Back to Nature in the Arboretum at Kew

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Whilst walking around an arboretum as a visitor it is not unusual to see mulched circles at the base of young or newly planted trees; however to see 30 metre - high mature trees with mulched circles extending out to the edge of the canopy dripline is a little more bizarre.

Over the past decades, Kew's mature trees have been placed under considerable stress due to many varying environmental factors. With the annual increase of visitor numbers and the mechanization of horticultural duties, compaction around the root plates from pedestrian traffic and machinery is the biggest cause of stress to a tree on a droughty soil. Once the soil is compacted, gaseous exchange and the percolation of moisture through to the root zone is limited, placing the tree in competition with the grasses of a mown sward and an accumulation of thatch. Trees of course naturally occur in woodlands, but gardeners tend to plant trees as isolated specimens in a lawn, with no natural feed available, as fallen leaves and deadwood are cleared away, leaving the tree vulnerable to parasitic root fungi such as *Armillaria mellea* (Honey fungus)and *Meripilus gigantea.*

Due to these factors, the growth rate of the trees at Kew has slowed because energy reserves have been utilized for maintenance and defence of existing tissues, at the expense of growth. Trees can cope to a certain extent with a single stress factor, but with multiple stresses energy production and reserves are further reduced and decline sets in. The important landscape trees in the Arboretum are now showing symptoms such as stunted growth, thinning crowns with small leaves, premature leaf fall, abnormally heavy crops of seed and branch dieback. If the stress is not alleviated, the tree will enter a mortality spiral, eventually resulting in death. Maintaining a stable environment around mature trees is critical in delaying the stages from maturity to decline and death.

At Kew the Arboricultural Unit proactively manages the tree collections using a computerized Tree Risk Assessment and Management System (TRAMS). By regularly inspecting and re-inspecting the trees, important specimens in the landscape which require preventative treatments to maintain health, rather than remedial measures once decline has begun, are identified and controls put in place as soon as possible.

From recent research in the USA, it has been clearly shown that var -

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The root crown is inoculated with a solution of mycorrhizal fungi and organic biostimulants using a pneumatic soil decompactor

-ous cultural practices, including root system protection and care, can increase the longevity of mature trees in manicured landscapes, as root loss is the most common factor causing premature decline and death of trees in an arboretum.

Relieving compaction around the root crown immediately allows for more efficient percolation of oxygen and moisture to the feeding roots. Mulching the root crown is highly effective in improving the soil environment for root growth. Mulches moderate soil temperatures, conserve soil moisture, provide organic matter and act as a buffer against further compaction.

Replacement of the turf with mulch eliminates competition for water and nutrients between turf and trees. Worm activity also increases, recycling organic matter as it falls, taking it directly to the active root zone, whilst at the same time opening up a labyrinth of small tunnels which will aid gaseous movement underground, including oxygen transfer.

In a natural forest setting, soil and root microbial associations are the norm and partnerships between roots and particular fungi benefit both the plant and the fungus. In a manicured arboretum, the need for beneficial mycorrhizae is even greater, because there is more stress and less water, nutrients and organic matter present in typical supporting soils. The presence of beneficial mycorrhizae in these conditions will help to successfully maintain healthy, feeder - root growth.

Aesculus indica 'Sydney Pearce' at Kew. To be effective the mulched circle should extend to the edge of the tree canopy

Mycorrhizal fungi benefit trees by increasing stress resistance, plant availability of nutrients and water, drought tolerance and plant viability in distressed soils. The presence of mycorrhizae decreases the risk of infection of roots from soil-borne disease organisms.

The two families of mycorrhizae used by trees are:

'Ecto' (i.e. ectotrophic, in which the fungus grows on the surface of the root and between the cortical cells) which are associated with broadleaf trees such as *Betula, Carya, Castanea, Fagus, Quercus, Tilia,* and many of the conifers.

'Endo' (i.e. endotrophic, in which the fungus penetrates the root cells) also known as VAM (vesicular-arbuscular mycorrhiza), which are associated with *Acer, Aesculus, Crataegus, Magnolia, Platanus, Pterocarya* and *Prunus*.

Some tree species require associations with both ecto and VAM mycorrhizae, e.g. *Alnus, Cedrus, Cryptomeria, Cupressus, Populus* and *Salix*.

The lists above are by no means complete and are purely examples, so in order to ensure that the correct mycorrhizae is inoculated; a mixture of both types is used for every operation in the programme.

Since 1998 a programme known as 'The Conservation of Heritage Trees' has been implemented by the Arboricultural Unit to conserve the garden's mature treescape. Each year a number of trees of high

landscape impact are selected, preferably before decline. Once the tree is selected, a mulch - retaining edge is made around the dripline by removing a single strip of turf and the remaining sward around the tree's root crown to the edge is partially killed by close mowing (scalping) with an old pedestrian rotary mower. At 1 m centres, in 1 m concentric rings out from the trunk, injections are made into the ground to a depth of approximately 300mm using the 'Terravent' machine, a pneumatic soil decompactor. The 'Terravent' uses nitrogen gas under pressure, which is clean, environmentally friendly and cheap; another advantage of this machine is that impurities such as gaseous cracked oils (e.g. exhaust fumes and lubricants) are not introduced into the soil during the operational process as happens with other compressor system soil aerators. Immediately after the decompaction blast mycorrhizal fungi and organic biostimulants suspended in a liquid solution are inoculated into the freshly aerated soil. A Yuccah natural wetting agent is also added at the time of inoculation to improve water penetration.

Once the entire root crown is inoculated, which can take up to 300 injections on a large heritage tree, the surface area is mulched with Kew's composted recycled green waste. This layer of organic matter will kill any sward that grows back from the close mowing, feed the mycorrhizae and retain any moisture in the soil that will now percolate into the ground through the freshly decompacted soil. The mulch is allowed to almost disappear before it is topped up, to prevent anaerobic conditions developing under deep organic matter, and any weed regrowth through the mulch is spot - treated with 'Glyphosate'. During the autumn, leaves are left to break down naturally under the mulched canopies, along with fruit - drop and deadwood, while in the pinetum the conifers are almost self-mulching with the natural biomass building up from fallen needles and cones.

Results from this work at Kew have been staggering, with tree health improving within a few months of inoculation on some species, particularly *Cedrus*. Extension growth and canopy density of the trees in the CHT programme is measured and recorded for comparison at a later date. The last hot, dry summer in 2003 was a testing time for many trees at Kew, but less so for the treated trees, which showed resilience to the lack of ground moisture. Each year a number of new trees will be added to the 150 already in the programme, hopefully creating an underground corridor and network for the movement of these beneficial but mysterious fungi.