Propagation of cherimoya *(Annona cherimola)*

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Satisfactory production of export quality cherimoya (*Annona cherimola*) is dependent on trees with a strong canopy framework and a well established root system. A trial was established to examine the effect of cultivar and seed orientation (sowing seed horizontally or vertically to its main axis) on the germination and seedling characteristics of cherimoya. Over 90% of all seeds germinated but approximately 35% of seedlings had bench roots. However, only 20% of 'Bronceada' seedlings had bench roots, which was significantly lower than 'Burtons', 'Burtons Favourite', 'Bays', 'Smoothey', and 'Reretai' where approximately 40% of seedlings were affected. The cultivars 'Burtons', 'White', and 'Jeté' produced the most vigorous seedlings, although 'White' seedlings had less lateral root development and a higher shoot/root ratio than the other two cultivars. The smallest seedlings were produced from self and cross pollinated 'Reretai' seed. Seed sown horizontally produced more vigorous seedlings with a lower incidence of bench roots than those planted vertically. Although these rootstocks have not been tested in the field, nurserymen should choose cultivars with a low incidence of bench roots, moderate vigour, and a balance between root and shoot growth for seedling rootstocks. Of the cultivars tested in this study 'Bronceada' and 'Jeté' best met these criteria.

INTRODUCTION

The cherimoya (*Annona cherimola*) is grown commercially in California, Chile, and Spain. More recently, plantings have been made in New Zealand and these trees are now beginning to produce fruit. The natural growth habit of the cherimoya produces a large, vigorous, open tree with long weak branches. In a commercial orchard a cherimoya tree must have a strong canopy framework and root system to support and protect approximately 75 kg of fruit. To produce high yields of quality fruit, particular attention must also be paid to pruning (Anderson and Richardson, 1992) and hand pollination is essential (Richardson and Anderson, 1990).

Cherimoya trees are readily propagated by grafting a selected scion onto a seedling rootstock. We have noted that, once trees begin to produce fruit, a high percentage of tree failure is linked to inadequate root systems. This is due to selection of seedlings with a pronounced curvature of the taproot (bench rooted) for rootstocks. A high incidence of bench roots in cherimoya seedlings is linked to the hard, heavily lignified seed coat physically restricting the emergence of the radicle. This problem is exacerbated by the use of shallow containers for seedling production.

The high demand for cherimoya plants in New Zealand has resulted in the use of all available rootstock and scion material. However, in the future, consideration must be given to desirable rootstock characteristics such as high germination rate,

low incidence of bench roots, and the production of moderately vigorous, well balanced seedlings. This study was initiated to determine which of the common cultivars produce the best seedling rootstocks and how seed orientation affects this.

Table 1. Cherimoya cultivars used in the study and their country of origin.

Cultivar	Country of origin
Bays	USA
Bronceada	Chile
Burtons	New Zealand
Burtons Favourite	New Zealand
Chaffey	USA
Jeté	Canary Islands
Reretai (self pollinated)	New Zealand
Reretai (cross pollinated)	New Zealand
Smoothey	New Zealand
White	USA

MATERIALS AND METHODS

Cherimoya seeds were obtained from mature fruit from nine cultivars (Table 1). Fruit used in the study were the result of hand pollination with pollen from a range of cultivars (cross pollination). Seed was also obtained from self pollinated 'Reretai' fruit. All seed was extracted from mature fruit, washed, dried, and stored at room temperature for up to 14 weeks prior to sowing. Seeds were sown in a peat-based mix in 170-mm deep pots on 13 December 1990. Each bin contained 12 seeds, with six seeds sown horizontally to their main axis and six vertically. Each treatment was replicated seven times and pots were regularly randomised within the greenhouse. The seed raising mix was maintained at field capacity and 25°C.

After 7 weeks, the seedlings were removed from the pots and the seed raising mix was washed from the roots. Treatments were evaluated for germination percentage, bench root incidence, shoot weight, root weight, stem length, taproot length, and lateral root development.

RESULTS

A high percentage (>90%) of all seed sown germinated, with no significant effect of cultivar or seed orientation on germination rate (Table 2). A high incidence of bench roots was recorded for all cultivars. However, the cultivar 'Bronceada' had a significantly lower percentage of seedlings with bench roots than 'Smoothey', 'Bays', 'Burtons', 'Burtons Favourite', or cross pollinated 'Reretai'. Seeds sown vertically also exhibited a higher incidence of bench roots than those sown horizontally.

Seedling vigour, determined by weight, varied by up to 50% between cultivars (Table 3). Both 'Reretai' seedling types weighed significantly less than other cultivars. It is of interest that the pollen parents of cross-pollinated 'Reretai' significantly increased the vigour of seedlings, compared to those grown from self pollinated seed. The cultivars 'Burtons', 'Jeté', and 'White' produced the heaviest

seedlings. There was a strong correlation between the average weight of a seed and the seedling produced from it (Fig. 1). However, although 'Bronceada' and 'Smoothey' had the heaviest seeds they were not as vigorous as cultivars with slightly smaller seeds. Seed orientation also influenced seedling weight, with seed sown horizontally producing more vigorous seedlings than that sown vertically.

Table 2. Effect of cultivar and seed orientation on the germination rate and incidence of bench roots in cherimoya seedlings.

Treatment	Germination (%)	Bench root incidence (%)
Cultivar		
Bays	95	40
Bronceada	94	20
Burtons	97	41
Burtons Favourite	99	39
Chaffey	92	37
Jeté	95	27
Reretai (self pollinated)	94	33
Reretai (cross pollinated)	96	38
Smoothey	96	42
White	96	34
SED	3	9
Seed Orientation		
Horizontal	97	31
Vertical	95	39
SED	1	4

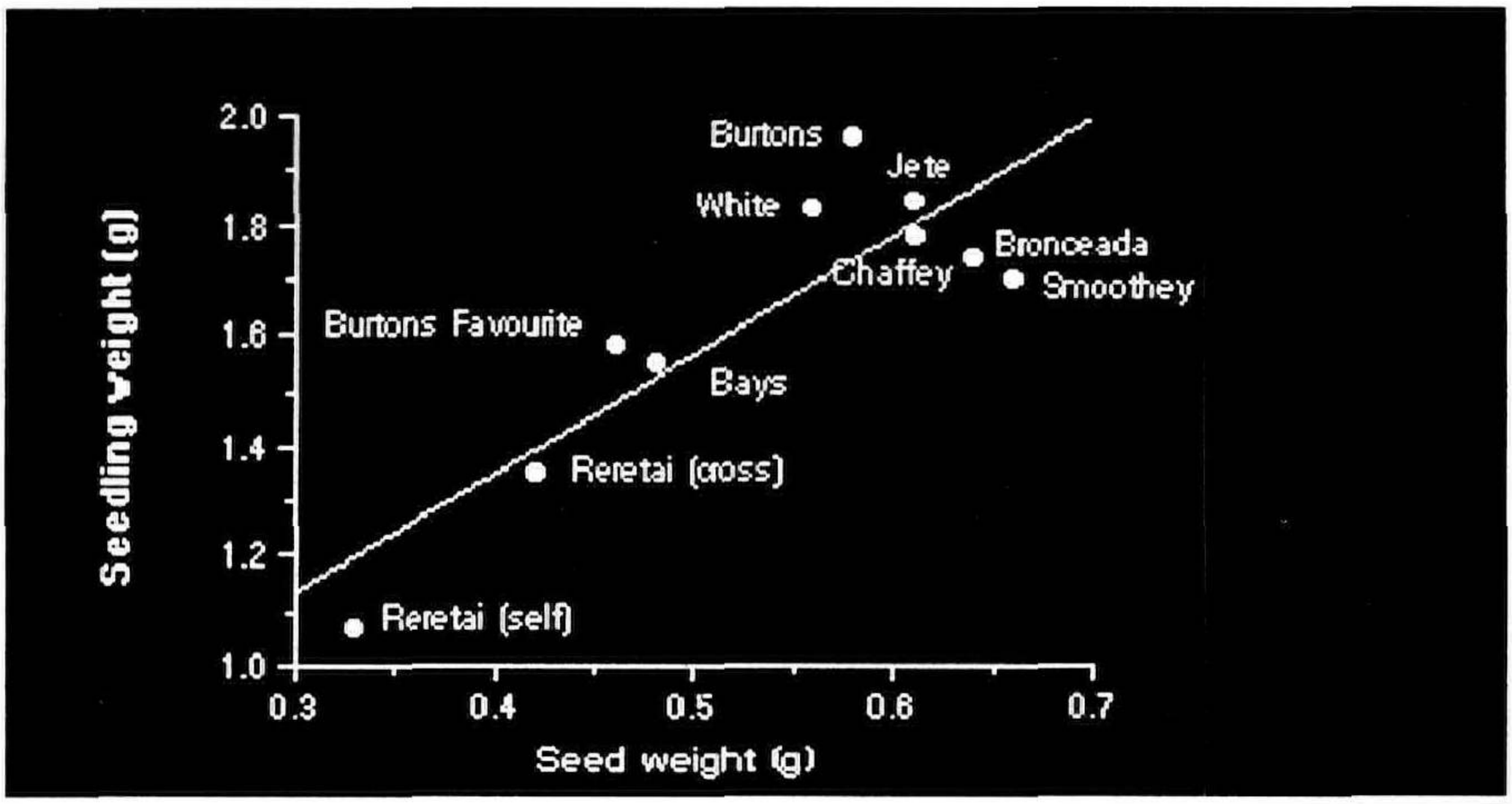

Figure 1. The relationship between seed and seedling weight for several cherimoya cultivars ($y = 0.5 + 2.1x$, $r^2 = 0.75$).

All seedlings had a much higher mass of shoot than root, shown by the shoot/root ratio (Table 3). The Californian cultivars 'Bays' and 'White' both produced seedlings with a higher proportion of shoot than other cultivars. The remaining cultivars had more moderate values. Seed orientation did not alter the shoot/root ratio of seedlings.

Seedling taproot length and the degree of lateral root development varied considerably between cultivars (Table 3). 'Burtons', 'White', and 'Jeté' had significantly longer taproots than other cultivars, while 'Bronceada' and 'Smoothey' had the shortest taproots. However, both 'Bronceada' and 'Smoothey' seedlings had as much lateral root development as most other cultivars.

Seven weeks after sowing, the cultivars 'Burtons', 'Burtons Favourite', 'Jeté', 'White', and 'Smoothey' had significantly longer stems than other cultivars. Both 'Reretai' types had considerably shorter stems, although seedlings grown from cross pollinated seed were more vigorous in this regard. Seedlings with bench roots were as vigorous as those with normal roots. Seeds sown horizontally produced seedlings with longer stems than those sown vertically. The variation in stem length, or the uniformity of seedlings, was not affected by cultivar or seed orientation.

Table 3. Effect of cultivar and seed orientation on the growth of cherimoya seedlings.

Treatment	Seedling weight (g)	Shoot/root ratio	Taproot length (mm)	Stem length (mm)	Lateral root [1]
Cultivar					
Bays	1.55	2.75	154.8	133.0	1.7
Bronceada	1.74	2.19	149.4	131.1	2.0
Burtons	1.96	2.08	175.6	144.0	2.4
Burtons Favourite	1.58	2.15	162.1	138.5	1.8
Chaffey	1.78	2.13	161.8	132.7	1.8
Jeté	1.84	2.00	163.6	140.2	2.0
Reretai (self pollinated)	1.07	1.80	158.1	105.5	1.7
Reretai (cross pollinated)	1.35	2.09	157.2	117.0	1.8
Smoothey	1.70	2.24	147.1	142.3	1.9
White	1.83	2.51	166.4	148.3	1.8
SED	0.08	0.19	6.2	5.5	0.1
Seed orientation					
Horizontal	1.72	2.21	160.3	136.3	2.0
Vertical	1.56	2.16	158.9	130.3	1.9
SED	0.03	0.04	2.5	2.1	0.1

[1] Scored on a scale of 1 = small, 2 = medium, 3 = large.

DISCUSSION

The germination rate of cherimoya seed in this study was considerably higher than either the 30% to 80% range reported by George and Nissen (1987) or the 35% to 90% range recorded in a previous experiment (Anderson, unpublished data). Seeds used in the current study were derived from artificial pollination of flowers with pollen from several cultivars. This may have enhanced the viability of seed, as natural set of cherimoya flowers is very low (Richardson and Anderson, 1990) and low germination rates have previously been ascribed to a high proportion of infertile seeds (Barnes, 1943). Seed extraction and storage procedures can also reduce the viability of seeds (George and Nissen, 1987).

Cherimoya seedlings exhibit varying degrees of bench root incidence which commonly leads to the failure of cropping trees. The cherimoya seed has a thick, heavily lignified seed coat which restricts the emergence of the radicle and thereby induces benching of the taproot (Soule, 1985). Seed size, shape, and resistance of the seed coat vary significantly between cultivars. Although the cultivar 'Bronceada' has relatively large seeds, it appears that the seed coat may not inhibit emergence of the radicle as much as it does in other cultivars. Soaking the seed for 24 to 48 h prior to sowing improves the germination rate and reduces the incidence of bench roots (Sanewski, 1991). Given the tendency of trees to fail through poor root systems, cultivars like 'Bays' and 'White' which have a lower proportion of roots than other cultivars, may produce less stable rootstocks.

The vigour of young seedlings is largely determined by the size of the seed. Although the cultivars 'Bronceada' and 'Smoothey' had the largest seeds, they are less vigorous than other cultivars. This is due in part to slower taproot development in these cultivars which may have inhibited seedling growth. The pollen parent of seeds also affects seed size and seedling vigour, as demonstrated by self and cross pollinated 'Reretai' lines.

Generally cherimoya seeds are sown horizontally to their main axis. Results from this study substantiate this practice as the more time consuming method of placing seeds vertically induces a higher incidence of bench roots and produces less vigorous seedlings. Although this investigation was carried out on 7-week-old seedlings, it suggests there are considerable differences between cultivars. Nurserymen should choose cultivars with a low incidence of bench roots and rogue out seedlings with this deformity, as it will undoubtedly lead to the subsequent failure of cropping trees. Cherimoya cultivars suitable for producing seedling rootstocks should be moderately vigorous with a good balance between shoot and root production. In this study the cultivars 'Bronceada' and 'Jeté' best meet these criteria.

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