INVESTIGATING THE FACTORS THAT INFLUENCE TREE ESTABLISHMENT IN THE URBAN ENVIRONMENT – A PROGRESS REPORT

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A means of evaluating the establishment of street trees planted as advanced stock has been determined (Leers 2000). This was achieved through a literature review and a survey providing data that has undergone statistical analysis. The survey was based on 510 trees representing 21 species in three municipalities in metropolitan Melbourne, Victoria. Consideration for the criteria used to evaluate tree establishment was given after reviewing the Revised Amenity Tree Evaluation Method (Moore 1991). The survey demonstrated that three key criteria give a workable measure of street tree establishment - the measurement of tip extension, trunk movement (using the Burnley Test) and the percentage of canopy dieback. From the investigation of the literature and the survey, a number of issues that affect tree establishment were revealed. These include inappropriate selection of stock or poor quality stock, poor planting technique and inadequate maintenance such as insufficient irrigation and weed control. The survey also revealed other issues that warranted further investigation. It was noted that out of the 510 trees assessed, more than 12% of the trees suffered from the symptoms of sunscald, (see Table 1). In some cases, this was so severe that the cambium was killed through to the xylem. It was difficult to discern the exact reason for sunscald on some trees and not on others in the same plantings.

Table 1. Average tip extension of trees with and without sunscald (Leers 2000).

Species	Months in ground	Number of trees	No. of trees with Sunscald	Avg. tip ext. of affected trees	Avg. tip ext. of unaffected trees
Acer buergerianum	40	8	4	1yr = 37mm 2yr = 109mm	1yr = 83mm 2yr = 161mm
Eucalyptus scoparia	12	17	4	57mm	106mm
Platanus x *acerifolius*	12	40	14	50mm	160mm
Platanus x *acerifolius*	40	38	27	1yr = 276mm 2yr = 238mm	1yr = 290mm 2yr = 290mm
Pyrus calleryana	12	37	9	21mm	31mm

The five species in Table 1 are those with a large percentage of individuals displaying sunscald symptoms. These symptoms ranged from mild, such as discolouration (sunburn) of the bark through to severe, where bark and cambium tissues were dead, revealing the xylem (see Figure 1). All five species in Table 1 had lower averages of tip extension where sunscald was present. However, only the *Platanus* x *acerifolius* that were 12 months post transplant showed statistically significant reductions of tip extension using a Two sample T-test with $p<0.05$ (Leers, 2000).

Kozlowski *et al.* (1991) refer to Northern winter sunscald lesions forming on thin barked trees as a result of alternate freezing and thawing in winter and early spring. This is characterised by patches of dead bark, which may peel. Sunken cankers are also characteristic and can be entry points for pathogens. The lesions can in turn, injure the phloem.

Equally damaging are the effects of high temperature injury. The temperatures involved are usually below the thermal death point, with symptoms of scorched leaves and fruits, sunburn, leaf abscission and inhibited growth and scorched bark (Kozlowski, 1991). There is also evidence of the bark of thin barked trees being killed by exposure to strong sunlight after the tree has been growing in shaded conditions (Rushforth 1987, Moore 1998 and Leers 2000).

The mechanism of heat injury is complex and it can be difficult to distinguish this type of damage from high levels of moisture stress. Direct "heat shock" injury as a response to high temperature exposure from seconds to minutes, mostly results in injury to cell membranes and proteins and lipids (Kozlowski, 1991). Moore (1981) goes on to state the fundamental parameter of heat stress is the duration for which the plant or plant parts are exposed to high temperatures. However, there have been very few reports of death from heat (other than fire) of higher plants in their natural growing conditions (Larcher 1995 and Moore 1981).
Stress of individual trees has occurred in heavily thinned forest stands of trees and the effects may not be apparent for several years. These effects include leaf chlorosis, reduced growth, sunscald, production of epicormic shoots and death of trees (Kozlowski *et al.* 1991). This may be similar for a tree coming from a relatively sheltered nursery, then being transplanted into an exposed street. Alternatively, there is the anecdotal evidence of the canopies of trees growing at a particular orientation then transplanted facing another compass point exhibiting different growth rates (Moore 1998). That is, one side of the tree starts its life facing south, with very little conditioning against solar radiation, then being transplanted with that same side facing northwest the tree experiences the shock of full sun.

Figure 1. *Acer buergerianum* with sunscald (Leers 2000).

This raises questions about the influence of a changed canopy/trunk orientation when the tree is planted in the streetscape. The changed orientation occurs when the tree is grown in the field or nursery with its north facing canopy always facing north. This orientation would almost certainly change after being planted in the street, i.e. the north facing canopy no longer faces north. The result of these questions is further investigation by means of a literature review and two experiments designed to provide empirical data to more thoroughly investigate this phenomenon.

ORIENTATION EXPERIMENT

This trial will consider the effects of orientation on the establishment of nursery and field grown advanced trees. The trees are planted into the streetscape of Hume City Council, northwest metropolitan Melbourne, (see Figure 2). Measurements of growth will include tip extension and caliper increase over two to three years. Before leaving the nursery, the trees were marked indicating the north facing side of the trunk. The trees were planted into the streetscape with that north facing side now facing east, west, south or north in a Random Block Design. In addition to growth measurements being taken, the symptoms of heat damage (sunscald) will be evaluated.

Figure 2. *Platanus* x *acerifolia* planted in Hume's streetscape as part of the Orientation Experiment.

There are three species being used for this trial; *Acer buergerianum*, *Melia azedarach* and *Platanus* x *acerifolius*.

The *Melia* have been grown in hard walled 40L plastic containers and were four years old at the time of planting. The *Acer* and *Platanus* are both field grown stock and were delivered as 45L rootballs wrapped in hessian. These trees were five years old at the time of planting.

Initial measurements were taken of the tip extension for the previous season's growth, made when the trees were still being grown *in situ* at the nursery in 2005. Watson (1987) describes tip extension as the distance between the scale scars and the terminal bud, (see Figure 2). For this trial, measuring tip extension involved choosing three branches from the canopy that showed 'normal' healthy growth and vigour facing each compass point. The three branches chosen for each compass point were at head height, chest height and waist height. These measurements were then averaged giving an average tip extension for the canopy at each compass point. Measurement was made with a ruler and was for the previous season's growth.

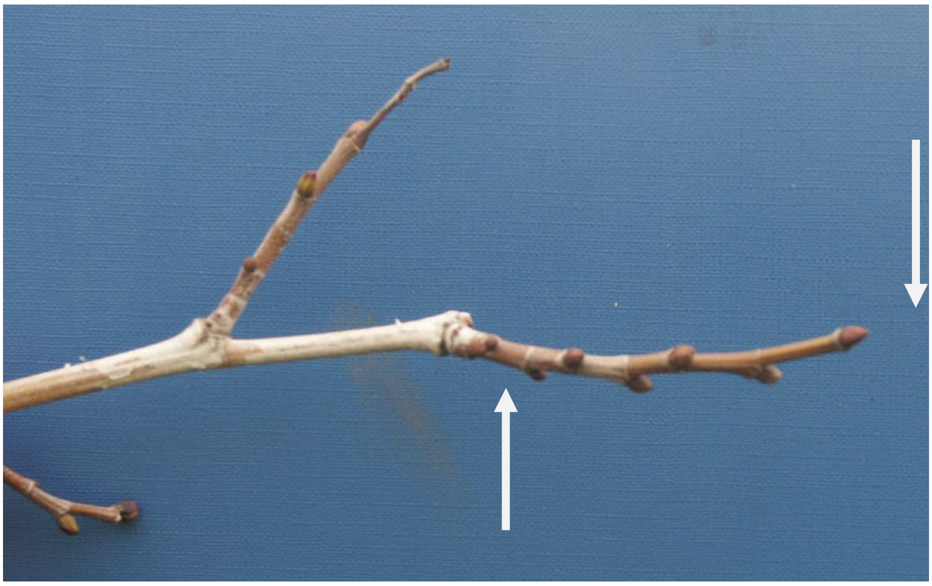

Figure 3. Indicates the scale scar and the terminal bud of *Platanus* x *acerifolia*. This is the tip extension used to measure the growth achieved in 2006.

RADIANT HEAT EXPERIMENT

This experiment will consider the effects of radiant heat from four different surfaces on tree establishment. The four surfaces, asphalt, concrete, granitic sand and green waste mulch are commonly found surrounding or adjacent to urban trees. This experiment will be conducted using field grown *Platanus* x *acerifolius*. The trees are to be planted into a Hume street with one square metre of surfacing on the west side of the tree.

The experiment will use four trees with each different surface adjacent to the trunk. In addition to these materials, tree planting orientation will also be examined. This will require a number of trees having their original north facing orientation to be facing north and the same number of trees with their original north orientation now facing south. Therefore, the experiment will have 32 trees in total, with 16 facing north and 16 trees facing south, and each group of 16 trees will have four trees alongside each of the four surfaces.

Growth measurements will be taken and sunscald will be evaluated during the first summer. Temperatures on the trunk and trialed surfaces will be recorded using thermal imaging. This data will then be statistically analysed to investigate the effects of these surfaces on tree growth and establishment.

RESULTS

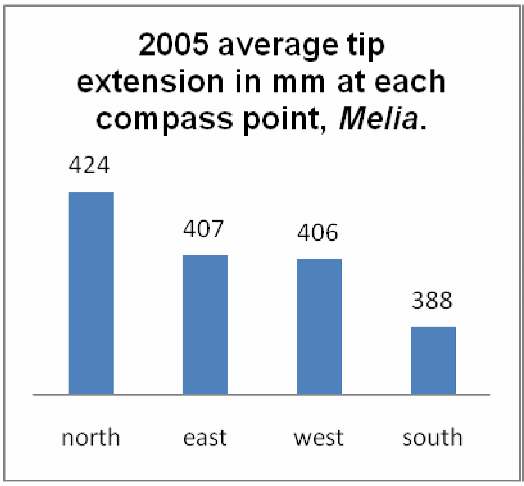

Figure 4. 2005 average tip extension in mm of the canopy at each compass point for *Melia azedarach*.

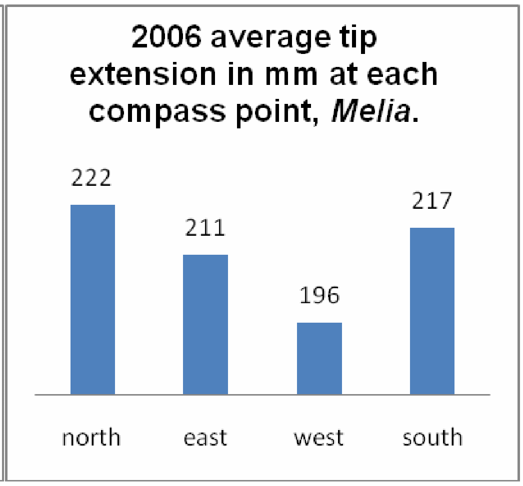

Figure 5. 2006 average tip extension in mm of the canopy at each compass point for *Melia azedarach*.

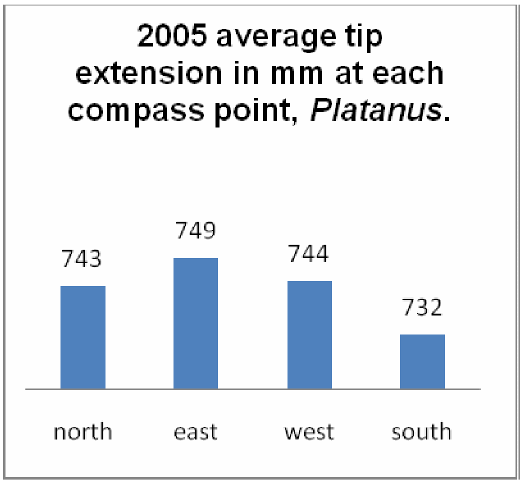

Figure 6. 2005 average tip extension in mm of the canopy at each compass point for *Platanus* x *acerifolia*.

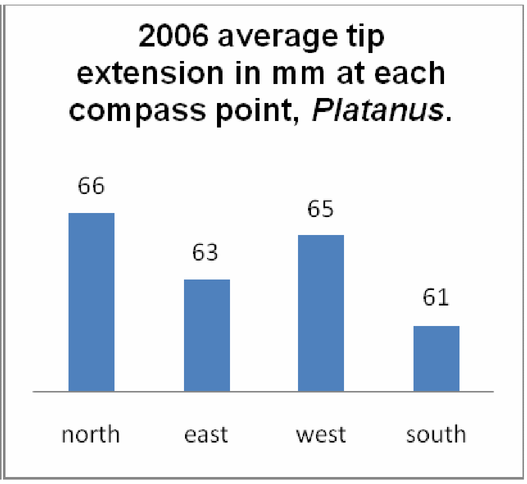

Figure 7. 2006 average tip extension in mm of the canopy at each compass point for *Platanus* x *acerifolia*.

Figure 4 and Figure 6 indicates the tip extension in mm for the *Melia azedarach* and *Platanus* x *acerifolius* made while the trees were growing in the nursery in 2005. A One Way ANOVA with $p<0.05$ indicated no significant difference for canopy growth between any of the compass points for either species. Figure 5 and Figure 7 indicates the tip extension in mm for both species made during the 2006 growing season, after the trees were planted into the streetscape. A One Way ANOVA with $p<0.05$ indicated no significant difference for canopy growth between any of the compass points for either species.

Figure 8 indicates the numbers of failed *Platanus* x *acerifloia* against their orientation, 12 months after being planted in to the streetscape. A One Way ANOVA with p<0.05 indicated no significant difference between the orientation and the numbers of failed trees.

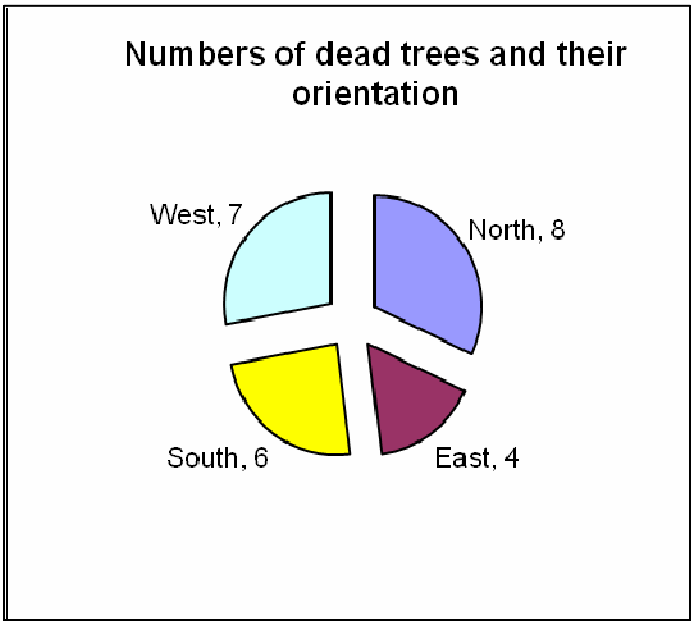

Figure 8. Numbers of failed *Platanus* x *acerifloia* and their orientation.

CONCLUSION

Though initial results indicate there is little difference in growth when canopy orientation is altered, further analysis may reveal differences in growth that are of concern to the manger of the urban 'tree-scape'. Also of interest are the initial observations of bark shedding on those sides of the trunk that do not face north. This goes against observations made by others (Moore 1981).

The Radiant Heat Experiment is yet to be set out. Data will be collected not only during the hottest months, which are of most concern to urban tree managers, but also during the cooler months. This will enable a more thorough comparison and evaluation of radiated heat from surfaces that are commonly found adjacent to young growing trees. The final results of the literature review and the two experiments are to be published in expected in 2008/2009 in a Masters Thesis.

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