Evaluation of Nursery Stock Tree Vitality

Final Report for Mr Keith Sacre,

Barcham Trees, Ely, Cambridgeshire, CB7 5XF

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SUMMATION

The health of 324 different tree species representing 80 genera was assessed over three growing seasons (2009, 2011, 2012) using three scientifically proven analytical system for assessing tree vitality; namely leaf chlorophyll fluorescence (Fv/Fm, Pi) as measure of photochemical and photosynthetic efficiency respectively, leaf chlorophyll content (SPAD) and cellular electrolyte leakage (EL) as a measure of membrane integrity. All trees were located at Barcham Trees, Ely, Cambridge. Using standardised Fv/Fm, Pi, SPAD and EL values associated with optimal plant health results of this investigation confirm that in 2009, 2011 and 2012, 96.8, 98.4, 99.2% respectively, of tree stock grown at Barcham Trees was in optimal health and "fit for purpose" prior to out-planting.

Statistical comparison (least significant difference at the 95% confidence level), of 2009, 2011 and 2012 base line data associated with tree health (leaf chlorophyll fluorescence (Fv/Fm, Pi), chlorophyll content (SPAD), EL) demonstrated that in 78.8% of cases Fv/Fm, Pi, SPAD and EL values did not significantly differ between years. Such a result indicates:

i.) A high level of robustness and repeatability of the three systems used by Barcham Trees to measure tree health.
ii.) A high degree of confidence in the base line values that can be used to assess tree health for monitoring purposes during growth in the nursery and after out-planting into urban landscapes.

Results of this trial have also provided baseline data associated with optimal tree health for yellow, variegated and red leafed ornamental tree species that prior to the instigation of this study did not exist. Such data will be of benefit to professionals involved in the care and management of woody plants in amenity landscapes

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INTRODUCTION

Physiological tests of plant vitality during nursery production are valuable because of their ability to identify low vigour or damaged plants that will perform poorly when planted into the landscape. Quality control of tree and nursery stock at present relies heavily on visual observation to record symptoms such as leaf yellowing and/or crown die-back etc. Visual observation suffers from two disadvantages; i.) this form of measurement can be very subjective as they are based on human knowledge and interpretation that can significantly differ between individuals. ii.) leaf yellowing and crown die-back are the "end product" of stress i.e. the damage has already been done and the tree is in decline.

Field diagnostic tools can objectively evaluate stress disorders in trees that are used as a basis for management decisions on cultural practice and proactive monitoring in urban treescapes. These diagnostic instruments and methodologies detect stress before the visible symptoms of plant decline are manifest so make possible, effective remedial intervention.

Three commonly used tree vitality measurement systems include:

1. **Leaf electrolyte leakage** has been shown to indicate incipient post planting needle damage and heat damage of conifer seedlings, this in turn highly correlated with damage and growth potential of four conifer species following warm and cold storage and correlates strongly with post freezing survival rates of a range of fruit tree species.
2. **Chlorophyll fluorescence**, an indication of the fate of excitation energy in the leaf photosynthetic apparatus, has been used to provide a rapid and non destructive diagnostic system of detecting and quantifying physiological injury in tree leaves and needles (photosynthetic organs) under low temperatures, salinity and water stress conditions. Chlorophyll fluorescence, especially Fv/Fm (ratio of variable to maximum fluorescence) has proved particularly useful in screening programmes as in many instances the effects of environmental stress can be detected prior to visible signs of deterioration. Previous work has demonstrated that measurements of chlorophyll fluorescence (Fv/Fm) post heat stress of several stocktypes of jack and black spruce were closely correlated with stem volume increment over time, concluding Fv/Fm measurements could be used to forecast field growth performance of the two test species. Recent work has also shown that chlorophyll fluorescence values were highly predictive of growth, foliar damage and survival rates in white and red pine and white and black spruce seedlings at week 7 post planting following prolonged exposure of seedling material to elevated storage temperatures.

3. **Chlorophyll content.** Environmental stresses limit the amount of carbohydrates available for growth and reduce nutrient uptake resulting in leaf chlorosis and necrosis. Exact knowledge of foliar chlorophyll concentrations i.e. “greenness” consequently provides a robust and accurate estimation of tree vitality. The chlorophyll meter (or SPAD meter) is a commercially available portable piece of equipment that is used to measure greenness based on optical responses when a leaf is exposed to light that in turn is used to estimate foliar chlorophyll concentrations. The meter makes instantaneous and non-destructive readings on a plant based on the quantification of light intensity absorbed by the tissue sample.

In combination these three analytical systems form an effective means of determining tree vitality at a specific time during the growing season.

The Objectives of this investigation were to i) determine the vitality of Barcham Trees nursery grown tree stock of a range of species not measured in 2009 and 2011 and ii) repeat measurements of trees evaluated in 2009 and 2011 and compare values with those in 2012 for consistency and robustness.

MATERIALS AND METHODS

Plant Material

Evaluation of tree stock vitality occurred during mid-July, a time when trees are displaying maximum photosynthetic efficiency and just prior to alterations in source sink carbon allocation, i.e. well beyond the initial 21 days required after leaf flush (*circa* early May), to allow the photosynthetic apparatus to fully develop (Kitao et al. 1998).

One hundred leaves were collected at random from throughout the crown from each species (5 leaves x 20 trees). All sampled leaves were transported in insulated boxes sheltered from light and all the material was prepared within 2 hours of collection.

Tree Vitality Measurements

All measurements were obtained from mature fully expanded leaves to include:

Leaf Chlorophyll Content (SPAD)

Chlorophyll fluorescence Fv/Fm and PI measurements

Leaf electrolyte leakage

See 2009 report for detailed explanation of each system

Statistical analysis

Mean leaf electrolyte leakage, chlorophyll fluorescence and chlorophyll content ± standard deviation are shown for each tree species tested. Least significant difference were used to compare and separate significance on each tree vitality parameter between years using the Genstat V version 3.1 program at $P<0.05$ following checks for normality and equal variance distributions.

RESULTS AND CONCLUSIONS

Leaf chlorophyll fluorescence (Fv/Fm, Pi) SPAD, and EL values of trees assessed were at, or above the levels specified for healthy trees for 96.8, 98.4 and 99.2% of all tree species evaluated in 2009, 2011 and 2012 respectively (Table 1; Percival, 2008; Maki and Colombo, 2001).

Results of three years assessments consistently show that greater than 96% of container grown tree stock located at Barcham Trees, Ely, Cambridgeshire was in optimal health and ‘fit for purpose” prior to out-planting.

Results consistently show that chlorophyll fluorescence values of red, variegated and yellow leafed species were lower compared to green leaved varieties. Fv/Fm values between 0.65-0.75 were associated with optimal tree health for red, variegated and yellow pigmented trees and provide previously unknown baseline health measurements that can be used by professionals involved in tree management of urban/amenity landscapes.

Base line data associated with tree health (leaf chlorophyll fluorescence (Fv/Fm, Pi), leaf chlorophyll content (SPAD), EL) of 156 tree species using LSD demonstrated that in 78.8% of cases Fv/Fm, Pi, SPAD and EL values obtained in 2009, 2011 and 2012 did not significantly differ between years. Such a result indicates i.) a high level of robustness and repeatability of the three systems used by Barcham Trees to measure tree health ii.) a high degree of confidence in the base line values that can be used to assess tree health for future monitoring purposes.

SUPPORTING LITERATURE

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