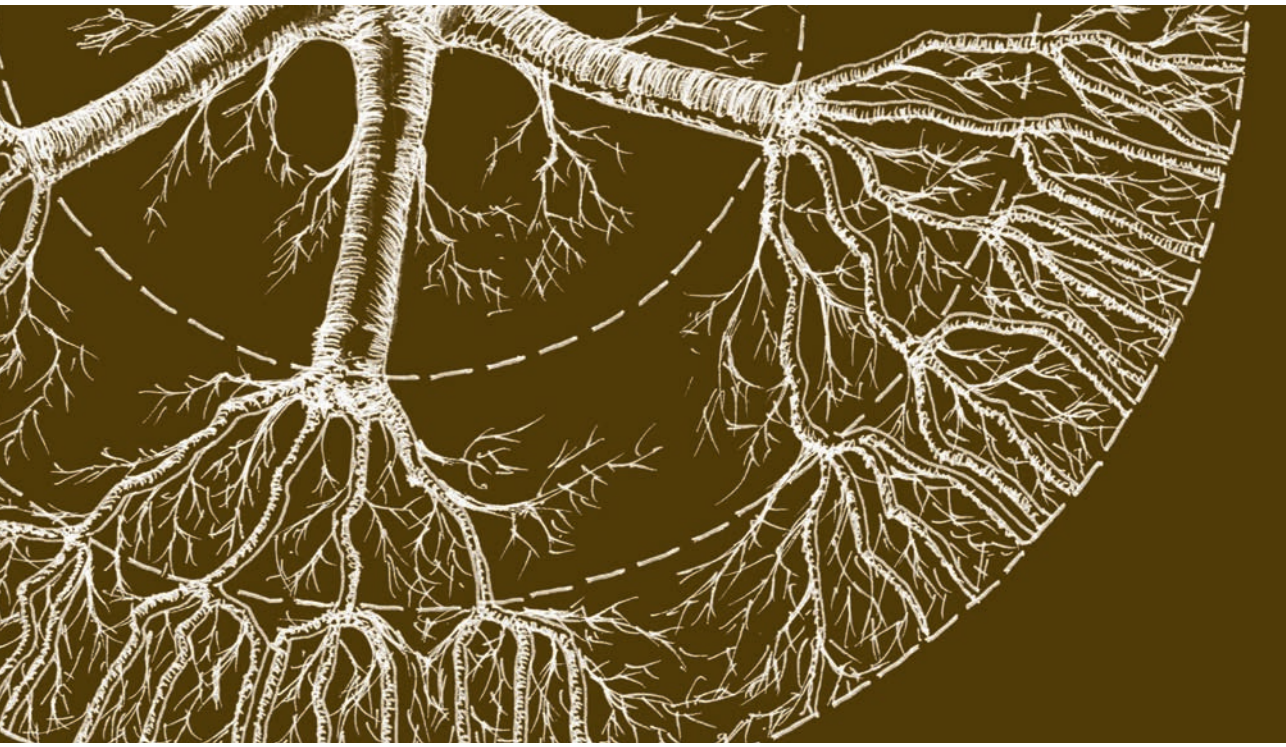
Young tree specification manual

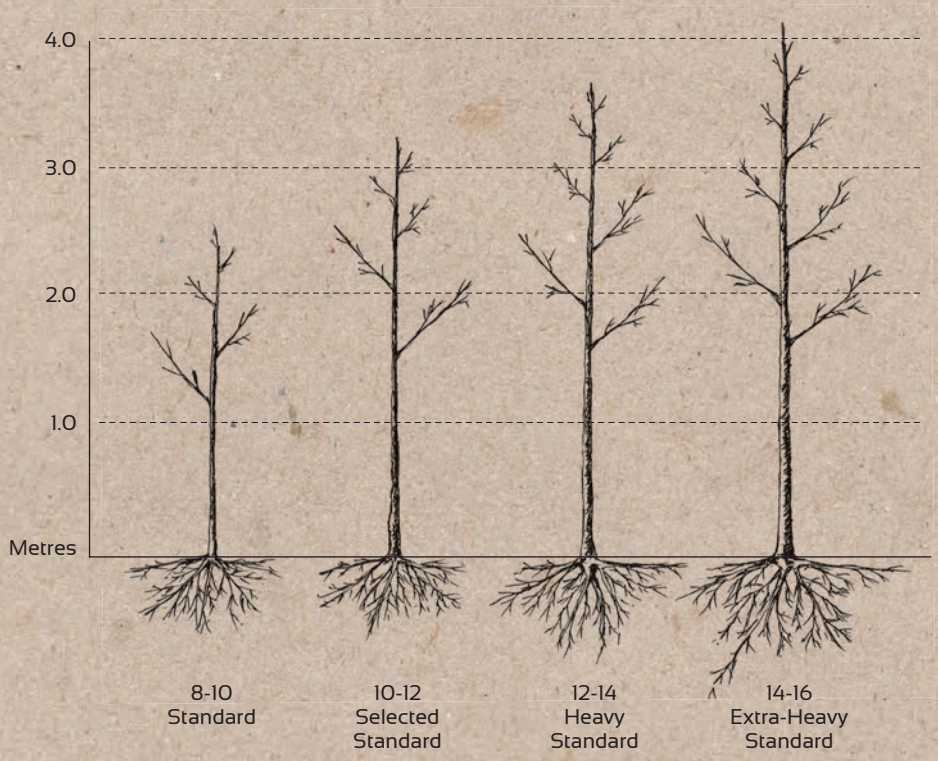
REVISED EDITION

How to ensure young trees from the nursery are fit for purpose



Trees & Design Action Group

Barcham
The Tree Specialists



Height and Clear Stem of Nursery Trees

(excluding whips, transplants and semi-mature trees)

Size of Tree	Circumference at 1 metre	Height of Tree	Clear Stem
Standard	8-10cm	2.5-3.0 metres	1.75-2.0 metres
Selected Standard	10-12cm	3.0-3.5 metres	1.75-2.0 metres
Heavy Standard	12-14m	3.5 metres	1.75-2.0 metres
Extra-Heavy Standard	14-16m	3.5 metres	1.75-2.0 metres
		BS 8545 and BS 3936	

1.0

Introduction

'Trees should be of the highest quality,' is an often used phrase when a prospective client first approaches the tree nursery. Usually they have a vision in their mind of what 'quality' is required but it is ill defined and rarely adequately described in a comprehensive specification which leaves the tree nursery in no doubt as to what is required.

The word quality means different things to different people and can be ambiguous to the point of being meaningless unless qualified in words, diagrams or photographs.

Nursery production systems, the reasons for nursery interventions in tree growth cycles, and the implications of these interventions are poorly understood. This lack of knowledge often results in poorly written and at best partial specification documents.

The purpose of this manual is firstly to rewrite the original, first published in May 2015 updating information where necessary, and secondly to reinforce the messages contained in the first publication.

It is intended that nursery production processes will be explained, with good and bad practice highlighted, where possible, and the advantages and disadvantages of the three principal tree nursery production methods used in the UK. It will provide clear and concise statements as to what can be included in specification documents and provide examples. The manual is supported by a series of photographs and diagrams used to illustrate key points.

It draws heavily on BS 8545:2014 Trees: from nursery to independence in the landscape, the National Plant Specification guide, and the European Technical and Quality Standards for Nursery Stock (2010). It also uses the National Plant Specification guide coupled with over 30 years of working in the nursery industry and visiting many tree nurseries across the world.

It is not intended to be a comprehensive guide to the nursery industry, it only focuses on the three main production methods used and specified most often in the UK. Space does not permit a useful discussion of peripheral or specific production methods or the details of production methods used to produce specialised tree forms such as espalier, cordon and multi-stem specimens.

It is important to recognise that the most detailed and comprehensive tree specification for young tree procurement will not compensate for inappropriate tree species choice.

I hope you, the reader will find this manual useful.

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2.0

Young Trees

In this section you will find the advantages and disadvantages of the three principal production systems used by tree nurseries in the UK.

It is limited to standard trees and above and does not pretend to represent all tree nursery production methods.

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2.0 Nursery Production Methods

There are three principal nursery production systems used in the UK:

- Bare root
- Rootballed
- Containerised

It has to be noted that each of the production systems is defined by a description of the root system.

Bare Root

Trees are lifted from the nursery field and dispatched bare root and usually protected either individually, or in batches by wrapping in specialised bags. Bare root trees are often protected by soil, hessian and wire cages. These can be confused with rootballed trees.

Rootballed

Trees are lifted from the nursery field having been undercut or lifted a number of times during the production process producing a fibrous root system which is contained in the rootball. (See photograph page seven).

Photograph illustrating constructed fibrous root system in a correctly prepared rootball which has been undercut repeatedly during the production process.

Photograph showing roots of a Ginkgo biloba sold as a rootballed tree. (Note the difference)

Containerised Trees

Containerised trees are lifted from the nursery field and potted into containers for growing on. They only spend a short period, one or two seasons, in the container before dispatch. As will be seen later (page 25) the length of time spent in the container is critical for optimal root development.

Photograph showing the Barcham White Bag production system.

Other systems include Air Pots, rigid containers and other coloured bags.

All three of these systems effectively influence root development rather than crown development. When best practice is followed, they are all effective and work well. Each system has its advantages and disadvantages which need to be fully understood if effective specifications are to be written.

The advantages and disadvantages of each are reproduced below:

Production System	
BARE ROOT (Open ground)	
Advantages	**Disadvantages**
• The cost of production is lower when compared with other methods, and this is reflected in the supply cost. • Bare root trees are lighter than rootballed and containerised equivalents, and are therefore easier and more economical to handle, transport and plant. • They are less likely to contain soil-borne disease than trees supplied with soil. • This is the best production system for identifying and correcting root deformities prior to planting in the landscape.	• The appropriate time for lifting from the nursery field and transplanting into the landscape is limited to the dormant season. • Not all species are tolerant of the technique. • A significant proportion of fine roots might be damaged at lifting and during transport. • As a general rule, the larger the bare root tree within a given species, the higher the mortality rate, with survivors slow to recover. • Field soil conditions can limit times of lifting and planting, with frozen, very wet and very dry soils being unsatisfactory. • Handling and care of bare root trees between lifting and planting is critical to achieving good survival rates. Roots need to be kept moist at all times, and where there is a delay between lifting and planting, the roots need to be heeled in. • Bare root trees are lifted directly from the field. Each field is part of a crop cycle with lifting occurring over a two/three year period. Often the best trees are lifted first. • Evergreen trees are rarely moved as bare root specimens.

Production System	
ROOTBALL (Ball and burlap)	
Advantages	**Disadvantages**
• The lifting and transplanting season is extended when compared to bare root trees. • Trees that have poor survival percentages when handled bare root can be transplanted successfully. • Trees may be lifted from the nursery field ahead of time and stored above ground if handled correctly. This extends the period for planting beyond the dormant season. • Care between lifting and planting is less critical than for bare root trees as the roots are ideally kept moist and frost-free within the rootball.	• If the nursery practice is poor then as much as 95% of the root system can be lost on lifting. • Actual lifting from the nursery field is limited to the dormant season for all but a very small number of tolerant species. • Handling of large rootballs is labour intensive with rootballs being heavy and awkward to transport. • If the rootball is broken or allowed to shift during handling and despatch, the chances of tree survival are reduced. • Field soil conditions can limit times of lifting, with frozen, very wet and very dry soils being unsatisfactory. • Rootballs are generally more expensive than bare root trees. • Successful transplanting and longevity in the landscape can be adversely affected if the primary root or root flare is too deep within the rootball as a result of poor nursery production. • This is the worst tree production system for identifying and correcting root deformities prior to planting.

Production System

CONTAINERISED TREES

Advantages	Disadvantages
• The root system is entire and undamaged when it arrives at the planting site. • Containerised trees can be planted at any time of the year, although soil conditions in the summer can be a limiting factor. • The trees are generally easier to handle than rootballed trees. • The trees are generally easier to store than trees from other production systems. • Post-transplanting stress and shock is reduced to a minimum, consequently achieving earlier benefits from planting. • Containerised trees generally weigh less than rootballed trees, as the growing media used is usually organic rather than soil based. • Trees are not lifted directly from the nursery field for despatch and are unlikely to have suffered root damage. • Irrigation and nutrition can be regularly monitored and easily adjusted throughout the production process on the nursery and any subsequent storage period prior to planting. • Trees are grown in a controlled environment throughout the production process.	• Additional irrigation might be needed during the post-transplanting maintenance period. • The organic soil-less compost used in containerised mixes can shrink if allowed to dry out. • There is the potential for root circling and subsequent root girdling. This is true of all container production systems irrespective of container type. If a tree is left in a container for too long, its roots fill the pot and become distorted. • If lifted for despatch too early there is a risk that root formation in the container will not be complete and compost will fall away leaving an exposed root system at the time of planting. • Some containerisation systems involve the root system being moved from production to despatch packaging. This movement can result in drying out and or root damage. • Containerised trees are generally more expensive than bare root or rootballed trees. • Movement from smaller to larger containers can result in root deformation and delayed failure in the landscape. • Containerisation can result in the root flare being buried too deep in the container.

3.0

Root System Development & Management on the Nursery

The three production systems predominantly used on tree nurseries in the UK all affect the root development of young trees in some way.

A series of root modifications occur during production irrespective of the system being used.

Each of these modifications has the potential to impact either positively or negatively on root development, and therefore eventual transplanting success into the landscape.

This section of the manual highlights good and not so good nursery practice for each of the three production systems.

3.0 Root System Development and Management

Nursery production systems for standard trees primarily affect root system development. A series of interventions are made during production to ensure both uniformity and specifiable quality. These interventions interrupt the natural development of the tree root system with consequences. An understanding of these interventions and the nursery production process underpinning them is critical if successful and meaningful specifications are to be written and best practice ensured.

Irrespective of the production system most trees are at some stage seed or cutting. There are other means of propagation, but it is beyond the scope of this manual to discuss them in full.

Seedlings are produced either in a seed bed or in plugs. The seedlings are then graded and lifted from the nursery bed or planted on from the plugs. This can be into the field or containers.

When lifted from the seedbed the naturally occurring tap root is severed. At the point where the lifting cut is made an adventitious lateral root system is formed, which is deeper than the lateral root system, which would have formed had the tree remained undisturbed.

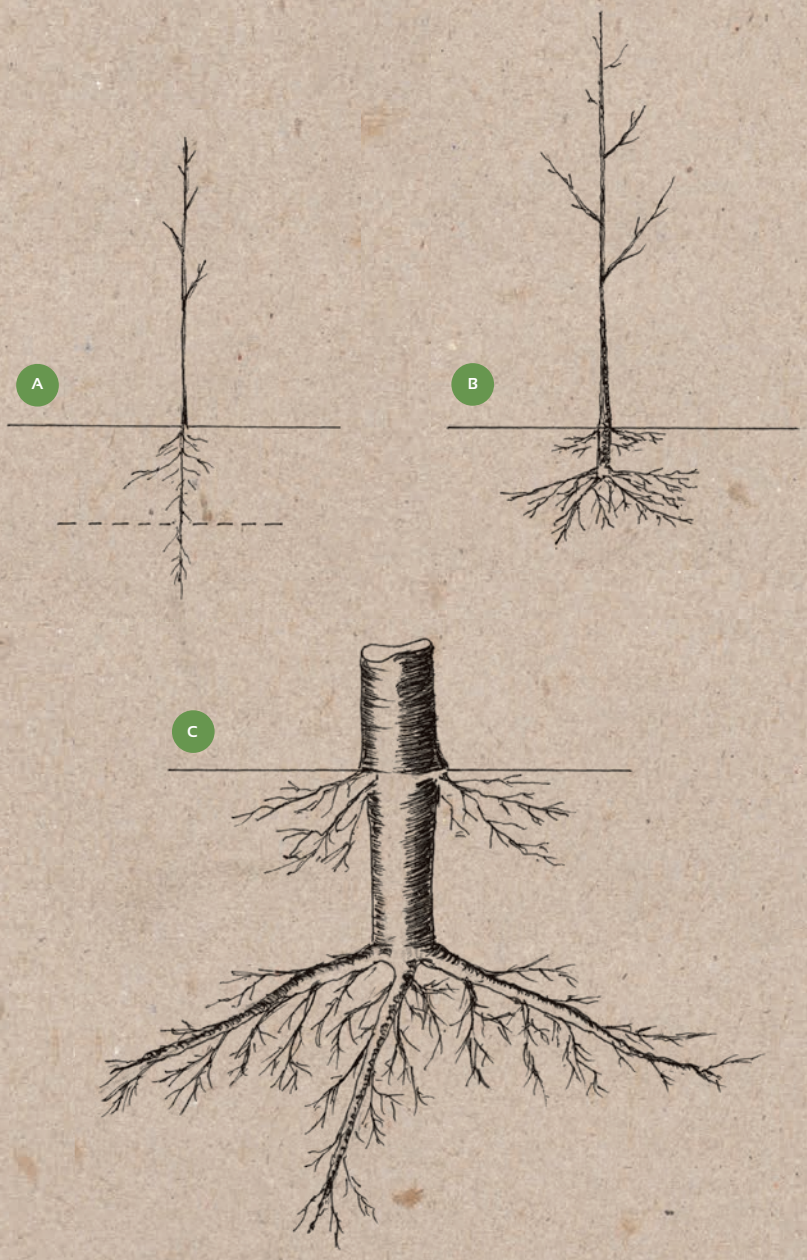
A nursery seed bed.

Plug production.

This adventitious root system is often more vigorous than that developing just below the root flare. The root area between the adventitious and naturally occurring lateral root stem is often referred to as the 'root shank.' Research has shown the adventitious root flare may be as much as 300mm below the soil surface.

With the adventitious root flare so deep there is an obvious impact on planting depth. Research has also shown that planting too deep by as little as 80mm can inhibit tree growth.

Root shank development



A	Nursery seedling in the seed bed
B	Seedling undercut and replanted. Proliferation of the new root development at the cut point
C	Root shank development between natural laterals root system and adventitious root system formed at the cut joint. This tends to be more vigorous

Seedlings produced in plugs can also suffer root distortion when seedlings are left in the plug too long or the shape of the plug has distorted and fixed root direction.

The seedlings produced can either be grown on to mature specimens or used as understock for the budding of clonal selections.

Either way the root defects are carried forward into maturity.

A similar process occurs when trees are produced from cuttings with prolific root development occurring at the base of the cutting where callous has formed.

Root initials developing at the base of a cutting.

Potentially deep root systems formed on a cutting.

The depth of the primary lateral root system is important when coupled with deep planting as there is potential for tree failure into the future.

Quercus palustris growing in a urban environment, Stockholm.

3.1 Root System Development and Management

Bare Root Trees

Writing a definitive description and generic specification for bare root trees is difficult as the root systems of young trees vary enormously, with each species having its own individual characteristics which may be modified according to the environment they have been growing in.



Examples of differing bare root systems.

Providing generalised guidance is difficult but it is reasonable to suggest that all bare root systems have a good lateral spread with at least four well developed lateral roots present and evenly spaced around the main trunk.

The root system should be free from major damage from lifting from the nursery field and/or significant pruning wounds.

The method used by nurseries to line young trees out in the nursery field can produce a wholly one directional root system which has been described as a 'hockey stick' root formation. Once this type of root system has developed its one dimensional characteristics will be retained and can impact on future stability when the tree is planted in the landscape


Examples of one directional root systems.

Bare root trees provide an opportunity to examine root structure, and while it is difficult to provide definitive guidelines, the depth of the adventitious root flare as described above needs to be assessed and its likely impact on eventual planting success considered. Overly vigorous adventitious root development at the lower end of the root shank can contribute to eventual failure in the landscape especially if coupled with deep planting.

It is possible to indicate the expected diameter of the root spread of bare root trees as illustrated in the following table.

Root Spread for Bare Root Tree Stock

Young tree height in metres	Diameter of root spread in millimetres
2.5 to 3.0	450
3.0 to 3.5	550
3.5 upwards	700

While some damage is inevitable when lifting bare root trees from the nursery field it is important that the root system retains a significant percentage of fibrous root, to facilitate early development post planting in the landscape.

When selecting bare root trees, the vigour as well as the structure of the root system needs to be considered. A simple iodine test can be performed to confirm the presence of stored carbohydrate. The darker the stain the higher the carbohydrate content. Stored carbohydrate is essential to stimulate new root growth following transplanting into the landscape.

It also has to be remembered that once lifted from the nursery field the root system is exposed and needs to be protected on the nursery, during delivery and on site prior to planting to avoid desiccation.

Idealised root system

A	Idealised bare root system
B/C	One directional root system caused by nursery production

3.2 Root System Development and Management

Rootballed Trees

The rootballing of trees is a process and should not be confused with the wrapping of bare root trees in soil, wire mesh and hessian. There is nothing wrong with either but it is necessary to differentiate between the two as they are often confused.

To produce a rootball there is a clearly defined and specifiable process which involves the regular undercutting or transplanting of field grown trees at stages in their development. At each intervention the roots are cut stimulating new prolific root growth at the cut points. Repeated undercutting or transplanting ensures that the root ball, when lifted for despatch, is full of fibrous root which will hold the ball together.

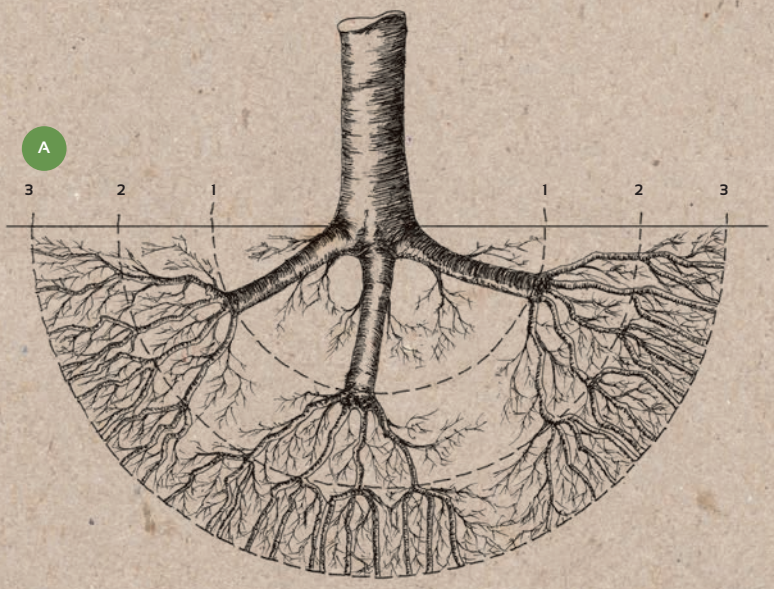
On lifting from the nursery field for despatch the entire rootball is wrapped in hessian and held in place by a non-galvanised wire mesh. If prepared correctly the rootball should hold together even when the hessian and wire mesh is removed.

Illustrations of well formed rootballs.

Where trees have been lifted as bare root trees and the roots wrapped in soil, hessian and wire mesh the soil ball will not hold together when the hessian and wire mesh is removed. This method of tree root protection can be differentiated from prepared root balls as the trunk of the tree will move independently of the soil ball.

The wrapping of bare root trees in soil, hessian and wire mesh is perfectly legitimate but should not be substituted for correctly prepared root balls.

Undercutting process



At each undercutting root will be lost but this is more than compensated for by the vigorous root initiated.

A	**Diagram of undercutting process and the impact of the process on root development**
	1: First cut
	2: Second cut
	3: Third cut
B/C	**Impact of not undercutting. Note the amount of fibrous root left in the ground**

The following table indicates the size of rootball and the number of times it should have been undercut/transplanted on the nursery.

Rootball Table

Girth of tree measured at one metre in centimetres	Minimum diameter of rootball in millimetres	Minimum number of times transplanted/undercut on the nursery
8-10	300	-
10-12	300	-
12-14	400	3
14-16	450	3
16-18	500	3
18-20	550	3
20-25	600	4
25-30	700	4
30-35	800	4
35-40	900	5
40-45	1000	5
45-50	1200	5
50-60	1300	6

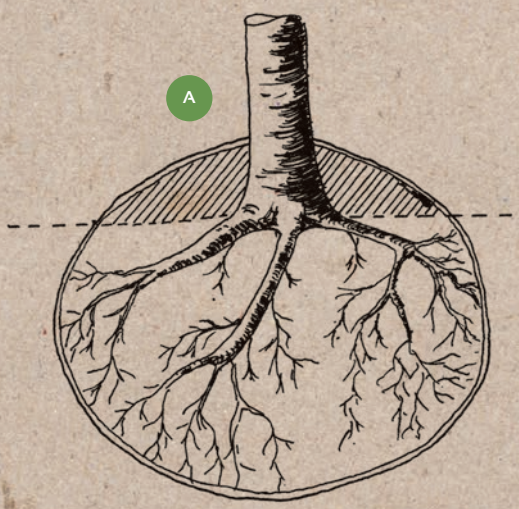
The lifting of trees from the nursery field to produce rootballs, where this best practice has not been followed, can result in as much as 95% of the trees root system being left in the ground.
A rootball which has a smaller diameter in relation to tree girth than recommended in the table above is unlikely to have been prepared according to best practice and will have had a significant percentage of its root system left in the nursery field.

A badly prepared root system from inside a rootball. Note the lack of development associated with the undercutting process.

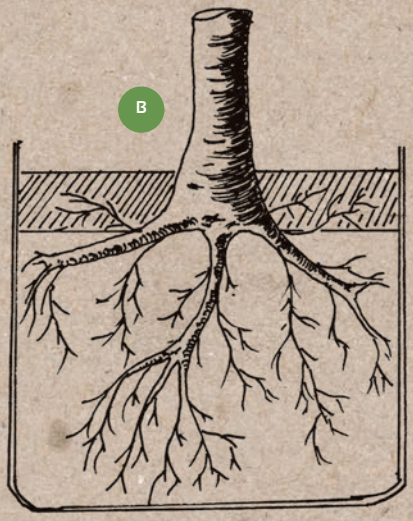
Poor practice in the preparation of a rootball is likely to result in poor performance in the landscape or failure.

During the production of both rootballs and containerised trees which will be covered on page 26 soil or compost can be mounded burying the root flare. If not removed at planting this mounding can exacerbate the potential for deep planting which can result in transplanting failure.

Mounding of soil/compost above root flare as a result of nursery production



Unless removed both result in root flare being too deep at planting into the landscape.



A Soil mounded during production process results in root flare buried and lifted inside rootball.

B Deep planting in the container results in root flare being buried and fibrous root growth in compost above root flare.

3.3 Root System Development and Management

Containerised Trees

Containerised trees are produced when young trees from the nursery field are containerised. The period between containerisation and despatch is used to build the root system following the inevitable, though minimal, damage caused to roots when lifted from the field.

Containerisation allows for the root system to be rebuilt on the nursery prior to despatch for planting in the landscape.

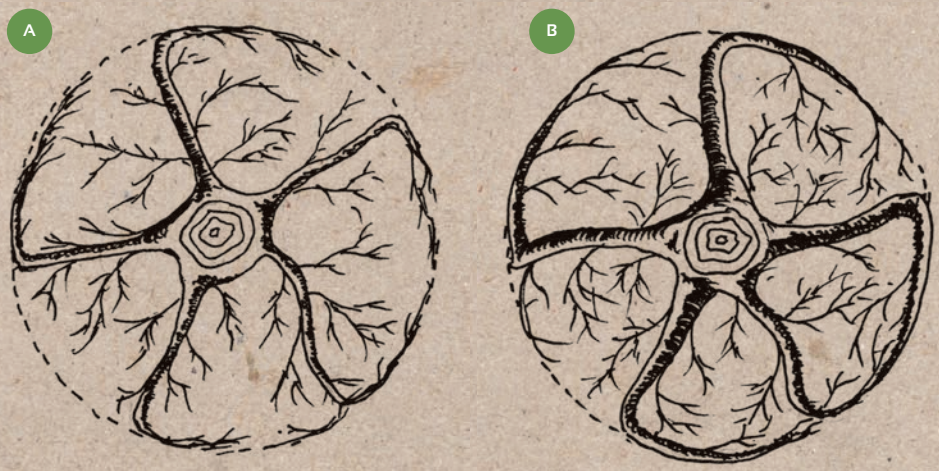
The critical consideration when specifying containerised trees is the length of time the tree has spent in that container. Any tree in any container if left in that container for too long will suffer damage in the form of root girdling. This is when the developing root system in the container meets the side wall and is diverted to follow the circular form of that container. Once directed roots begin to thicken the distortions are maintained and continue once the tree has been planted into the landscape. This can lead to failure many years after planting.

A Example of irreparable root circling developed in a seedling liner.
B Root circling on a more mature specimen

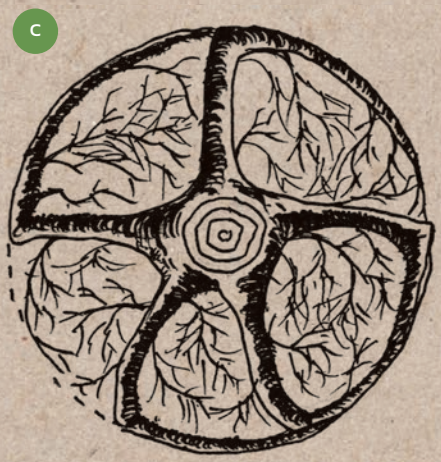
There are many claims made about containers that prevent root girdling. The reality is that any tree left in any container for too long will suffer root distortion and girdling.

The only satisfactory method of ensuring that root girdling has not occurred is to enquire of the supplying nursery as to how long that tree has been in the container. This is often referred to as **'shelf life'.**

Development of root circling/girdling



Cross sectional view showing development of root circling leading to root girdling.



A,B,C Illustrates stages in the development of circling/girdled roots in a container

Stages in the development of circling/girdling roots with an extreme case illustrated in picture B.

Developing girdling roots in a container ball emphasising the importance of shelf life.

A Close up of peripheral roots on a well developed containerised root system.
B Example of well formed root system from containerised production.

Containerised root system with compost washed away. Note lateral direction of roots.

Containerised should not be confused with container grown trees. Containerised trees are trees lifted from the nursery field and grown on in containers for a limited period of time.

Container grown trees have been grown in containers for the whole of the production period. The trees are moved from smaller to larger containers as the trees develop. Without appropriate remedial action as trees are moved between containers, distorted or girdling roots can be hidden as the tree's root system continues to develop.

The appropriate remedial action between movement from a smaller to larger container is for the root system to have been shaved (pruned) with all girdling and distorted roots removed.

A really good container root system with the compost washed away. Note the well developed lateral root system.

4.0

Branch, Stem and Crown Development

There are alternative methods of developing young tree root systems.

These have been discussed earlier in this manual.

Irrespective of which production method has been used the production systems used to develop the branches, stem and crown are the same and consistent.

Outlined in this section are examples and explanations of good and not so good practice.

Trained forms are not discussed.

4.1 Branch, Stem and Crown Development

The development of young tree begins primarily, either through vegetative propagation or from seed. Trees produced from either cuttings or seed may be grown on their own roots, budded, or grafted onto the root system of trees of the same species, known as stock wood.
The material that is grafted or budded onto the receiving root system is known as scion wood. The technique is shown diagrammatically on page 33 opposite.

The compatibility of scion wood and stock wood, coupled with the quality of contact between the cambium and other meristematic tissue of both at the point of union, is essential in the successful formation of a permanent bud or graft union.

Poor or incompatible bud or graft unions can lead to failure in the landscape, sometimes years after planting has occurred. Such poor or incompatible bud/graft unions can be identified on the nursery where there is a visible differential in growth rates between stock and scion wood, or there is a significant amount of epicormic growth emerging from the stock wood at the base of the young tree.

Budding or grafting is normally found at the base of the tree just above the root flare where a small s-bend can be seen but budding or grafting may occur at the top of the stem (topworked) or two or more buddings or grafts may appear on the same tree.

Budding and grafting facilitates the production of cultivars.

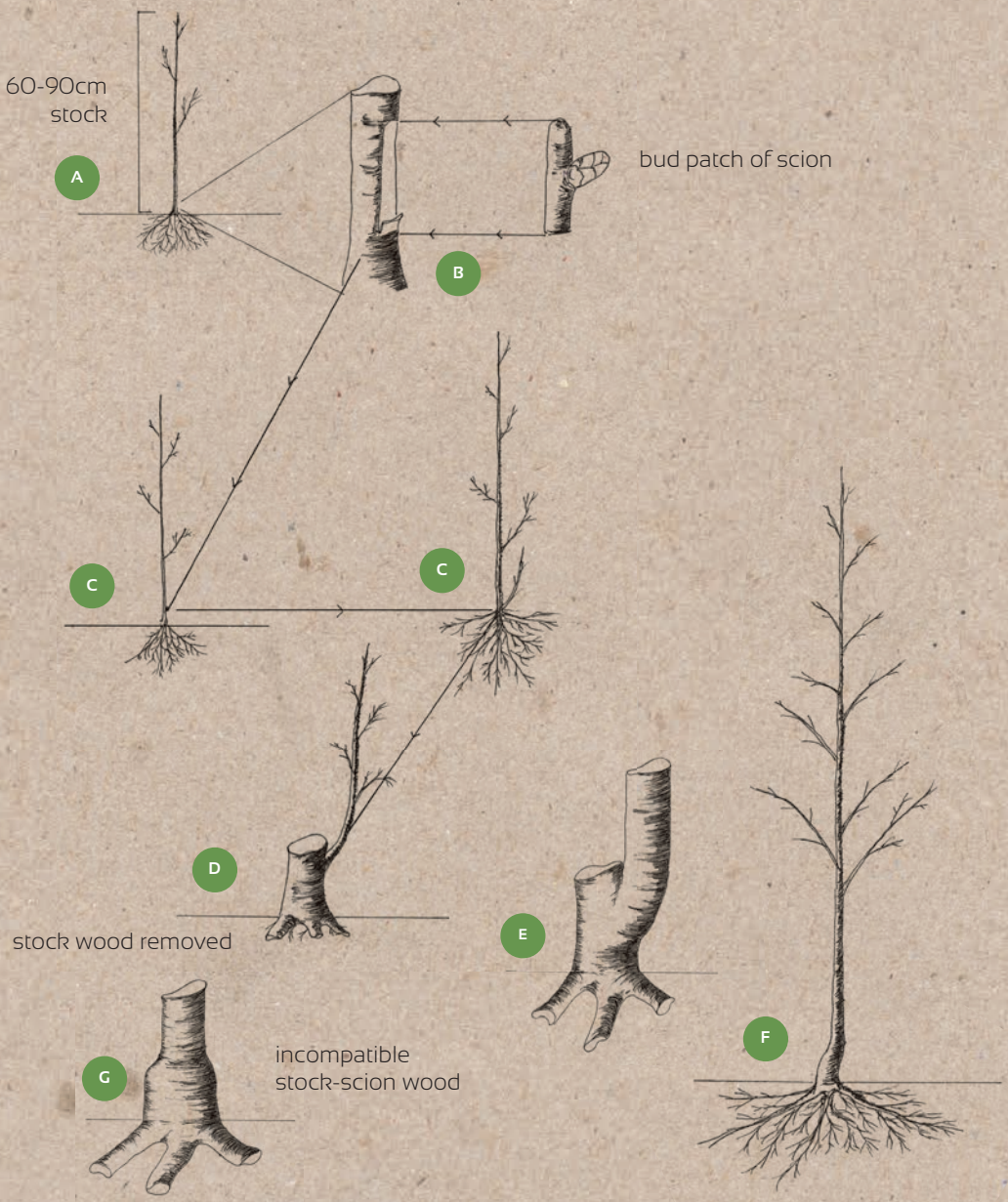
Successful bud union, note uniformity of growth and s-bend at the point of union which will become less apparent as the tree grows.

Examples of budding at the base of the tree include:

- Acer campestre Louisa Red Shine budded onto Acer campestre
- Pyrus calleryana Chanticleer budded onto Pyrus communis
- Sorbus aucuparia Sheerwater Seedling budded onto Sorbus aucuparia

Examples of 'topworked' trees include:

- Chitalpa tashkentensis Summer Bells with Chilopsis being grafted onto a main stem of Catalpa bignonioides
- Fraxinus ornus Meczek



A	Understock planted out in nursery field
B	Bud of scion wood inserted in stock wood
C	Bud begins to develop
D	Understock removed leaving scion bud to develop as a main stem
E	Diagram of cut. At no time should the bud union be below soil level
F	Young developing budded tree
G	Swelling at the bud union which may indicate incompatibility. As the young tree develops growth masks the cut area which remains visible as a slight bend at the base of the main stem
H	Disproportionate growth in the area of the bud union is an indicator of incompatibility between stock and scion wood

Examples of poor bud unions which may result in eventual failure in the landscape.

While all tree species have clearly identifiable, individual growth characteristics all broadleaved deciduous and evergreen trees can be placed in one of two categories.

- Excurrent Trees: These trees have a naturally occurring straight leader which remains prominent throughout the life of the tree. Example Liquidambar styraciflua.
- Decurrent Trees: Trees which lose leader definition as the tree develops. Example Crataegus monogyna.

This is illustrated in the diagrams on page 35.

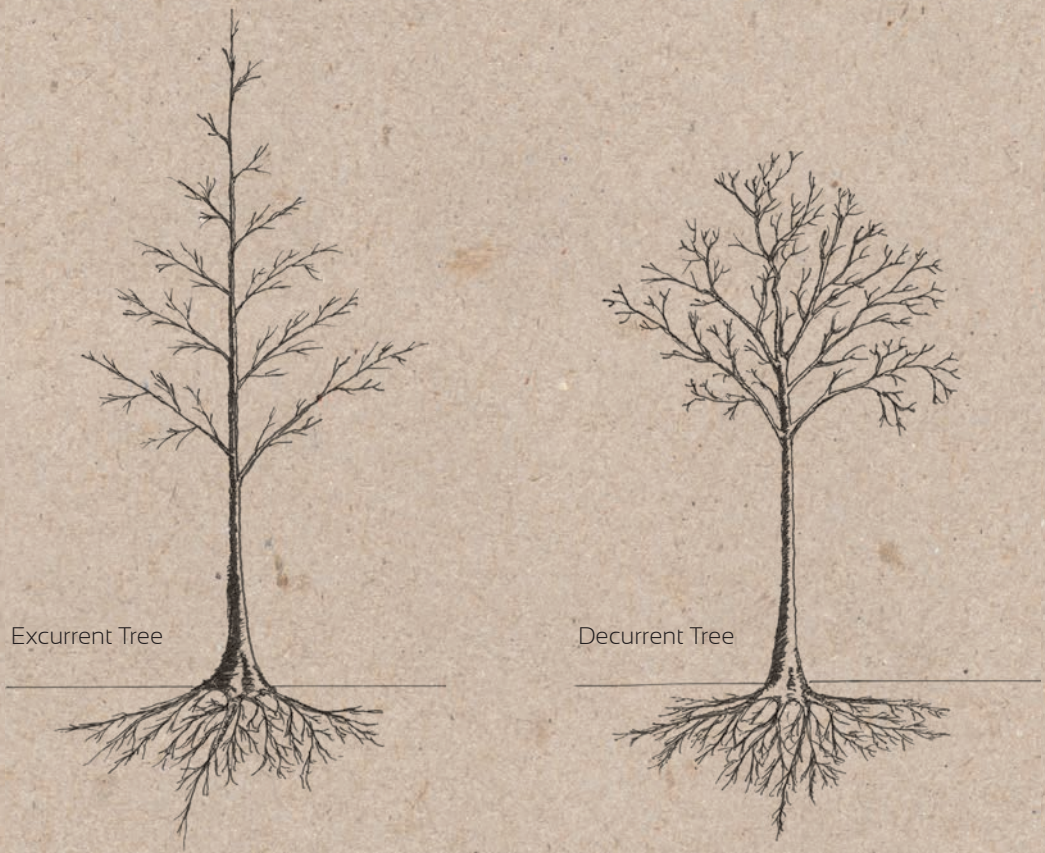
Young tree newly planted from the nursery. Note vigorous lateral branches which could be subordinated and loss of dominant central leader.

All best practice nursery production will aim to produce a strong central leader irrespective of whether the natural habit is excurrent or decurrent. Decurrent trees should be pruned to retain a strong well defined central leader until they have reached two thirds of their mature height.

The leader can be said to be dominant where none of the lateral branches are more than 50% of the diameter of the stem at the point of union and where vigorous lateral branches have been suppressed through formative pruning.

A strong dominant central leader is essential as this will be the main support for the permanent branching system of the tree. As the final clear stem is achieved much of the lower branching system on the nursery tree will be obsolete.

The above does not apply to or include trained trees.

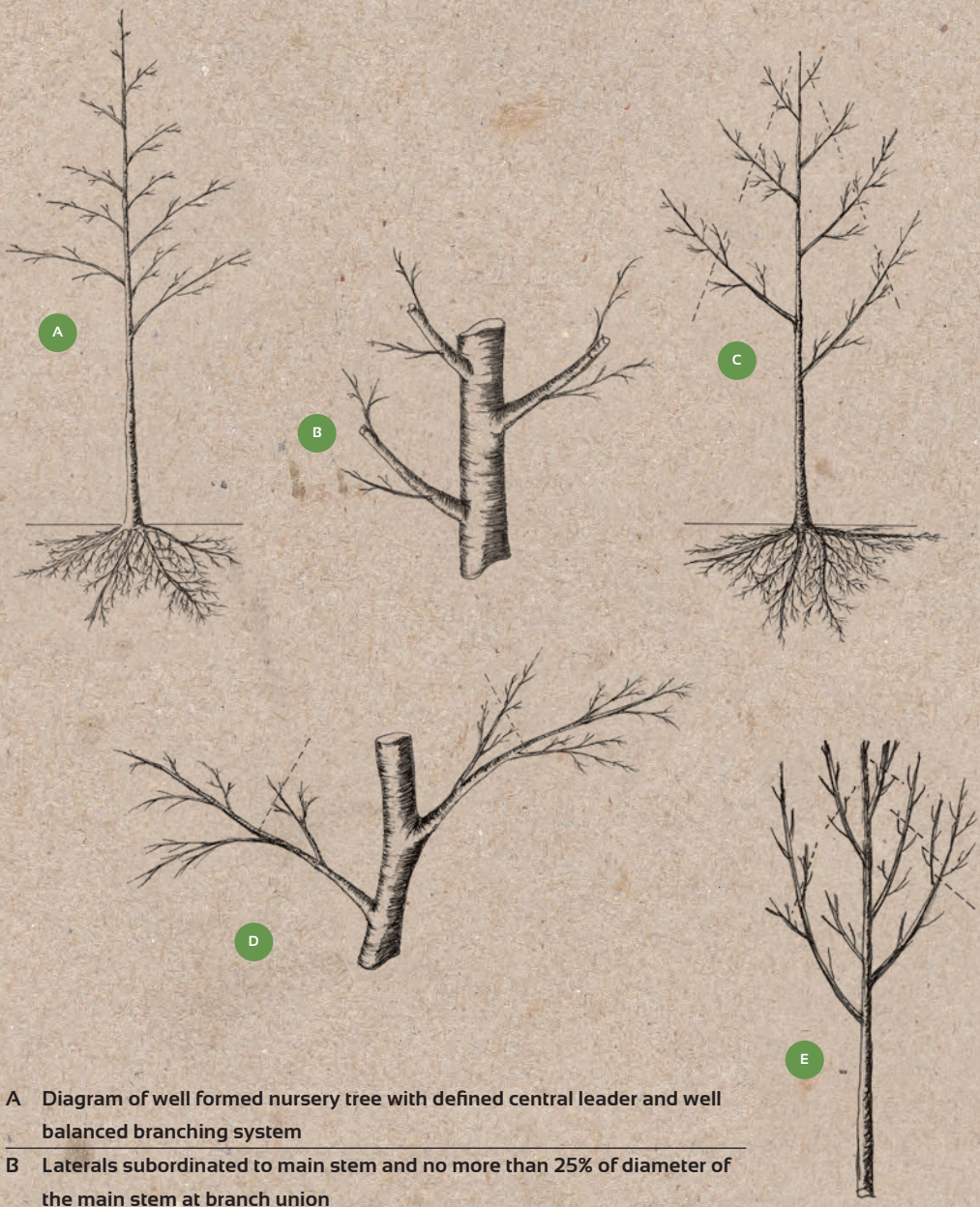


The difference in growth habits of excurrent and decurrent trees

Failure to achieve the above can result in a weak central stem which is ill defined and ill equipped to support the construction of a well balanced permanent branching system as the tree develops both on the nursery and in the landscape.

To achieve the above, some nursery formative pruning will have taken place with lower branches either subordinated or removed. The resultant pruning wounds will be visible on the main stem. These wounds will heal naturally providing the branches removed do not exceed the branch/main stem ratio referred to above, and that the branch collar has been retained during the pruning process. Wound healing will be clearly visible with signs of occlusion taking place even though the wound may not be completely healed.

Poor or large pruning wounds may not occlude successfully leaving ingress points for disease, structural weak points or distorted, misshapen main stems which may not recover as the young tree develops.



A	Diagram of well formed nursery tree with defined central leader and well balanced branching system
B	Laterals subordinated to main stem and no more than 25% of diameter of the main stem at branch union
C	Nursery formative pruning with all laterals subordinated to the main leader
D	Diagram of nursery formative pruning cuts
E	Potentially co-dominant laterals subordinated to the central leader in crown development

During the formative pruning process it may have been necessary to prune out the natural leader and train a new dominant leader with all laterals subordinated to that new leader.

A poorly healed nursery pruning wound.

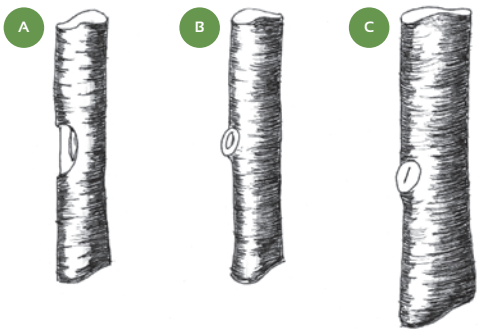
A well healed nursery pruning wound.

Formative pruning on the nursery is designed to produce a strong balanced leading stem capable of supporting the future permanent branching system of the tree.

This permanent structure will not begin to develop until a clear stem of between 2.5 and 3.0 metres is achieved. All branches below this point are temporary and will be removed at some time during the trees development. This does not apply to multi-stemmed trees.

It is important that during the nursery process poorly attached branches, branches with included bark and inward growing branches are either removed or subordinated. Failure to address such problems can lead to ill formed crown development, compromised leader formation and structural weakness.

A	**Large pruning wound with branch collar removed. Pruning cut indicates branch over 50% diameter of main stem has been removed. Unlikely to heal satisfactorily**
B	**Acceptable branch removal with branch collar intact and cut less the 25% diameter of main stem**
C	**Fully occluded wound**



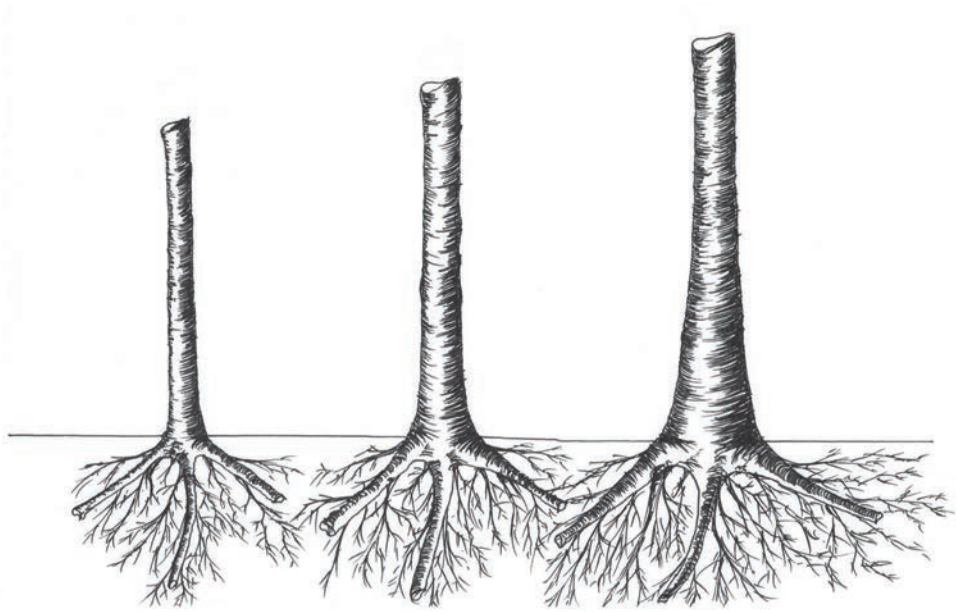
Young trees develop new wood at points of mechanical stress. A certain degree of mechanical stress is beneficial in the production of structurally sound young trees. The spacing of trees on the nursery, coupled with the type of support and length of time that the support has been left in place, impacts on the trees mechanical integrity when transplanted into the landscape.

Trees which have been grown too close on the nursery tend to produce elongated central stems. This leads to a proportional visual disparity between the height and the stem girth of the tree and a mechanical disparity where the central stem has not developed sufficiently to support the height of the crown. Such trees when planted into the landscape have a tendency to lean and incur additional stress when trying to correct the mechanical imbalance. This relationship between height and stem girth can be defined as the height stem growth ratio but can only be defined visually.

Close spacing on the nursery which impacts badly on both stem and crown development.

Wider spacing on the nursery which allows for full stem and crown development.

Support systems restrict the trees ability to bend naturally which influences the deposition of wood on the main stem. Such restricted movement inhibits the development of stem taper. Each tree species develops at a different rate and some species have a more developed stem taper earlier in the growth process. However, all trees, during development and uninhibited by external support exhibit a taper from stem tip to stem base with the greatest circumference apparent just above the root flare at the base of the tree. Trees which have not developed a stem taper or where no stem taper development is apparent, can leave the tree mechanically ill equipped to thrive when planted into the landscape.



Stages of stem taper development.

Nurseries often use canes and ties in the crown to train leaders, and encourage balanced crown formation. The impact of such support, if left in place for too long, is the same as with stem development, with mechanical integrity compromised. All such support should be unnecessary and removed, along with the tie holding that support in place, before planting into the landscape is considered. Ties left in the crown can result in permanent damage occurring often several seasons following transplanting.

Examples of crown developed through formative pruning on the nursery.


MYM 62R

5.0

Tree Health

Tree health has increasingly become a significant and crucial factor in the procurement of young trees from the nursery.

It is obviously important that young trees from the nursery are in optimum physiological health and fit for purpose at planting.

The increasing threats from imported pest and disease makes biosecurity critical.

This section looks at physiological health and biosecurity.

Barcham
The Tree Specialists

5.0 Tree Health

There are numerous methods of assessing tree health on the nursery when selecting young trees. These are largely visual and assess morphological characteristics and are only as effective as the level of expertise of the assessor.

These morphological characteristics are described in the diagram (opposite).

Each of these characteristics can be used to construct young tree specifications.

Foliage is a good indicator of the presence of a pest or disease. Abnormal colouration or leaf lesions can indicate nutrient deficiency, poor physiological health, biotic or abiotic stress and the presence of foliar damaging pests.

Any die back in the nursery formed crown can be an indicator of physiological dysfunction, inadequate or interrupted irrigation, poor pruning or reflect the impact of pest and or disease.

Sparse, erratic, uneven and stunted foliage are indicators of physiological dysfunction and stress.

Extension growth is a good indicator of tree health. This should be evenly distributed across the whole crown with growth patterns commensurate with previous growing seasons and typical for the species or cultivar under consideration. Nursery formative pruning may make the comparison of seasonal growth difficult.

Young trees, other than multi-stemmed and feathered specimens, are produced on a clear stem. Abnormal erratic adventitious shoot formation on this main stem can be an indicator of vascular dysfunction.

Untypical or abnormal flattening on the main stem can be an indicator of root pathogens.

A	Ill defined leader and/or shoot tip dieback
B	Weak laterals with dieback or poor growth
C	Strong growing laterals which may compete with, or obscure the leader
D	Stunted or one-sided growth
E	Upright branches which run up through the crown
F	Untypical or abnormal growth
G	Large pruning wounds which show no signs of healthy occlusion
H	Large amounts of epicormic growth on the main stem
I	Epicormic growth emerging from the understock
J	Disproportionate growth of stock or scion wood in relation to each other
K	Abnormal flattening of the main stem which may indicate a degree of vascular dysfunction
L	Poor annual growth in relation to previous years (this may not be apparent where nursery formative pruning has taken place)
M	Shoot tip dieback
N	Abnormal foliar distortions or areas of foliage missing
O	Areas of abnormal discolouration on the foliage
P	Weak, irregular or untypically small foliage

5.1 Tree Health Physiological Health Testing

In addition to the visual methodology outlined on pages 42 and 43 additional assurance can be gained as to the physiological health of nursery trees.

At the time of writing and to the authors knowledge, Barcham Trees are the only tree nursery to carry out physiological health testing on trees at their nursery. The nursery has been following a set procedure using independent consultants for more than 15 years, publishing an annual report and using the data obtained to inform nursery production, as well as offering assurance to clients that trees are in optimum physiological condition.

Trees are tested annually with a minimum of 10 leaf samples taken from each tree.

The two tests carried out involve the use of leaf fluorescence and leaf chlorophyll content, both of which have been verified as being significant indicators of tree vitality and tree health.

It is beyond the scope of this manual to discuss at length the detail of either of these methods.

5.2 Tree Health Biosecurity

It remains a reality that many of the imported pests and diseases which threaten the resilience and longevity of tree populations are traceable to UK nurseries who have imported trees for immediate planting into the UK landscape.

A significant percentage of young trees planted into the UK landscape, both rural and urban, have spent no more time on a UK nursery than it takes to transfer trees from one lorry to another. Each nursery should have an existing biosecurity policy available for inspection and ideally another form of environmental accreditation.

Due to the importance of biosecurity, it is considered essential within the framework and context of this manual that a minimum requirement of any specification drawn up for tree supply should insist that the supplying nursery has 'Plant Healthy Certification'.

It is beyond the scope of this manual to describe in full the plant healthy scheme but further details can be found at planthealthy.org.uk.

Plant Healthy

Certificate of Conformity

Awarded to: Barcham Trees plc

Address: Eye Hill Drove, Ely, Cambridgeshire, CB7 5XF

Standard: Plant Health Management Standard version 1.2 - issued 1st July 2022

Scope: Plant Nursery

Registration Number:	**PHCS-0003-UK**
Date of Evaluation:	**6th December 2023**
Certification Date:	**13th November 2023**
Certification Expiry Date:	**12th November 2024**
Certificate Issue Number:	**0003-04**

Technical Manager
Grown in Britain

Grown in Britain

This certificate is the property of Grown in Britain and must be returned immediately on request.
To check validity contact: Grown in Britain, 19 Common Road, Hanham, Bristol, BS15 3LL
Tel: +44 (0) 7584 169094 Email: enquiries@growninbritain.org.

The Specification

There is no definitive specification for the supply of trees from a tree nursery. Outlined below are items which might be included. Those which are considered essential are in **bold, green** type. The other points are advisory, but it is recommended that as many of these as appropriate are included in the specification.

It should be remembered that the writing of a specification is only one part of the procurement process. To ensure that trees supplied from the nursery are of the quality and specification required it is recommended that:

- A good working relationship is developed with one or more tree nurseries along with a familiarisation of their production processes.
- That nurseries are visited on a regular basis.
- That trees to be procured are marked at the nursery on a nursery visit.
- That trees be grown in advance under contract wherever possible.

What Should be Included?

General Inclusions

- **A comprehensive list of the trees required including genus, species and cultivar.**
- **The number of trees of each species and cultivar required.**
- **The girth size of the trees required.**
- **The height of trees required.**
- **The type of production system required (Bare Root, Rootballed, Containerised)**
- **The anticipated delivery date.**
- **The delivery address.**
- **Details of the recipient of the trees if different from the person ordering the trees.**
- **The invoice address if different from the address of the person ordering the trees.**
- **Any restrictions at the delivery address.**

Specific Inclusions

Type of Production System

Bare Root:

- All root systems should be typical for the species and should display a well-balanced radial root system comprising of at least four obvious and substantial lateral roots.
- Root systems should not be predominantly one directional. (See page 18)
- **The size of the bare root system. (See page 19)**
- All bare root systems should have a significant amount of fibrous root commensurate with the species.
- **The supplying nursery should be asked to supply details of when the trees were lifted from the nursery field, how the trees were stored prior to despatch, how the trees are to be protected during despatch. Details should be confirmed in writing.**

Rootballed Trees:

- **It should be clearly stated that rootballed trees are required, and not bare root trees protected by a soil ball.**
- **The number of times root balled trees (size/stem girth) should have been transplanted or undercut during the production process. (See table page 23)**
- The root flare should be clearly visible at the surface of the root ball.
- The final pruning cut produced when transplanting or undercut should be at least 5cm from the exterior of the root ball. (It is recognised that this will be difficult to evaluate as it is difficult to evaluate the root system of a tree when in a rootball.)
- **The soil ball should not move independently of the central stem/trunk of the tree.**
- The root ball should be wrapped in hessian which will biodegrade and the wire used to bind the ball should be non-galvanised.
- It is recommended that the supplying nursery is advised that a sample percentage of the rootballs supplied will be opened to inspect the root system, and that any rootballs discovered in the sample not prepared to the specified standard will result in the whole load being rejected and returned to the supplying nursery.

Containerised Trees:

- **The nursery should be asked to state clearly the date on which the tree was potted into a container and the length of time that tree has been in that container. (Shelf life)**
- **All containerised trees should be free of circling or girdling roots. The nursery should be advised that a sample number of containerised trees will be opened and inspected, and that should any girdling roots be found in the samples the whole batch will be returned to the nursery.**
- The developing root flare at the base of the stem/trunk should be clearly visible.
- Where trees have been transplanted from a smaller to larger container the supplying nursery should provide evidence that any root circling/girdling roots have been removed by shaving.

Branch, Stem and Crown:

- **Growth between stock and scion wood should be equitable with no disproportionate growth apparent between the two.**
- **The supplying nursery should be asked to state the understock used for any cultivar.**
- **At no time during the production process should the bud-union have been below soil level.**
- **No epicormic growth should be apparent emerging from the stock wood.**
- **All young trees should have a clearly defined and dominant lead shoot with lateral branches subordinated to that central leader.**
- **All lateral branches should be subordinated to the leading stem/trunk and not be more than 50% of the diameter of that lead stem/trunk at the point of branch/stem union.**
- **All formative pruning wounds should exhibit healthy and continuous bark occlusion with all pruning cuts made leaving the branch collar clearly visible and intact on the main stem/trunk.**

Continues on the next page...

Branch, Stem and Crown *(continued)*:

- **All branches which are poorly attached, are growing inwards or crossing and rubbing other branches should be removed or subordinated to the central stem/trunk.**
- **All trees should exhibit a clearly defined stem taper appropriate to the species and evident from crown tip to root flare.**
- **All trees should have a proportionate and balanced height/stem girth ratio appropriate to the species.**
- **At the point of dispatch all trees should be wholly self-supporting and free from extraneous canes or ties in the crown.**

Tree Health:

- All foliage should be free of significant leaf lesions or abnormal discolouration and display a density and size typical of the species. (This can only be verified during the spring, summer and autumn when foliage is visible and underpins the value of nursery visit to select trees.)
- **The crown structure should be free from any die-back.**
- **Extension growth should be compared with and comparable to the growth of the previous year if apparent.**
- **The main stem/trunk should be free of abnormal excessive adventitious bud development.**
- **The main stem/trunk should be free from any significant untypical flattening.**
- **There should be no epicormic growth emerging from the understock on cultivars which have been budded or grafted.**
- A statistically significant sample of all tree species on the nursery to have been independently tested for physiological health with the report available for inspection.

Biosecurity:

- **Trees will only be procured from a nursey with 'Plant Healthy Certification'**

Glossary

The terms described in the glossary refer how they are used in this manual.

Adventitious buds: Those buds which develop uncharacteristically on main trunk/stem.

Adventitious Root System: The roots produced at root severance.

Budding: The nursery method of producing cultivars by inserting the bud of the cultivar into the wood of a compatible understock.

Bud Union: The point at which the bud of the cultivar is joined to the understock.

Clear stem: The distance between the base of the tree and the first branches. The amount of clear stem will vary as the tree develops and increases in height with lower branches pruned off until required clear stem is achieved.

Chlorophyll Content: The volume of chlorophyll contained within foliage.

Decurrent Trees: Trees which lose leader definition as the tree develops. Example Crataegus monogyna.

Extension Growth: The annual incremental growth of stem/trunk and branches measured according to length.

Excurrent Trees: These trees have a naturally occurring straight leader which remains prominent throughout the life of the tree. Example Liquidambar styraciflua.

Formative Pruning: Nursey pruning to aid crown development

Grafting: The nursery method of joining two different tree types of the same genus.

Graft Union: The point where the graft has been made.

Height: The entire height of the tree from base to tip of the central stem/trunk.

Height Stem Girth Ratio: The relationship between stem/trunk height and stem/trunk thickness.

Leaf Fluorescence: The light energy not dissipated by photosynthesis or heat. A guide to tree vitality.

Morphological: The physical structure of the tree.

One Directional Root: Produced through nursery practice where lateral root development is inhibited.

Physiological: The internal and functional condition of the tree. How well are the natural systems working.

Production System: The method used by tree nurseries to produce young trees: bare root, rootball or container

Pruning wound: The point where pruning has occurred and a wound produced.

Rootball: The production of a root system through regular transplanting or pruning. Despatched in hessian and wire mesh.

Root Circling: The first directional change of the root system where roots circle following the container wall.

Root Girdling: Where roots which have circled thicken and develop woody tissue.

Root Shank: The length of root stem between the adventitious root system produced through root severance and the naturally occurring lateral roots.

Root Spread: The circumference/diameter of a bare root system.

Shaving: The removal of circling and or girdling roots by removing the outer edges of the container compost.

Shelf Life: The period beyond which root circling or root girdling is likely to have occurred in the container.

Stem Girth: The circumference of the stem/main trunk measured at 1 metre from the base of the tree.

Stem Taper: The thickening of the main stem/trunk towards the root flare of the tree.

Structural Pruning: Pruning in the development of the permanent canopy.

Subordination: The pruning of vigorous lateral branches subordinating them to the lead stem/trunk.

Support System: The use of canes and other items to retain a shape or form until the tree has developed enough to sustain itself.

Transplanting: The movement of young trees from one position on the nursery to another to facilitate development.

Tree Health: The morphological and physiological health of the tree.

Undercutting: The nursery practice of severing the root system of the tree while in the nursery field.

So much can be achieved.

The Trees and Design Action Group is pleased to be associated with this Specification Manual produced by Barcham Trees. It provides valuable technical guidance and supplements the recommendations made in the TDAG publication, Trees in Hard Landscapes: A Guide for Delivery, and BS8545 Trees: From Nursery to Independence in the Landscape, with regard to specifying young trees from the tree nursery.

It is essential that trees planted, particularly in the harsh urban environment, are fit for purpose and this can only be achieved if specifications are written with understanding and with sufficient rigour. This guide provides a blueprint which can be followed and will be of great benefit for all built environment professionals, whose work will gain from a better knowledge of how to provide the right specification for trees.

Trees & Design Action Group

Martin Kelly

Chair of the Trees & Design Action Group

Barcham
The Tree Specialists

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