The effect of propagation methods on some growth and physiological characteristics of seed- and vegetatively propagated *Eucalyptus* varieties

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INTRODUCTION

The purpose of this study was to deepen our understanding of the field performance of micro- and macro-propagated *Eucalyptus grandis* x *nitens* (GN), in comparison with seed-propagated *E. grandis* and *E. nitens*. The emphasis was on the relationship between root characteristics (hydraulics, anchorage efficiency) and above-ground parameters (survival, leaf gas exchange). Cold-tolerant GN clones are planted across low-productivity, high altitude sites in South Africa[1].

METHODS

Propagation of saplings using established protocols ➞ establishment of a field trial ➞ Measurements: leaf gas exchange (Fig. 1A),' root hydraulic conductance (k_r)[2] (Fig. 1B), vertical uprooting resistance[3] (Fig. 1C), root architecture.

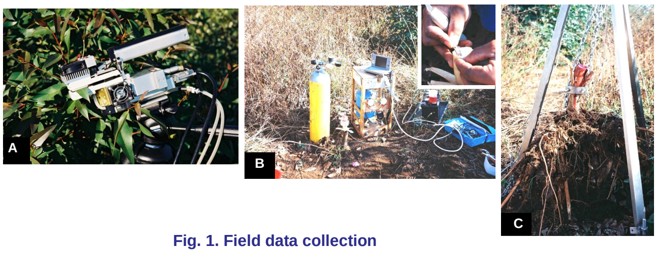

Fig. 1. Field data collection

RESULTS

•Growth deformations were observed particularly from macro- (Fig. 2D, E) and micro-propagated GN (Fig. 2F, G):

Fig. 2. Growth deformations of vegetatively propagated saplings

After 16 months of field growth:

• drought and occasional air and soil frosts resulted in 50% survival of micro-propagated GN, compared with 98% macro-propagated GN, 93% *E. nitens* and 60% *E. grandis;*

•differences in instantaneous leaf gas exchange, and parameters derived from light- and CO_2- response curves (e.g. A_{max} and J_{max}) were not significant across all plant types, and Ψ_L was maintained above -2.0 MPa;

•differences in k_r and K_r were not significant between micro- and macro-propagated GN; however, roots of the latter were 32% more efficient in conducting water to the leaves (Table 1).

Table 1. Root hydraulic conductance (k_r) and specific root hydraulic conductance expressed per unit leaf area (K_r) of 16 months-old trees

	E. grandis	*E. nitens*	Macrop GN	Microp GN
k_r (x 10^{-3}) (kg s^{-1} MPa^{-1})	2.68 ± 0.28[b]	2.18 ± 0.48[ab]	2.09 ± 0.31[ab]	1.69 ± 0.55[a]
Min; Max	2.38; 3.05	1.87; 3.00	1.84; 2.54	1.05; 2.32
K_r (x 10^{-4}) (kg s^{-1} m^{-2} MPa^{-1})	3.46 ± 1.43[a]	3.12 ± 0.803[a]	3.49 ± 3.11[a]	2.36 ± 0.793[a]
Min; Max	2.18; 5.51	2.20; 3.78	1.90; 8.29	1.19; 2.94

•50% of vertically uprooted macro-propagated GN (Fig. 3H) produced a root system similar and equivalent in resistance to the tap-root system (Fig. 3I) of seed-propagated *E. grandis* and *E. nitens,* whilst none of the micro-propagated GN (Fig. 3J) produced equivalents of tap roots at that age;

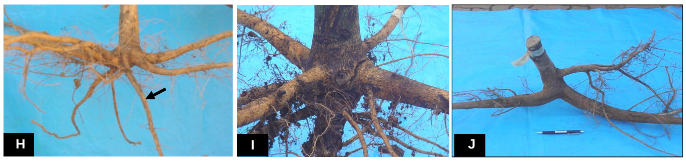

Fig. 3. Root types of vegetatively propagated GN (H = root type 1: 'tap-sinker' present (arrow); J = root type 2: 'tap-sinker' absent) and seed-propagated *E. grandis* and *E. nitens* (I)

•the number of roots and root x.s. area had a significant effect on the maximum force required to vertically extract roots (Fig. 4);

•micro- and macro-propagated GN produced fewer and thicker I-beam shaped roots (Fig. 5G), whereas seed-propagated *E. grandis* and *E. nitens* produced numerous T-beam shaped lateral roots (Fig. 5H) and O-beam shaped tap-roots (Fig. 5I).

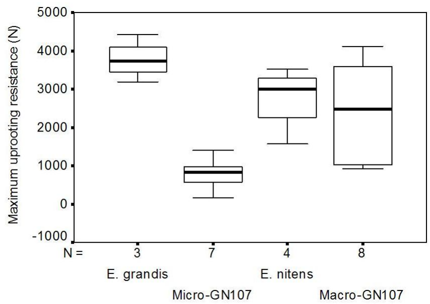

Fig. 4. Vertical uprooting resistance

Fig. 5. Root cross sections

DISCUSSION

Although there were no major physiological differences between micro- and macro-propagated GN, and seed-propagated *E. grandis* and *E. nitens*, the root system yielded by micro-propagation was generally inferior, and failed to support the survival and anchorage of most saplings in the field. Macro-propagated saplings with 'tap-sinkers' had symmetrical and deeper lateral roots around the stem, which increased resistance to vertical extraction, similar to seed-propagated saplings. Micro-propagated saplings may therefore not be suitable for planting across sites with strong winds, and those likely to be affected by prolonged dry periods during climate change. However, the simulation of wind-loading during acclimatization of vegetatively propagated saplings could improve the development of efficient roots in terms of anchorage and acquisition of water from deeper soil levels. Nursery conditions and practices which influence root properties of saplings should be given more attention.

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