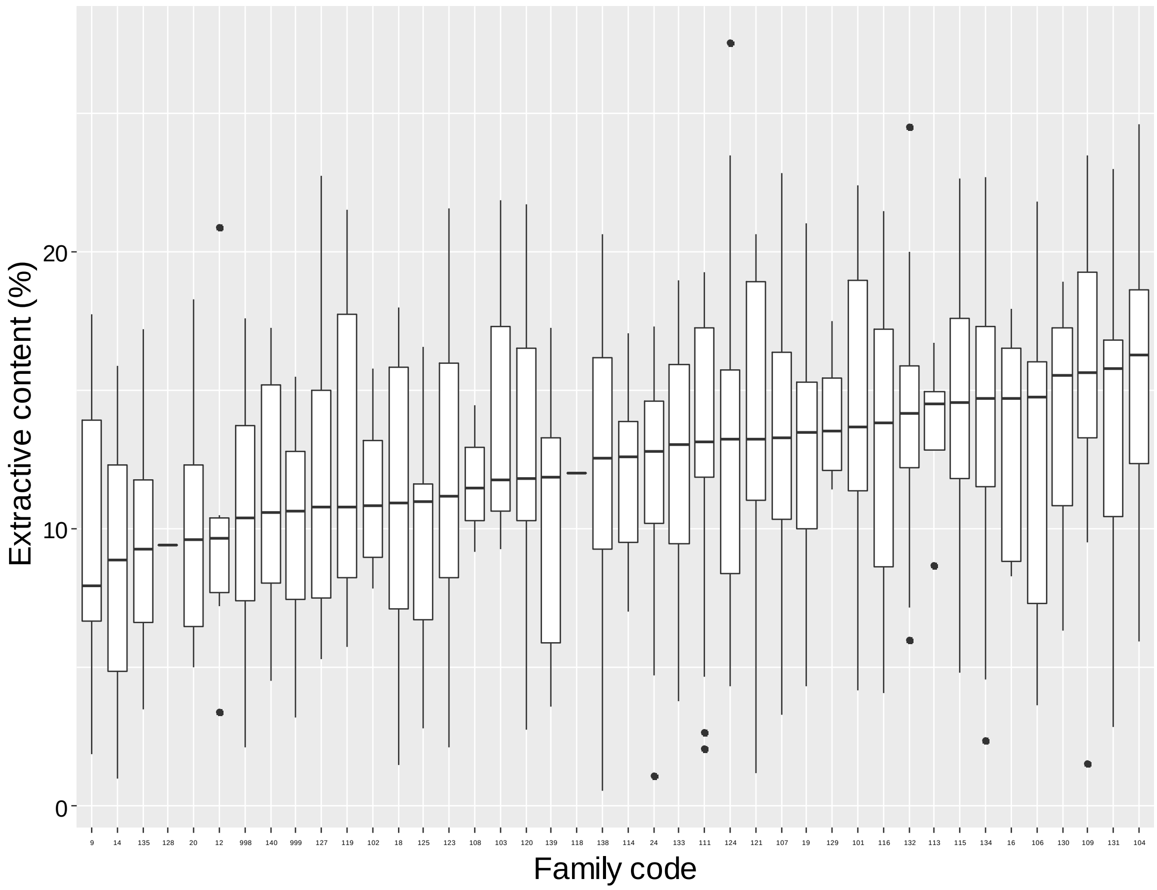

Figure 6: *E. bosistoana* families ranked for extractives content at age 7.5 at Avery

CONCLUSION

- Variation in heartwood diameter and EC between the families was observed. This opens the possibility to improve heartwood quantity and quality in *E. bosistoana* by selection of superior genotypes.
- The data was comparable to that obtained from other *E. bosistoana* breeding trials (Li and Altaner, 2016b, SWP-T028). In detail, the trees were smaller but had a higher EC at Avery.
- The data has been deposited into the NZDFI database and will be used to select the 1st generation of improved *E. bosistoana*.

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