RPBC
Radiata Pine Breeding Co Ltd
BREEDING QUALITY

Technical Newsletter

June 2018

2018 Trial Establishment Programme

With the onset of the 2018 trial planting season, the Radiata Pine Breeding Company (RPBC) has undertaken some significant changes aimed at improving the rate of achievement of genetic gain and maximising cost-effectiveness. The decisions have been made using sound scientific principles and align with key recommendations in the evolving RPBC Genetic Improvement and Deployment Strategy. Although this strategy has not been formally ratified, the deferral of implementation of the changes until next season was seen as a substantial opportunity cost. The changes are outlined in this newsletter.

The conversation around this work has evolved over several months and has had many contributors – too many to list here. However, special mention goes to the team at University of Wollongong (Brian Cullis, Alison Smith, and Chris Lisle), Ruth McConnochie, Luis Apiolaza, and Mike Carson.

The Rolling Front

The "Rolling Front" is defined as a breeding strategy that uses overlapping rather than discrete breeding generation cycles. The current and future focus for RPBC is the identification of superior germplasm via forward selections (FS), and we implement the "Rolling Front" through annual crossing, testing and forward selection among the best individuals available at the time. The strategy of FS requires accurate prediction of Estimated Breeding Values (EBVs) for the individuals themselves, rather than for their parents, which is best achieved by testing material as (replicated) clones. Prior to 2018 this was limited to material grown in the Clonal Elite trials (24 trials planted between 2013 and 2017), but this year the scope has been expanded to include material from the Main population. Thus, in line with a key RPBC Genetic Improvement and Deployment Strategy recommendation, the Main and Clonal Elite populations will be combined to be managed as a single population. The implications of this decision are positive and substantive for RPBC.

Analysis of Material for Trial Plantings in 2018

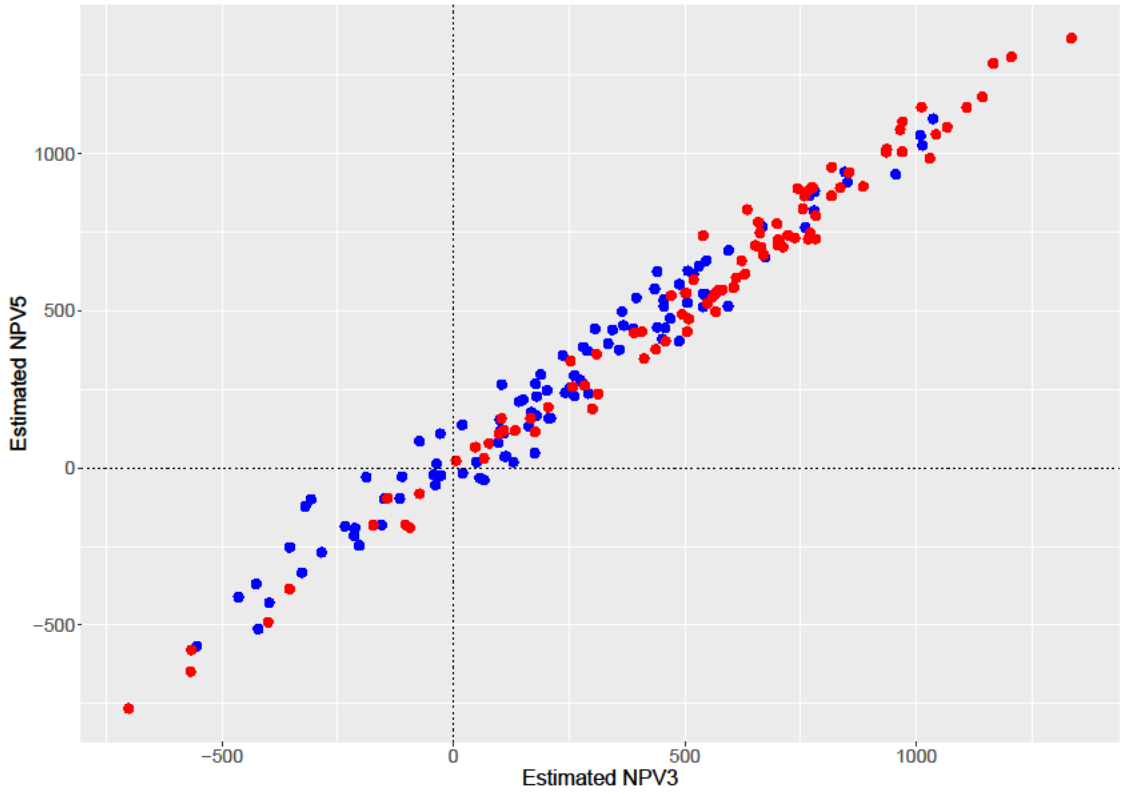
The material available for planting in 2018 comprised 957 and 1531 individuals from the Clonal Elite and Main populations, respectively. This represents a total of 198 families. Given that the individuals from the Main population were not originally intended for evaluation as potential FS, their suitability for planting needed to be assessed in comparison with the individuals in the Clonal Elite. This was achieved by applying an economic breeding objective ($NPV) based on overall performance EBVs from the most recent multi-environment trial (MET) analyses. The objective was defined by combining the overall performance EBVs for the key breeding traits (volume, straightness, branching, corewood stiffness and density at rotation age) with their relative economic weights.

The analysis was undertaken using two objectives: one based on all five traits (to be denoted NPV5) and one based on the three traits of volume, density and corewood stiffness (NPV3). These objectives were applied to the 198 families (using mid-parental overall performance EBVs) and the

resultant values are shown in Figure 1. The points are coloured red and blue for families represented in the Clonal Elite and Main populations, respectively. The first thing to note is the strong agreement between the two objectives which means they have ranked the families in a similar way. A conservative approach to culling was adopted so that only those families with negative estimated NPVs for both objectives (corresponding to points in the bottom left hand corner of Figure 1) were discarded. This equated to the culling of approximately 20% of the material. The remaining 2023 individuals therefore comprise the current Rolling Front.

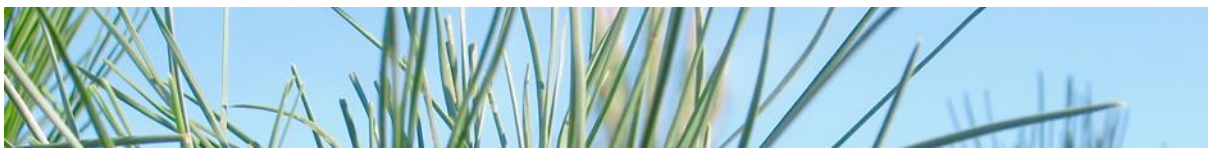
Importantly, the genetic diversity of this population is nearly double that of the existing Clonal Elite population, with status numbers of 113 and 65, respectively, (the status number can be thought of as the average number of unrelated individuals in the population).

Figure 1: Comparison using Two Different Breeding Objectives



2018 Trials and Trial Design

The material originally available for 2018 trials was planned to be planted as 9 trials, with the Main population individuals being grown in 6 and the Clonal Elites in 3 trials. Merging the two populations had several ramifications for both the number of trials and the experimental design of those trials. Given there was no longer a need to plant separate Main and Clonal Elite trials it was cost-effective to reduce the total number of trials from 9 to 5. The decision on the final number was reached by examining the accuracy of overall performance EBVs for clonal material as obtained from the most recent MET analyses. It was concluded that 5 trials would provide an acceptable level of accuracy for FS decisions. The decision on the location of the trials was based on maximising the sampling of environments, both within the set of 5 for 2018 and also with respect to existing trial sites that contained similar germplasm. The selected sites are Mangatu (East Coast), Kinleith (Waikato), Kaingaroa (Bay of Plenty), Spooners (Nelson) and Berrick (Otago).



The allocation and level of replication of the 2023 clones across the 5 trials was achieved using a sophisticated and new technique called sparse phenotyping. This allowed for the fact that there were unequal numbers of cuttings (thence replicates) of clones and that, given the number and size of the trials, not all clones can be grown in all trials, nor can clones always be replicated within a trial. Even in this highly unbalanced scenario, the sparse phenotyping method can be used to provide an allocation that will ultimately permit accurate estimation of breeding values for FS. A key to the success of the method is the use of information on the genetic relatedness of all clones (that is, more than just family information). At the within-trial level, it was noted that the Main and Clonal Elite material will be sourced from different nurseries so that it is not feasible to completely randomise these. Thus a restricted randomisation strategy based on the use of 60 planting sets (groups of 36 cuttings) was employed. All cuttings within a planting set were from the same nursery, so they were either all Clonal Elite or all Main material.

In Situ Genomic Selection

The merging of the Main and Clonal Elite populations provides an additional benefit for the RPBC Genomic Selection (GS) programme. There has been a long-standing concern that the current GS training population has insufficient genetic diversity that will not fully represent the breeding population. The creation of the new rolling front, with an associated doubling of status number, has the potential to provide a solution. The recommendation, therefore, is to genotype all the clones being planted in the 2018 trials (as described in this newsletter) that have not already been genotyped. This means that the GS programme is “in situ”, being based on standard breeding trials without the need for separate training population trials. The potential gains for the RPBC GS programme are substantial and the additional costs are minimal.

What Next?

RPBC is reviewing the quality of all germplasm in the various stages of the breeding pipeline. Think of this as a stocktake, which essentially covers:

- ✓ Material for deployment in 2018 trials as described in this newsletter;
- ✓ Cuttings to be deployed in trials in 2019;
- ✓ Pollen to be collected in 2018;
- ✓ Seed to be sown in 2018 for the 2019 trial suite;
- ✓ Material in the Breeding Archive;
- ✓ Trials which will be measured this year;
- ✓ All other crosses and collections made in the last 5 years;
- ✓ All remaining unmeasured trials.

Each step of the review provides an opportunity for further enhancing genetic gain. Once the stocktake is completed, the RPBC will be well-placed to determine its trial establishment and assessment processes for the next 5-10 year period. We will keep you appraised of findings and decisions as the project progresses.

If you have any questions regarding this newsletter, please contact Mark Paget on +64 21 858 747 or mark.paget@rpbc.co.nz