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A novel open pollinated seed production strategy to exploit both additive and non-additive genetic effects in *Eucalyptus dunnii*

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Eucalyptus dunnii, an important plantation species, is deployed either as clones or open-pollinated (OP) seed. OP seed lots are mainly sourced from seed orchards, where the mothers are known and the pollen is an uncontrolled mix of orchard genotypes. Seed Energy's current *E. dunnii* clonal seed orchards have been established using genotypes selected for their general combining ability (GCA), an approach that exploits additive genetic effects. OP progeny trials of the seed orchard parents have been used to increase genetic gain deployed via backward selection. The best parents have demonstrated growth gains of up to 19.3% over unimproved native forest collections. Evaluation of control pollinated (CP) progeny trials, established from crosses of the best seed orchard parents, have shown growth traits to be under a degree of non-additive genetic control. The presence of non-additive variance in these traits suggests that additional genetic gain can be made by specific combinations of mother and pollen parent, known as specific combining ability (SCA). Capturing and deploying the gains from GCA and SCA effects into plantations at commercial scale currently require capital intensive clonal propagation programmes. Here we present a new strategy to exploit both additive and non-additive genetic effects through a novel open-pollinated seed orchard design called micro-orchards. This strategy aims to increase the frequency of the best performing combinations of mother and pollen in an OP environment. These orchards are structured with a central mother genotype tree initially surrounded by ten pollen parent genotypes, which is replicated in a repeated block design. The pollen parents are culled over several years to retain only the best specific combinations with the mother genotype. The culling of pollen parents is based on the results of iterative genetic evaluations of data from the CP trials, which contain families of the mother-pollen combinations present in the micro-orchards. The number of pollen parents culled increases with trial assessment age, concluding with a cull utilising age 6 trial data. The cost and productivity of this strategy allow gains from GCA and SCA effects to be accessible to a significant portion of the Uruguayan market at lower costs and complexity than operating a clonal propagation program.

Keywords: Eucalyptus, open-pollinated, non-additive, orchard

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