Treenet Proceedings of the 4th National Street Tree Symposium: 4th and 5th September 2003
ISBN 0-9775084-3-9

ARBORICULTURAL INNOVATIONS IN URBAN TREE ESTABLISHMENT

Mr Kym Knight Arbortech Tree Services

Every day thousands of trees are planted in our towns and cities by people from a wide range of industries and professions including Construction workers, Horticulturists, Arborists, Green Keepers, Maintenance workers, Council workers, subcontractors, volunteers and many more.

Hundreds of tree species of every size and form available are installed into a vast array of different growing environments.

Planting sites can range from relatively undisturbed native soils with few impediments to growth, to soil-less man-made planting pits in windy urban canyons. More often than not trees are planted into compacted narrow roadside verges or medians with limited root space and multifaceted competition for above ground space.

In each case the basic requirements for unhindered tree growth are the same. Trees need sufficient water and nutrients, an open medium for anchorage and oxygen exchange and sunlight to provide the energy. They also require space above and below ground for expansion of the root system and crown. Where any of these elements are limiting, tree planting is unlikely to succeed.

A range of factors can impact positively or negatively on tree planting ventures including project planning, site conditions, site preparation, planting technique and maintenance procedures.

These factors combine with an almost infinite variety of tree species, tree and nursery production systems, stock size and quality to make tree planting in the urban environment a multidisciplinary task requiring considerable skill and knowledge to ensure a successful outcome.

The main driving force behind positive change in all of these areas is research. Studies by notable researchers including Watson, Gilman, Perry, Arnold & many others into all aspects influencing tree growth and function serves to focus our attention on every detail of the tree production and establishment process and assists in providing a constant scientific basis for improvement.

Much of the impetus for research is driven by past failures. Who has not seen a dead or dying newly planted advanced tree in an expensive landscape, or an older tree wobbling in the ground, its root system circling beyond any hope of adequate support or future growth. Tree planting failures or poor tree performance often provides cause for speculation. Was it a poor quality tree?, or the way it was planted? or too much or not enough water? In my experience the cause of tree planting failure is often all of these things and more.

The wide variety of tree production techniques used by nurseries produces many poor quality trees. In recent times planting trials, research and experience on the ground have enabled tree producers who are genuinely interested in improving quality to modify existing practices or develop new ones and raise the standard of trees available.

> While it may be preferable for root system development reasons to produce trees with some systems over others, particularly with advanced trees, the imperative to improve tree quality applies equally to all nurseries and all production systems, as it is unlikely that tree production methods with inherent design problems will ever cease entirely.[1] Adaptations of old production systems with new or modified techniques is an important process that brings together the results of research with client demands for higher quality trees.

Many tree production and planting innovations have positively influenced urban tree planting over a long period of time. Some of these are listed below:

- Balled & Burlapped trees.
- Container grown trees.
- Development of the plastic pot.
- The use of artificial soil media in tree production.
- Tree production in bags.
- Air root pruning containers in tree production.
- Geo-textile bags for in ground tree production.
- Tree improvement and breeding programs.
- Specifications to control tree quality.
- Improved site preparation and tree planting methods.
- Improved irrigation practices.
- The development and use of structural soils.
- The development and use off root vaults.
- Root control devices.
- Species provenance trials for improved characteristics.
- Airknife excavations in sensitive planting sites.
- Delivering adequate soil volumes to meet the intended landscape outcome.

[1] *Trees in pots and the problem of circling roots is a classic example. The answer to producing quality root systems lies in the management of the root ball and understanding the limitations of the method of production.*

Despite these significant advances, long term tree planting success with advanced trees still eludes many tree establishment projects. Success is concentrated with those organizations with experienced, trained staff and who are committed to quality outcomes.

One of the most obvious causes of tree planting failure is poor quality trees. There are still many tree producers whose stock is not up to an acceptable standard [2] and whose trees will inevitably fail for a host of reasons.

The other major cause of tree planting failure is the use of inappropriate and or inadequate tree establishment practices. Some or all of these practices still occur within a broad spectrum of the public and private sectors, sometimes with catastrophic results. They include:

- Poor species selection.
- Inability to recognise poor quality stock prior to planting.
- Poor stock holding and handling practices.
- Poorly planned projects and poor site preparation.
- Poor planting technique.
- Insufficient or absent follow-up maintenance.

[2] *More information on tree quality can be found in 'Specifying Trees' by Ross Clark. 2nd edition. Published by NATSPEC. 2003*

The outcome of poor tree planting practices on the community as a whole are significant.

Failed tree planting ventures waste resources on trees often costing many thousands of dollars.

The cost of labour in preparation and planting, or provide the expensive site fixtures such as grates, guards etc., further add to the losses sustained by tree planting failures.

Perhaps the greatest impact falls upon the landscape. Trees that do not thrive in their new environment rapidly degrade and reduce amenity rather than enhance it.

The time lost between the initial planting and the planting of a replacement is often many years, during which time the chance for value adding in urban landscapes has been lost.

It is my view that community perceptions of tree planting must be coloured by widespread inept tree establishment practices. This is likely to reflect poorly on peoples attitudes towards trees, tree planters and Councils or other tree planting bodies. It may also be at least partially responsible for the high incidence of vandalism to newly planted trees.

Planting trees should be a satisfying experience that provides a wide range of benefits to the community and the environment.

It is personally rewarding to all those involved with long term positive effects for the community when carried out with care and attention to detail.

Planting a tree is a task that must be carried out correctly from start to finish if a young tree is to establish rapidly and eventually reach maturity.

Tree planting in urban areas has been made all the more difficult by a range of site alterations that limit the potential for root growth.

The most common of these include:

- Disturbed soil profiles. In some instances the natural profile may be absent entirely due to repeated or extensive previous site works.
- Soils are more often than not compacted, sometimes to the point where root growth is not possible. The depth and thickness of compacted layers is unpredictable.
- Underground services are increasingly an issue for tree planters. The cost of repairing an optical fibre cable damaged by tree planting operations can be many thousands of dollars. [1]
- Drainage, runoff and infiltration lines are altered by trenching, impervious surface coverings, soil level changes, lowering of water-tables etc.
- Soils may be polluted by chemicals, fuel products, herbicides, or other agents affecting soil structure or pH. The may also be contaminated by building waste or other materials.
- In some areas, the level of the water table has been influenced by earth works or other factors and trees can become water logged unless special precautions are taken.

[1] *The use of air or water excavation techniques is increasing all the time in tree planting and provides the safest and most effective method of preventing underground service damage. Caution:Ensure the use of these excavation methods does not lead to compromises in the quality of site preparation.*

Other issues commonly preventing planting success include:

- Species selection mistakes can result in the wrong tree in the wrong place. Species chosen are often unsuited to the site or climate.
- The project design does not cater for the trees basic growth requirements.[1]
- The quality of trees is variable or not up to an acceptable standard.
- Site preparation is inadequate for the circumstances.
- The training and experience of many tree planters is inadequate and their technique is often poor.
- Follow-up irrigation, mulching, weed control and pruning, maintenance can be inadequate, ineffectual or absent.

[1] *Many urban landscape designs do not provide sufficient soil volume in the planting pit. Ensure trees have enough space to grow to the size anticipated and produce the desired landscape effect.*

Any one of these issues can prevent the establishment of newly planted trees.

Getting it Right.

Success in tree planting requires:

- The right species for the site.
- Good quality stock.
- A well designed & properly prepared site.
- Good planting technique.
- Adequate follow-up maintenance.

Species Selection:

Ensure the species selected are suitable for the climate and the site conditions. Tree habit and characteristics must be suitable for the purpose.

The following factors should be considered as a minimum before making choices.

- Site rainfall and timing, irrigation availability.
- Yearly temperature range & the number of frosts/yr.
- Wind exposure, airborne salt, pollutants.
- Soil type & pH.
- Drainage.
- Deciduous/evergreen/native/exotic requirements.
- Available space, suitability of various habits, fruiting, leaf litter, root system performance, tolerances to site extremes.

If unsure of the right species for a particular site, seek specialist advice.

Purchase only high quality trees from reputable growers.

Tube-stock. Use only small, actively growing, un-pruned plants in balance with the container size they are growing in. Trees should be largely free of circling root growth. All roots should be fibrous. Remove the container to check root systems. Reject diseased, weedy plants

Field Grown Deciduous Trees. Bare root, balled and wrapped trees grown in the field, should have a minimum of 3-4 primary roots.

Advanced Trees grown from the beginning in root control systems designed to produce good root architecture (shape and structure). Production systems include ‘Rocket Pots’, ‘Root Control Bags’, ‘Spring Ring Containers’. Trees produced in these systems are available in very large sizes. The majority of high quality advanced trees used in South Australia are brought in from specialist advanced tree growers in Victoria & NSW.

Pot and Bag produced trees should avoided unless their root system configuration & quality are of an acceptable standard. Trees grown in these systems have a considerably higher risk of root deformation and this will limit tree growth, possibly cause instability and reduce longevity. Regular root pruning and potting on can ensure root systems are not malformed.

Trees grown in pots treated with ‘Spinout’, a chemical additive to the inside of the pot will help prevent root circling. Care is needed when selecting any tree grown in a pot.

Where pots or bags are concerned, use small trees in preference to large trees. There is less likelihood of root problems with trees that have spent minimal time in containers.

Prior to planting, prune all root balls with sharp tools so there are no visible circling or kinked roots on the outside or the base. Only root ends should be visible.

Stock purchasing & quality control issues.

- Always specify what you want from the supplier and when you want it.
- Ensure the supplier understands that supplied trees not conforming to the standard as outlined will be returned at the suppliers expense.
- Don't compromise. Insist on the highest tree quality.
- Reject trees that do not qualify with your specifications.
- Get professional help with specification writing if necessary.
- Wherever possible purchase premium quality trees from reputable growers using production systems known to develop good root system architecture.
- If you are unsure about tree quality, commission a qualified Arborist to purchase and take delivery of trees for you.

Tree Condition:

Above Ground

[1] *Trees with excurrent form (dominant central leader) must have well defined central leader.*
Round headed trees (decurrent) should not branch too low. (specify height of lowest limb prior to purchase) In most species codominant stems with included bark in the crotch are not acceptable.

The ratio of limb to trunk diameter is important in the development of sound structure. Side limbs should be less than 50% of the diameter of the main stem measured just above the crotch.

- Tree stock should be healthy and actively growing, free of pests, disease or injury.
- Trees should have well tapered trunks and no need of additional support.
- The container size should be in balance with the size of the crown.
- The stock should be free of bark inclusions in the crotches and free of multiple leaders. [1]
- The crown should balanced evenly and the clear section of trunk no greater than 40% of the total tree height.
- The tree should not show signs of recent substantial pruning.

Below Ground

[1] *If in any doubt, use an Arborist to act as a purchasing agent for your new tree requirements.*

- Root systems should be fibrous, free of circling or kinked roots and girdling surface roots.[1]
- The root crown must be visible at the surface of the root ball.
- The tree trunk must be located in the centre of the container.
- The root ball should fully occupy the root ball and should hold together when handled.
- Except for small trees below 45 *litres*, root ball diameter should not exceed root ball depth. Not root ball should exceed 550m depth.

Site Assessment:

Take note of the following:

- Soil texture & pH
- Soil profile at depth
- Depth of the water table
- The degree of soil compaction
- Site drainage
- Available soil volume
- Suitability of planting pit design
- Location of underground services
- Presence of overhead services or other structures
- Surrounding surface infrastructure and potential impacts
- Site wind patterns and intensity
- Site radiant heat loads
- Degree and duration of shade
- Rainfall and likely method of irrigation

- Likelihood of periodic flooding
- Levels of atmospheric pollution
- Location and height of street lighting
- Community wishes in relation to tree planting at the site

Planting Site Design:

- Ensure sufficient soil volume is available, matched to the species being used and the intended design outcome.[2]
- Maximise root space through good design wherever possible, linking adjacent areas suitable for root growth to the tree, below the ground.
- Keep trees well away from footpath and other surfaces to minimize root damage.
- In streets consider planting inside of the footpath and away from the kerb.
- Place the footpath adjacent to the roadway. This will minimize root damage to the footpath.
- Negotiate tree friendly fencing with adjacent property tenants. i.e. various forms of post & rail fencing, suspended section masonry fences.
- Provide root access to public & private garden areas for street trees wherever possible.
- Use linked linear beds in car parking areas, either around the perimeter or internally where space allows.
- Long linear beds are the preferred option for car parks, providing shared root space and increased soil volumes.
- Narrow linear beds or individual planting pits will not sustain large tree species for long in the vast majority of cases.
- Design wider beds for larger trees and longer landscape life. Beds 10m or greater in width are required to enable the growth of large trees and the development of sustainable landscapes.

[2] *For healthy trees in open beds provide between 28-56m^3 of soil depending upon the size of the trees to be planted. Multiple tree plantings can co-exist in the same soil sharing the total soil volume without the need for significant volume increases for each additional tree.*

Site Preparation:

Ensure there is sufficient space between the tree and the surrounding infrastructure to accommodate trunk and woody surface root growth for the species being planted.

The tree should be positioned so as to prevent future interference with the surrounding buildings or services at maturity.

All site parameters should have been assessed. Prepare the site according to need. Prior knowledge of the site is valuable.

Where site drainage conditions are poor [1] use tolerant species. Very poor drainage is difficult though not impossible to change.

Mounding of the planting site 100-200mm above the surrounding area can help to alleviate the effects of poor drainage.

[1] *Dig a .5m deep hole and fill with water. If it is gone the same day, drainage is OK. If water is still present in the hole the following day additional site drainage may be required or special planting precautions will be necessary.*
Note: Testing drainage when the soil is dry will require repeated tests in the same hole.

Preparation of the Planting Hole/ Planting the Tree:

The size and depth of the planting hole are critical factors.

[2] *Gilman advocates leaving the root ball 10% above the surrounding soil, thus ensuring the new root growth emerges near the soil surface, where conditions are most favourable.*
Note: In hot dry climates this may be counterproductive and lead to the root ball drying out unless the planting site is mulched and regularly irrigated. In sandy sites planting above the soil level is not necessary .

- Wet the root ball of the tree several hours prior to planting.
- Remove the container and inspect the root system.
- Closely examine the root ball of the tree to be planted
- If necessary prune away any circling or kinked roots from the sides and the bottom of the root ball. Good quality stock should have few root problems.
- Remove excess soil from the top of the root ball if present, exposing the upper surface of the topmost main root/s.
- Measure the depth of the remaining root ball.
- Excavate the hole no deeper than the depth of the root ball. [2]
- The hole diameter should be a minimum of 3x the root ball diameter. This will allow new root growth to rapidly colonise the surrounding loosened soil. In effect, the wider the hole diameter the better.
- In heavy soils care should be taken to break up any glazing on the sides of the hole caused by spades or machinery.
- In highly compacted sites that are unable to be decompacted the sides of the hole should slope gradually up to the surface.
- Do not excavate more than the depth of the root ball, or if you do, firm down the soil immediately below the root ball to prevent root ball subsidence. Subsidence of soil below the root ball is a common cause of tree failure.
- Position the top of the root ball level with the surrounding soil. Depending upon the drainage and degree of compaction it may be necessary to plant slightly above the natural soil level, as per Fig 1. Bare root trees should be positioned with the soil line level to the previous planting mark on the trunk.

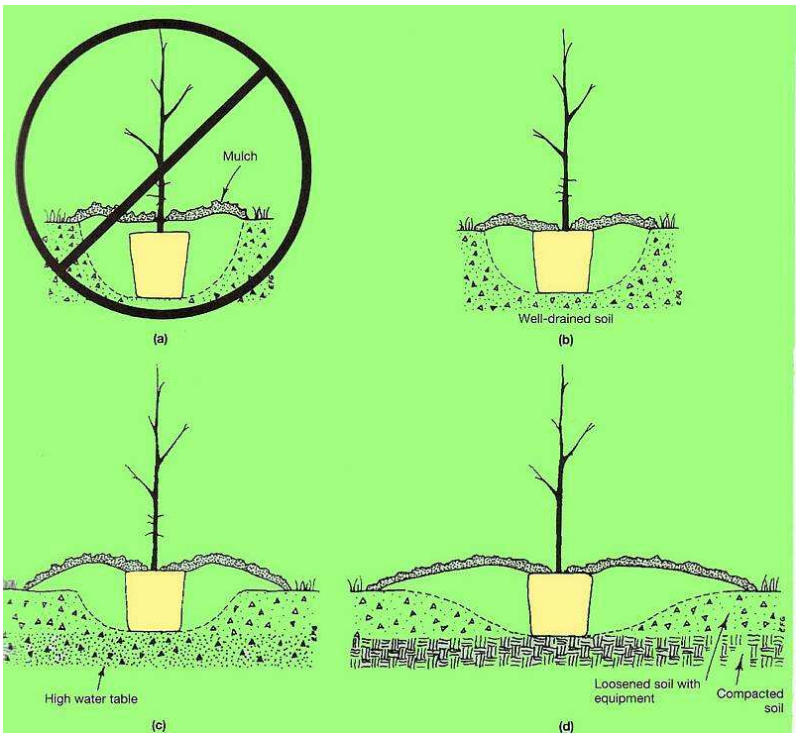

Fig. 1
(a) Never plant trees too deep and never place soil over the root ball.

(b) In most well drained soils locate the top of the root ball level with the soil line.

(c) In poorly drained soil, install the root ball slightly higher than the surrounding soil.

(d) In compacted sites, loosen the hard soil around the planting hole as far away from the tree as possible (5-10m is not unreasonable) and install the root ball slightly above the grade. Diagrams courtesy of Ed Gilman. From 'Trees for urban & Suburban Landscapes'.

- Under no circumstances should the top of the root ball be positioned below the soil line.

- Backfill with site soil that has not been amended (no additives, including organic matter or fertilizer).
- Firm the soil gently around the lower portion of the root ball to provide stability.
- As additional backfill is applied, flood the loose soil in with a hose or bucket. To eliminate large air pockets it may be necessary in heavy soils to break up the larger soil clods with a spade.
- Depending upon the method of irrigation it may be necessary to create a berm or moat around the tree. It is preferable to use mulch for this rather than soil as the soil can end up spread over the root ball.
- Water in well.
- Protect the site from further soil compaction where possible.
- Use stakes only if required for protection.[1] Ensure stakes/guards do not rub against the tree and are removed at the earliest possible time.
- Water regularly during warm dry periods, ensuring the root ball itself is wet. Irrigate regularly and often during the first year.
- Cover the surrounding area with a layer of organic mulch between 50-75 mm deep.
- In compacted sites, use a backhoe or mini-excavator to decompact (loosen) a large area.
- The minimum area loosened for an open space park planting would be 5m^2. More is much better. If many trees are to be planted in one area, deep plough or multiple rip the whole area.[2]
- Working the surrounding area to a depth of 300-400 mm should be sufficient.
- Follow-up maintenance should include regular checks for formative pruning requirements, irrigation system performance, mulch top-ups, assessment of tree grates, removal of stakes, control of weeds etc.
- Control weeds regularly by hand or with careful use of Glyphosate at recommended rates.
- Formative prune trees as required, to AS 4373- 1996, every 1-2 years depending upon the growth rate to ensure the development of as sound framework

[1] *Quality trees should not need stakes for support. Protect trees from vehicles, mowers, animals etc. with large stakes driven into the ground outside of the root ball.*
It trees must be connected to stakes for support in very windy sites the ties must allow trunk movement. Use preformed strong tree guards in areas where protection is needed against vandalism.

[2] *Decompacting the planting site with rippers will damage existing tree root systems. Ripping is far more effective in dry soils, than in damp soils.*

Soil Amendments:

The addition of organic matter, gels, fertilizer, sand, or any other material is unnecessary except in rare cases where the soil is very poor. Unless the soil is so bad you have no other choice, use the existing soil.

Organic matter belongs on the soil surface not mixed into the backfill or at the bottom of the hole.

Fertilizer:

With few exceptions, there is little or no benefit from the use of any fertilizer except nitrogen in improving shoot or root growth in trees.

Many researchers have shown little or no benefit exists in fertilizing transplanted trees with nitrogen.

Research is divided as to the benefits of fertilizing established trees with nitrogen.

Where fertilizer is deemed appropriate there is consensus from research indicating the best placement is spread over the top of the soil or mulch around established trees.

In most soil types the form of fertilizer, be it slow release, organic, inorganic, liquid or granular will make no difference as to the growth response

There are few documented benefits to fertilizing young trees except in very poor soils.

The root systems of newly planted trees can be easily burned by fertilizer, leading to poor performance or tree death.

Fertilize only on the surface when soil testing indicates poor soils have nutrient deficiencies, once the tree is established and actively growing.