TECHNICAL NOTE TN691 October 2017 • ELEC

Plants and Planting Methods

Farm Advisory Service

National Advice Hub
T: 0300 323 0161
E: advice@fas.scot
W: www.fas.scot

Summary

- **Select the appropriate plant type for your planting programme and method of planting. Cell grown trees can extend your planting season but are more expensive.**
- **Plant size is not as important as quality. Be realistic: larger plants may look attractive and create instant impact but initial size is not a reliable indicator of speed of establishment.**
- **Always match species to site conditions and use plants with a suitable origin or provenance, failure to do so could result in widespread losses.**
- **Mixtures can speed establishment and improve the conservation and amenity value of a woodland, but careful selection and management is critical for success.**
- **Pruning willows and shrubs before planting promotes a dense growth habit and reduces dieback**
- **Always handle plants with care and never allow their roots to dry out.**
- **Machine planting can be very efficient and offers many benefits, but is only suitable for certain sites.**
- **Tailor plant spacing to your objectives, using denser spacing for timber production and to achieve rapid establishment or wider spacing for amenity planting and to achieve more natural edges.**

Introduction

Forest nurseries offer a wide range of plants that can vary considerably in terms of size, provenance, age and method of production. There is also a variety of techniques you can use for tree planting and ground preparation

The selection of the appropriate size and type of plant for the planting location and ground preparation or planting method is important to ensure good growth and cost effective establishment.

Plant Types

Plants are supplied by nurseries in three forms:

- **Bare Rooted Plants**

Bare rooted plants are, as the name implies, sold with no soil around their roots. They are the traditional choice and nearly all common woodland species can be bought as bare rooted stock. They can only be handled and planted when the tree is dormant, usually from late November to early April. The planting season can be extended in the spring if the plants are 'cold stored'.

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The disadvantage of using bare root plants is that some root damage during handling and planting is unavoidable. This can cause stress or checking (poor or very slow growth) after the tree is planted. Some species, such as birches, Douglas fir and Corsican pine, have very delicate roots and may suffer relatively high losses when planted as bare rooted stock.

The main problems encountered with bare rooted stock arise from roots being allowed to dry out, which can happen very quickly, or damage from rough handling. Bare rooted plants should always be delivered in co-extruded polythene bags which are black on the inside and white outside. These help reflect the heat of the sun and insulate against frost. They also make handling easy and convenient, and, most importantly, help prevent roots from drying out. Plants may keep in the bags for several weeks, but it is always best to carry out the planting as soon as possible after delivery. Bags should be kept closed at the neck except when removing plants and, as far as possible, must be protected from sunshine and frost. They must always be handled gently.

Bare rooted plants are usually cheaper than alternative types.

• Cell grown plants

Cell grown plants or root trainers are grown in small cells of peat or compost and are supplied as a rootballed plug. Some species, such as holly, are only sold in cells or containers.

Due to their method of propagation, cellular plants are slightly more expensive than bare rooted plants. Because the root system is protected by the rootball, their great advantage the planting season can be extended from September to May, even when the plant is in leaf. This usually means a reduced risk of checking in certain species, notably Corsican pine and birch and losses after planting are usually lower than with bare rooted plants. This reduces future costs of replacing failed trees and subsequent weeding and compensates for the higher initial cost of the plants. Cell grown plants have become increasingly popular as the price differential between them and bare rooted plants has reduced.

Cell grown plants must be kept well watered prior to planting, especially in the spring when the plants are in leaf.

• Cuttings

Plants produced vegetatively by cutting a section from a young branch or stem, are known as cuttings. New root and shoot growth develop from buds on the stem. A cutting can be planted directly onto site (short rotation coppice plantings employ this method) or can be allowed to grow on in a nursery bed for a year to form rooted cuttings.

Willows, aspen and poplar trees are almost always sold as either cuttings or rooted cuttings as seed is often unavailable or seed grown plants are more expensive. 'Elite' Sitka spruce is also grown from cuttings.

Rooted cuttings are effectively bare rooted trees. They are handled in the same way and have the same advantages and disadvantages.

Cuttings are cheap to produce and can be quickly and easily planted by hand or machine, making them cost effective, especially when high planting densities are required as in a biomass plantation.

As a cutting is a clone, it is important to use a variety of parent plants to reduce the risk of disease. In practice, it is recommended that a variety of clones and species are used for anything other than small scale planting.

Cell grown plant Willow cutting Larch transplant

Figure 1 Examples of plant types.

Plant size

Nurseries sell trees in size categories; typically 20-40cms or 40-60 cms. Many will also sell trees in a variety of age classes, especially coniferous species. Labelling indicates whether the seedlings have been transplanted or undercut in the nursery. For example 2+0 indicates a two year old seedling that has not been transplanted, while 1u1 indicates a seedling that was undercut after one year and allowed to grow on for a second year. Undercutting or transplanting helps create a bushy root system. This range of types gives one the choice between a slender tree or a more sturdy bushy individual, each of which maybe suited to a particular site or planting technique.

For most woodland schemes, plants will normally be between 20 and 60 cm tall. Cell grown plants tend to be at the lower end of this range. Size is not in itself an indicator of plant quality. The ratio of root to shoot is important and a plant should have a good, well-developed system of fibrous roots to balance their shoot growth. If a tree has poor roots and a lot of shoots and branches, it is more likely to die back when planted.

There is no one ideal size, as the most appropriate plant to use will vary with the site and to some extent also with the species.

When planting broadleaves in tree shelters in situations where the environment is favourable to tree growth, a 30cm tall plant is adequate. However, if planting on a less favourable site, a larger plant will have greater reserves to deal with adverse conditions and a size of 40-60cm is often more appropriate.

If planting without shelters the opposite applies.

On exposed sites with poorer soils or on sites close to the sea, plants of 20 - 40 cm should be used, as exposure may cause dieback of the shoots before the roots have a chance to establish. On fertile and sheltered lowland site large plants are better able to withstand heavy weedgrowth.

There are disadvantages to using bare-root stock larger than 60cm in height. Invariably, the root to shoot ratio suffers, plants go into check and die-back is likely to occur. Larger plants are also more expensive to buy and to plant.

Conifers are seldom planted in tubes and on an open site, a plant of 20-40cm is generally used. For Scots pine which has denser foliage that tends to catch the wind, a smaller plant of about 15-30cm is often more appropriate. As with broadleaves, larger trees can reduce weeding on a fertile site.

Machine planting requires smaller plants that are uniform in size and not too bushy as they have to be easily handled and fit in the machinery.

Species choice

Matching the correct species to the site conditions is essential if trees are to establish and grow well. Ecological Site Classification and local knowledge are the best methods of assessing which species are best suited to a given site.

Species choice will also depend upon the purpose of the scheme. If timber production is the primary purpose, the range of species is likely to be limited to conifers and a few hardwoods such as oak or cherry. In a native woodland then only native broadleaves or Caledonian Scots pine will be used.

Suitable species of tree should be identified at the design stage as within a planting site there may be considerable variation in micro-climate, soil types and wetness so species or mixtures of species will need to be allocated to specific areas within the site. For example, Norway spruce should be planted rather than Sitka spruce in frost hollows; pines will tolerate drier and poorer soils than spruces, and different species of oak may be required, depending upon whether soils are light or heavy.

Provenance

Once suitable species have been chosen, and all other factors taken into consideration, the provenance or origin of a tree is probably the most important factor in determining successful establishment and subsequent growth. This is particularly important for native woodland schemes

In a species growing over a wide geographic area, local populations can arise which are suited to the local environmental conditions. The provenance of a tree refers to the local climatic area where its parent tree was grown and from which its seed was obtained. If the parent tree has thrived, then there is a degree of assurance that the offspring will do equally well in a similar situation.

Some species of trees become more closely adapted to localities and show more variation than others, therefore, the importance of provenance varies between species. Birch for example should not be moved more than 200 km from its provenance source, whereas oak from the Netherlands can be grown successfully in most parts of Britain.

Under the Forestry Grant Scheme when creating a native woodland one must use local provenance plants. FCS publish a map showing Provenance Regions for broadleaves, basically East and West Scotland, broken down into a series of smaller seed zones. So for example a native woodland planted in Aberdeenshire should normally use trees grown from seed collected within seed zone 202 which covers Aberdeenshire and part of the central highlands. The same applies to Caledonian pine but the boundaries for the zones for this species are different.

Nurseries indicate clearly the provenance or seed zone of their trees and provide 'Seed Certificates' confirming the seed zones which must be submitted with any grant claim to verify compliance with the rules of the FGS.

Tree Diseases

Several tree diseases have appeared in recent years. Most of these are specific to particular species and where they have a high mortality rate or their effects are severe then that tree species should not be used. The main species affected are Japanese larch which is affected by Phytophthora ramorum, poplar hybrids, affected by various rusts, ash, affected by Chalara (ash dieback); Scots pine affected by red band needle blight and wych elm affected by Dutch elm disease. There is currently (2017) a ban imposed the use of ash while wych elm should only be used in small numbers.

Mixtures

It is common practice, especially when growing trees for timber production, to plant areas with a single species for ease of management. There are however advantages to using mixtures when planting.

Tree mixtures are used to improve the conservation and amenity value of woodland, speed the rate of woodland establishment, provide early utilisable timber and to nurse some more demanding tree species. Broadleaf mixtures are commonly planted in native woodlands, land reclamation schemes and amenity plantings and these attempt to mimic the species' distribution within a natural woodland.

Mixed conifer plantings are used when establishing productive trees on nutrient poor soils, or to avoid the visual monotony of a single species.

Care must be taken when selecting mixtures as tree growth rates must be compatible. Mixtures also require greater attention in their management than single species plantings, especially in the timing and selection of trees for thinning. This is critical in conifer/broadleaf mixes, where a faster growing conifer can out-compete a potentially more valuable but slower growing broadleaf. The rule of thumb is that the yield class of the conifer (its expected rate of growth for a given site in m3/ha/year) should never be more than double that of the broadleaf. For example an oak of expected yield class 6 (YC6) can be mixed with Norway spruce of an expected YC12 but not YC16.

In some cases, non-compatible species are deliberately planted with the intention of one outgrowing the other. An example of this is Scots pine planted with Sitka spruce on a heathery site. Here the pine suppresses the heather which would otherwise cause 'checking' of the spruce, allowing the spruce then to come away and form the final crop.

There are three common types of mixture:

- **Intimate**

Here different tree species are planted in close proximity to one another. A system commonly used in nursed crops is to plant alternating species along a row. This, while diverse at the individual tree level, can appear monotonous at distance and is better suited to timber crops where only two or three species are used. Intimate mixes for timber production require careful species selection, high levels of supervision at planting and during subsequence maintenance and management to ensure success.

- **Group mixtures**

In a group mixture, trees are planted in single species groups of often between10 to 25 trees. Competition between faster and slower growing species is therefore less critical and in this respect

the planting is more robust. Such mixtures are quickly planted but care must be taken to ensure that individual tree groups are suited to their planting location. For example, a group of silver birch should not be allowed to extend onto flushed wet ground which does not suit this species. On very variable sites, planters need to be experienced to achieve good results. Group mixtures are often appropriate for multi-species and multi-purpose woodlands, as they allow considerable flexibility in management.

In both the above cases in native woodlands the mixture should try to replicate the structure of a native woodland and pay account to the growth habits and environmental requirements of each species.

• Line mixtures

Possibly the easiest of mixtures to plant and manage, line mixtures consist of single species rows, traditionally of three and three in conifer and broadleaf mixes. This mix is almost entirely used for commercial timber production, but is now rare, as the 'pyjama strips' can be visually intrusive.

Mixed tree planting, spruce & larch

Table 1: Common mixtures for timber production

	Nurse trees				
Final Crop trees	Norway spruce	European larch	Scots pine	Lodgepole pine	Western red cedar
Beech	✓	✓	✓		✓
Oak	✓	✓	✓		
Sitka spruce			✓	✓	

Pruning or cutting back

Some plants, especially willows, roses, hawthorn, blackthorn and other shrubs, characteristically grow very fast in the nursery. Even if your order specifies willows at 45-60cm tall, they may be taller (perhaps up to 2 metres) when they arrive. If plants arrive outsized, or unbalanced in terms of root and shoot growth, send them back!

Pruning of some species at planting is essential. Willows should be cut back to 60cm for planting. Thorns, roses and other shrubs such as elder should be cut back to 45 cm, or even 30 cm if being used in a hedge. This will do the plant absolutely no harm at all, and, in fact, is positively beneficial. Pruning reduces die-back of the shoots after planting and will stimulate thick bushy growth from the base, developing the dense multi-stemmed form desirable in a shrub. Conifer species, however, should never be pruned.

Planting method

Planting may be done by hand or on some sites by machine.

Planting work should be planned in advance. To avoid stressing plants or drying plant roots, each day only take out to site those trees that will be needed. Leave the main stockpile of plants in their bags in a shed or undercover where they are protected from the weather. At all times keep plants in bags to prevent roots from drying out, and handle them as little as possible.

Planting machines are now commonly used on larger schemes where ground conditions are suitable. Some machines are attached to the three point linkage of a tractor and these can be hired from machinery rings or a specialist contractor. Planting machines allow the work to be completed quickly. However they are only cost effective where trees are planted at higher densities. They are not suitable for use on steep or unimproved ground, or where variable spacing or more complex mixtures of trees may be required for landscaping reasons.

On most schemes, especially those undertaken on a DIY basis, or with farm labour, the planting will be carried out by hand. To prevent poor root development, trees are best planted in a T or an L notch, with the ground level with the top of the root collar, straight and firmed in; as illustrated in Figure 2. Special forestry spades are available, but a normal garden spade is almost as effective. For large rooted plants, pits may be needed.

Planting is much easier when the plants are carried in a planting bag worn over one shoulder. This allows roots to remain protected until planting and avoids the damage that may be caused by dragging a bag along the ground. If planting into a grass sward, the turf over a circle of about 20cm in diameter should be scraped away. This is known as screefing and also provides a degree of weed control, aiding subsequent maintenance. Hand screefing should be followed up soon using a chemical herbicide.

Sometimes the planting pattern is complex. In this case do avoid the temptation to lead out plants and drop them on the ground in the required planting position, returning only later to plant them. It is far better to spend a little time measuring out the planting site and marking the boundaries where different species or mixtures are to be planted with canes or pegs.

On wetter areas, where water can lie on the surface, or high water tables affect the trees for considerable periods, it is essential to cut a raised turf of at least 30cm square, and then notch plant into this. The raised planting position helps drain the soil locally and aerates the root system, as well as providing localised weed control. It is important, however, that the roots make contact with soil and that no airspaces are left. For this reason, it may be better to cut long or rank vegetation prior to turfing. Turfs can be cut by hand, or, on larger sites, can be created by machine in a process known as mounding. On mounded sites additional drainage may also be required.

The planting position on mounds should be as central as possible. Machine mounds tend to be much larger than hand cut turves and require a period of settlement before planting, sometimes of several months.

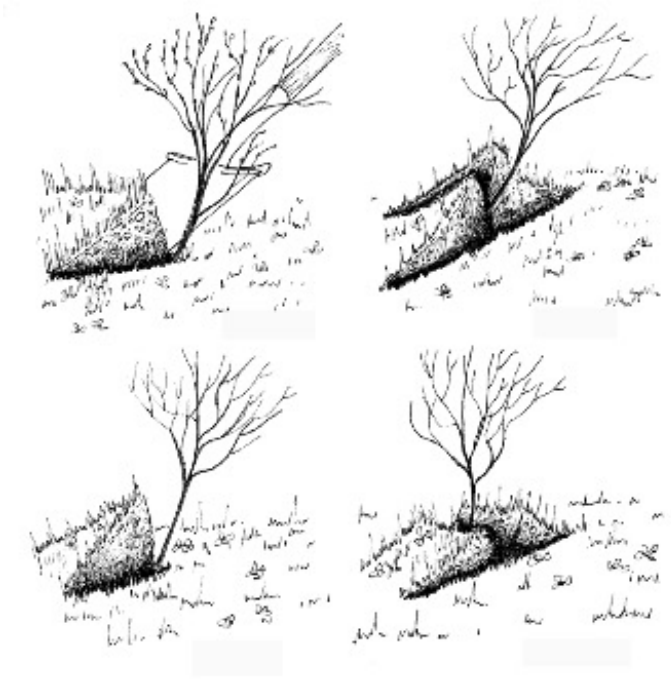

Figure 2: Planting notches L, T, V and H

Machine Planting

Two types of planting machine are available; each with very specific applications.

The Bracke type planter is mounted on a tracked excavator and consists of a carousel holding the trees mounted onto a planting head. This cultivates the ground by creating a mound or inverting the turf, plants the trees and can also apply a dose of fertiliser. It uses cell grown trees exclusively as these are small, and easily handled by a machine due to their uniformity. An advantage of this machine is that it carries out physical ground preparation and planting in a single operation, reducing some supervision and management costs. The cab also provides a comfortable working environment for the operator. Although this machine could be used on any site, in practise it is only advantageous where soil cultivation or brash raking is required. For this reason they are used mainly on restocking sites with heavy brash or upland sites

where drainage or cultivation is required.

Bracke planting machine

The other type of planter is best suited to improved grassland or arable land. Often custom built by a contractor with engineering skills in their simplest form they are little more than a sub-soiler and a pair of compacting wheels mounted on a tractor's three point linkage. The planter sits above the rip and places the plants into the ground and the paired wheels then firm up the soil. More sophisticated versions have a cab for the planter and a conveyor mechanism that places the tree into the soil.

Planting machines plant a very regular crop with clearly defined rows and uniform spacing. Often they can also apply herbicide in bands or spots as they plant. Machine planting can be substantially cheaper than hand planting and up to 15,000 trees per day can be planted.

Machine planted trees

Machine planting offers several other benefits. One can plant at a higher density than the minimum required by the contract so that low levels of losses can be ignored. Stocking densities are easily checked. Inter-row mowing to control tall grasses or noxious weeds is facilitated and also it is usually possible to carry out further applications of herbicide in bands by quad bike or small tractor. All of these benefits help reduce ongoing maintenance costs.

Machines such as these usually use bare-rooted plants, typically 20;40 cms tall though cells can also be used. They are best suited to productive woodlands with only a narrow range of species as it is not practical to plant complex mixtures requiring a close match of species to site.

Spacing

Plant spacing is very important and is always specified in the grant contract. Plant spacing is a function of the species and scheme

objectives. For instance, many trees will do well at wider spacing, but trees such as oak or beech when grown for timber need much tighter spacing at planting to help achieve straighter, unforked stems. Initial close spacing can speed up establishment and thus reduce weeding costs, but as more trees are required, expenditure at planting is greater. As there will always be some losses after planting, it is often sensible to plant at a slightly higher density than specified in the contract. This will reduce subsequent costs associated with replacing failed plants (known as beating- up).

Spacing is ultimately a compromise, based on a range of considerations but, as a general rule, the closer the spacing the more options you have at a later date, when thinning. Table 2 provides a table of recommended spacing.

Table 2: Recommended spacing

Species	Amenity & conservation		Timber production	
	Spacing	Density	Spacing	Density
Pines, Larches & firs	2.1 x 2.1m	2,000/ha	2.0 x 2.0m	2,500/ha
Spruces	2.0 x 2.0m	2,500/ha	1.9 x 1.m	2,800/ha
Sycamore	1.6 x 1.6m	1,600/ha	2.0 x 2.0m	2,500/ha
Beech	1.6 x 1.6m	1,600/ha	1.8 x 1.8m	3,100/ha
Cherry	3.0 x 3.0m	1,100/ha		
Oak	2.0 x 2.0m	2,500/ha		
Poplar	N/A	N/A		
Native woodland	Random or irregular	1600/ha		

Note; if planting is funded under a grant scheme the plant spacing will be specified in your contract: do not allow your woodland to drop below the stocking density stated in the contract as there may be a financial penalty.

A simple method to check that the desired planting density has or is being achieved, is to lay out sample plots with an area of 0.01 hectares. This is done by putting a peg or stake in the ground at random positions. Tie a tape to this and sweep out a circle with a radius of 5.6 metres and count all the trees within the plot. Multiply this by 100 to obtain the number of trees per hectare; see Figure 3.

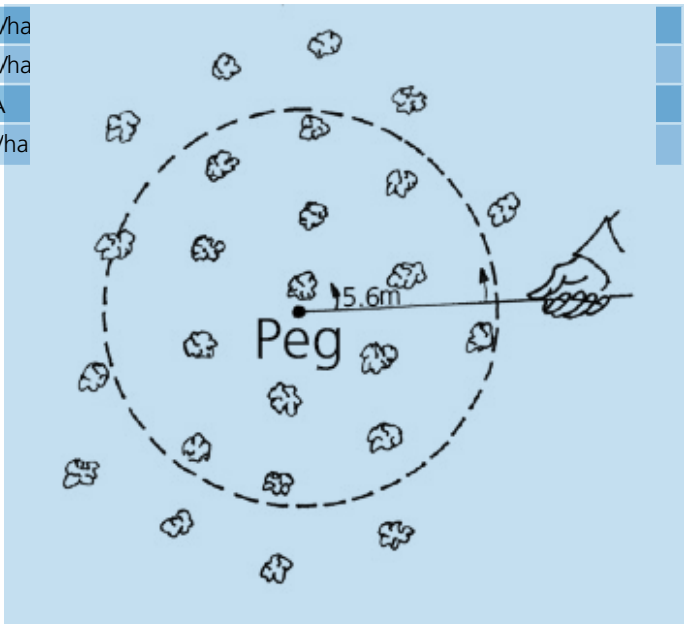

Figure 3 How to measure plant density.

Further Information

Further information can be found from the following publications and sources:

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