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CELL GROWN BROADLEAVED STOCK

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Summary
There is no clear and consistent evidence to suggest that cell grown stock establishes more successfully than well bare-root stock, even when planted outside the normal planting season. However, cell grown stock is less prone to transit and handling damage that bare-root stock and allows flexibility in the planning and implementation of small planting programmes by non- experts.

Background

1. Cell grown trees are those produced within one growing season on low volume containers. They are of similar or smaller size to seedlings or transplants (as defined in B.s3936 part4). The range of container types currently available is described by Mason and Jinks (1990). Forestry Commission research on the production and performance f cell grown conifers has been underway for longer than that fro broadleaves and is summarised by Mason and Hollingsworth (1989).

Fig.1 first year survival of Downy birch planted monthly throughout the year

2. Cell grown broadleaves for amenity, farm woodland and forestry planting are promoted as having four main advantages over bare-root stock.

i) short production period enabling rapid response to consumer demand;
ii) stock is grown under relatively controlled conditions enabling the production of a plant to consumer specification;
iii) cell grown stock is less vulnerable to handling damage and can be stored by the consumer to be planted at his convenience.
iv) transplanting stock is minimised due to elimination of root loss and disturbance between nursery and planting site. The subsequent onset of tree growth is therefore rapid due to the presence of intact root tips and a high fine root to shoot ratio;
v) cell grown stock can be successfully established when planted outside the normal planting season.

3. These possible benefits should, however, be balanced against the advantages offered by bare-root stock and current advances in their production, and viewed in the light of research results.

Rapid response to consumer demand

4. Cell grown stock is generally raised within one growing season enabling rapid response to consumer demand. Development and increasing production of the 1/2ul/2 (one year old undercut stock) is also giving bare-root stock producers the opportunity of a one year production period.

Controlled nursery conditions

5. Cell grown stock production systems allow precise control of temperature, water, fertilizing, spacing and even lighting regimes resulting in potential for a high degree of control over morphological and physiological characteristics of broadleaves (e.g. increasing root system fibrosity by using copper carbonate lined cells (Arnold and Struve, 1989); controlling plant height and diameter growth by

manipulating cell density and fertilizer regimes). However, high density production methods can produce spindly plants out of proportion with the small root mass, which can be tender if not hardened off carefully. JPP (Japanese Paper Pot) cell types; volume containers formed from a degradable paper 'honeycomb', are generally of even higher density that purpose designed ,moulded plastic cell types.

6. The development of undercutting and cold storage are also enabling greater control over the morphology and physiological quality of bare-root stock.

Resistance to handling damage

7. Cell grown stock is less prone o desiccation and physical damage between nursery and planting site than bare-root stock as the growing medium in the cell holds a small reserve of moisture and protects the root system from physical damage. However, bare-root stock is generally easier and cheaper to deliver and get to the planting position, particularly when remote and inaccessible.

8. Whilst trees are dormant they can be stored for considerable periods provided they do not dry out. This is so with cell crown stock delivered in the containers and with bare-root stock that is stored in sealed co extruded plant bags in shaded conditions. However, if planting cannot be avoided outside the dormant season cell grown stock delivered in the containers can, with regular watering, be stored on site for longer than bare-root stock or cell grown stock delivered in plant bags.

Reduced transplanting shock giving good survival and growth

9. In the mid 1970's a number of experiments were established the performance of broadleaves raised in JPPs compared with fresh lifted bare-root transplants. No consistent trend emerged as to the relative values of these stock types. This was also apparent from other research undertaken in the 1970's highlighted by a review (Insley, 1982) which found literature on outplanting performance almost equally divided between evidence for the superiority of container grown stock and that for bare-root stock.

10. Later research on the outplanting performance of cell grown broadleaves is rare but Althen and Prince (1986) found that survival of container grown Black walnut (*Juglans nigra*) seedlings was significantly less than that of 1+0 bare-root seedlings. The surviving container grown stock, however, grew significantly better than the bare-root stock. Watzek and Lupke (1987) reported that Sessile oak (*Quercus petraea*) (average height 50cm at planting) grown in a soft walled, bitumen impregnated 500cm $^{-3}$ containers showed 50%survival at the end of the first growing season, compared with 95% for 2+1 bare-root stock of the same size.

11. More recently, comparisons have been made between English Oak (*Q.robur*) and beech (*Fagus sylvatica*) growing purpose designed Rootrainer "Sherwood" (175cm $^{-3}$ cells). Stock of each species was sown at the same time and had a common seed origin. After the first growing season survival of both stock types was over 90% for each species, although significantly better with the rootrainer stock ($P<0.05$ for oak and $P<1.01$ for beech). Height growth also tended to be greater with Rootrainer stock.

12. There is still no firm and consistent evidence to suggest that cell grown stock is superior to good quality bare-root stock in terms of outplanting performance.

13. There is evidence from work on Corsican pine (*Pinus nigra* var *maritime*) that, when exposed, the papers of JPP's can act as a wick in early establishment phase, reducing root moisture content. During the later establishment phase slow degrade of JPP papers can cause root deformation (Insley and Patch, 1980), although possible long tem root deformation of trees grown in plastic cells has been indicated in established experiments using cell grown conifers.

Planting outside the normal planting season

14. Three experiments established in the 1970's compared the survival and growth of Downy birch (*Betula pubescens*) and beech grown in JPP's to well handled, fresh lifted bare-root stock for out-of-season planting. Apart from poor first year survival of bare-root birch planted in August and September (fig1), there was no significant differences between the survival and growth of JPP stock and well handled, fresh lifted, bare-root stock.

Fig 2: first year survival height and stem diameter growth of oak, by stock type and date of planting.

15. In 1989 an experiment was established on a south facing trunk road embankment near Edinburgh using English oak bare-root transplants and Rootraniner "Sherwoods" planted at three dates; early September , January and, using cold stored transplants, late May. The bare-root stock tended to be sturdier (higher root collar diameter for any given plant height) that Rootrainer stock, but the survival of September planted bare-root stock was only 36% with a mean height of live trees at the end of the first growing season 14.6cm less that at planting; significantly ($P<0.001$) worse that the 99% survival and 2.1c, growth of September planted Rootrainer stock (fig 2). However initial size differences between the two stock types planted in September may have influenced the results, the bare root stock planted in September being, on average, 24.5cm taller that the Rootrainer stock and thus more exposed to desiccation when planted in full leaf and to severe winter winds on this exposed site.

16. All trees planted in January and May survived well but bare-root stock grew on average 6.5cm whereas the Rootrainer stock died back by 1.6cm

17. The planting of any stock type when mot dormant will increase the risk of poor plant survival; and growth. However, if plating actively growing trees is unavoidable, research indicates that, apart from mid and late summer, well handled bare-root stock establish as well as cell grown plants. Cold storage, by extending the duration of dormancy, could reduce the rise of failure of bare-root stock planting in late spring.

Conclusion and recommendations

18. Research evidence to date indicates that there are no clear and consistent survival and growth benefits for the use of cell grown stock. Factors such as scale and remoteness of planting, expertise of those undertaking the planting, requirement to fit planting around other work programmes and relative prices of bare-root and cell grown stock should be the main determinants for which stock type is used.

19. Planting programmes should be planned to follow sound practice; that is to avoid planting outside the normal planting season. Planting of trees which are not dormant, whether bare-root or cell grown, greatly increases the risk of mortality. However, bare-root stock performs as well as cell grown stock when planted in late spring, particularly if cold storage has been used to prolong dormancy.

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