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AMENITY TREE PLANTING WITH CARE-ROOT STOCK
By S J Hodge Research Officer, DoE Arboriculture Contract, Forestry Commission

Summary

Poor performance of bare-rooted stock of some tree species, particularly when planted as large stock sizes, could be due to the species dependent root system characteristics resulting in loss of intact root tips at lifting and slow regeneration of new adventitious roots after planting. Using smaller stock sizes, and in particular undercut stock, tends to reduce plant losses as a large proportion of the root system is lifted with the plant, thus maximising root to shoot ratio and retention of intact root tips leading to less moisture stress, and rapid growth after planting.

Background

1. The range of tree sizes available for amenity tree planting is wide (table 1). Larger bare-root or rootballed stock (light standards and larger, as defined in BS 3936 – I 1992) are used particularly in urban planting. Smaller stock types are often used in extensive and rural planting schemes, but whips tend to be more common than smaller bare-root stock even in these situations. This Note gives an overview of research into the role of smaller, cheaper bare-root stock types for amenity tree planting.

Table 1: Stock types available for amenity tree establishment.

Stock type	size and age	predominant use
Bare-root	seedling (1+0)	forestry
	transplant and whip (1/2+1/2, 1+1, 1+2)	forestry
	undercut (1/2u1/2, 1u1)	forestry
	feathered standard	amenity
Root-ball	half standard to semi-mature	amenity
Container	seedling (cell-grown)	forestry
	Containerized (>1 year)	amenity

Species variation in post planting performance

2. Species vary in performance after planting. Sturve (1990) explains this variation in terms of root system fibrosity. Struve found that ash *(Fraxinus pennsylvanica*), being a fibrous rooted species, still had a good number of intact root tops after transplanting. These root tips began elongation within nine days and adventitious (new) root regeneration began 17 days after planting. In

contrast Red oak (*Quercus rubra*), a coarse rooted species, had very few intact root tips after transplanting and the start of adventitious root regeneration form incised lateral roots took 24 days and from the main root 49 days.

3. Struve's evidence appears largely consistent with practical experience of species commonly used in Britain. Species such as ash (*F.excelsior*), wild cherry (*Prunus avium*), rowan (*Sorbus aucuparia*) and sycamore (*Acer pseudoplatanus*) fit Struve's "fibrous root" category and are relatively easy to establish. Such species may commence root regeneration soon after outplanting, thus limiting moisture stress in the season after planting. Species that end towards Struve's "coarse root" category, for example English oak (*Q. robur*), beech (*Fagus sylvatica*) and hornbeam (*Carpinis betulus*), are more difficult to establish, possibly because loss of most root tips and slow regeneration of adventitious roots make these species prone to extreme moisture stress, particularly when large stock with low root/shoot ratios is outplanted.

4. The simple relationship between root fibrosity and ease of establishment does not, however, appear to hold true for all species. Birch (*Betula Pendula*), for example, is fibrous rooted but also difficult to establish. There are indications that species vary in the origin of adventitious roots. A species which tends to regenerate such roots from the larger woody roots may establish better than a species regenerating most new root from small woody roots, as many roots are lost lifting. In addition, species vary as the main source of stored carbohydrates for growth. In one study (Abod and Webster, 1991), birch fine roots were the main reservoir of carbohydrates, whereas with lime (*Tilia cordata*), primary roots were the principal reservoir.

Transplant Stock size

5. An experiment established in 1984 on a motorway embankment with a disturbed clay soil compared the growth of 1+1 transplants, whips and half-standard Sessile oak (*Q.petraea*) and rowan. The planting stock types of each species were raised from the same origins of seed. The effect of weed control was also included in the experiment. Where weed control was not undertaken, survival of oak half-standards was 27% and survival of whips 39%, whilst survival of transplants was 90% (Table 2). Effective control of wed competition for the first four years after planting was more critical to the survival of the oak half-standards and whips than for the transplants. The survival of **rowan** was good with all stock sizes, even unweeded.

6. Growth of all **oak** and **rowan** stock sizes was slow on this inhospitable motorway site (table 2). The slowest growth has taken place with the **oak** half-standards; with those unweeded showing severe dieback. In contrast, the most rapid height growth was recorded from weeded **rowan** transplants; 138cm of seven years.

Table 2: Survival, height and height increment of three stock sizes of oak and rowan after seven years on a clay motorway embankment.

	Transplant weeded	Not weeded	Whip Weeded	Not weeded	Half-standard Weeded	Not weeded	Sig *
Oak							
Survival (%)	99	90	97	39	90	27	P<0.001
Height (cm)	164	86	156	78	229	131	P<0.001
Height increment (cm)	104	25	42	-33	3	-99	P<0.001
Rowan							
Survival (%)	77	96	73	99	77	92	NS
Height	185	110	194	125	253	192	P<0.001

(cm) Height increment (cm)	138	63	104	37	37	-24	P<0.001

Statistically significant differences between stock sizes.

7. In 1989, another experiment was established on a low-lying site with a heavy calcareous clay soil to compare the survival and growth of oak, rowan and ash 1+1 transplants, whips and half-standards with weed control. Second year results (table 3) are consistent with those of the 1984 experiment.

8. It is clear from these experiments and from observations of general practice that large (and expensive) stock often fail to result in fast growing amenity trees that are fulfilling their role in the landscape. Losses of small planting stock during establishment phase are often relatively slight and early growth can be very rapid. Coarse rooted species such as oak, beech and hornbeam show particularly poor survival and growth when planted as large stock.

Table 3 : Survival, height and height increment of three stock sizes of oak, rowan and ash after two years on a calcareous clay site.

	Transplants	Whip	Half-standard	Sig*
Oak				
Survival (%)	100	100	68.3	P<0.01
Height (cm)	72.7	104.8	227.3	P<0.001
Height increment (cm)	18.3	6.8	-1.0	P<0.01
Rowan				
Survival (%0	100	100	100	NS
Height (cm)	123.5	154.3	277.0	P<0.001
Height increment (cm)	59.7	45.0	23.2	P<0.05
Ash				
Survival (%)	100	100	100	NS
Height (cm)	112.3	136.2	245.3	P<0.01
Height increment (cm)	61.8	26.7	18.3	NS

* Statistically significant differences between stock sizes.

Undercutting

9. In ornamental stock nurseries undercutting is generally undertaken in late summer, with little benefit to the structure of the root system, in order to make lifting easier. However, in forest nurseries undercutting in early summer is a long established practice to promote root branching by severing tap roots. Though little comparative research has been done on the performance of broadleaved undercut and bare-root stock, work comparing these stock types is commercially important conifer species has shown consistent benefits in the use of undercuts (1u1's) over transplants (1+1's) (Mason and Hollingsworth, 1989).

10. Development and increasing production of the 1/2ul1/2 is enabling bare-root stock producers to respond rapidly to consumer demand by producing stock with well branched root systems within one growing season.

The urban tree context

11. The logistics of lifting and moving bare-root and root-balled stock causes the loss of a high proportion of the root system. Planting a tree with an artificially low root to shoot ration in a harsh environment increases the probability that extreme transplanting stresses, particularly moisture stress, will be experienced by the tree as the incomplete root system is unable to supply the demands of a large crown. The result is often death, die back or poor condition and low growth, particularly of coarse rooted and other sensitive species. A survey in 1979 of standard trees planted in Scotland (Skinner,1986) showed that 46% had died within the fist five years after planting.

12. The use of smaller stock sizes, and particular undercut stock, often results in reduced plant losses. A major reason for this is the generally lower levels of moisture stress experienced by small stock after planting due to generally good root to shoot ratios obtained when a high proportion of the root system is lifted with the plant.

13. A survey of 3600 urban trees undertaken in 1989 (Hodge, 1991) identified a distinct trend towards increased planting of urban street trees in shrub beds. This practice was found to confer benefits of increased growth rates and reduced tree damage, and may further enable smaller, cheaper stock sizes to be successfully established even along streets.

Putting the theory into practice

14. Species differ in their ease of establishment and this may reflect differences in root morphology and regeneration. "Coarse rooted" species such as oak and hornbeam tent to suffer greatly from transplanting stress, particularly when larger stock sizes are used. To avoid significant loss and moribund trees in very poor condition, smaller stock sizes are used. To avoid significant losses and moribund trees in very poor condition, smaller stocks of these species should be used wherever possible.

15. "Fibrous rooted" species such as rowan, ash and cherry suffer less from transplanting stress and, although the growth of the larger stock sizes is slower than that of smaller planting stock, survival of half standards can as good as that of transplants and whips. However, even with species that are relatively easy to establish there are still strong financial reasons for planting smaller and much cheaper stock types. In situations where the use of large planting stock cannot be avoided consideration should be given to the use of fibrous rooted species that are most likely to establish successfully and grow well.

16. The emphasis of research into the production of broadleaved stock is moving from "growing shoots" to "growing roots". The result is an increasing ability to produce standardized, high quality stock with well branched root systems. Further research will examine and develop the full potential if undercutting.

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