

A RAPID TECHNIQUE FOR THE EVALUATION OF MATURE TREE CROWN GROWTH

by John R. Seiler and Paul N. McBee

Abstract. A simple, rapid technique for estimation of projected tree crown area was evaluated. The technique utilizes photographs of tree crowns taken from two directions with an object of known scale present in each photograph. The photographs are then displayed onto a dot grid and the projected (two dimensional) crown surface area in square feet is estimated. Total height, crown width, and live crown length can also be estimated from the photographs. The estimates obtained from the photographs agree well with on-ground measurements of height and crown width. With this technique, reduction in growth due to pruning, growth regulator application or loss of vigor can be quantified.

The use of plant growth regulators for the control of growth in urban tree species has shown promise in recent years and their use is expected to increase in the future (4). Through the use of these chemicals, pruning intervals can be lengthened and the amount of material removed reduced. Several studies have shown reductions in shoot elongation following application of growth regulators (1, 3, 5). None of these studies measured growth of the crown. Instead, length and weight of individual shoots were measured. One study presented percent crown growth reduction with no explanation of how it was quantified (6). Bieller (2) pointed out the need for standardized, unbiased field data for the evaluation of tree growth regulators. A large amount of data on the effectiveness of tree growth regulators are subjective estimations with little or no data quality assurance.

To adequately test the effectiveness of these chemicals as well as other factors which impact crown size (eg. pruning or loss of vigor), a reliable and repeatable method to estimate crown size is needed. Ideally this technique should have a high level of quality assurance and quality control. It should also be relatively rapid, simple to do, and suitable for use in an urban environment. This report outlines a technique which we feel meets all of the above criteria.

Materials and Methods

The technique utilizes the use of images (photographs) for the assessment of projected crown surface area (two dimensional displayed area), total height, length of live crown and crown width. Two photographs are taken of each tree at 90° to each other. The bearing of each photograph and the distance away from the tree should be recorded so that future assessments can be made from the same locations. In each photograph, a stadia pole with one foot increments or an object of known dimensions is placed where it will be clearly visible. By placing a known scale in the photograph the need for keeping distance from the tree constant is eliminated. We utilized a board of known dimensions (Figure 1). The same board was used for tree identification by covering it with an erasable plastic cover and numbers written directly on the board with an erasable felt tip marker for future reference. We initially evaluated two film types (black and white print negatives mounted as slides, and ektachrome color slide). We found 35 mm ektachrome color slide film to work best. Crown edges and interference from surrounding vegetation were more easily identified with a color image.

To assess the projected crown surface area and the other dimensions, the slide is projected onto a dot grid and the projector distance adjusted so that the distance between two dots was equal to one foot on the stadia pole or other reference object placed in the picture. The number of dots hitting any portion of the tree crown is then counted (Figure 1). Since the distance between two dots is adjusted to one foot, the number of dots intersecting the crown is equal to the area in square feet. The numbers obtained from the two photographs at right angles to each other were then averaged. To determine the accuracy of the technique, total tree

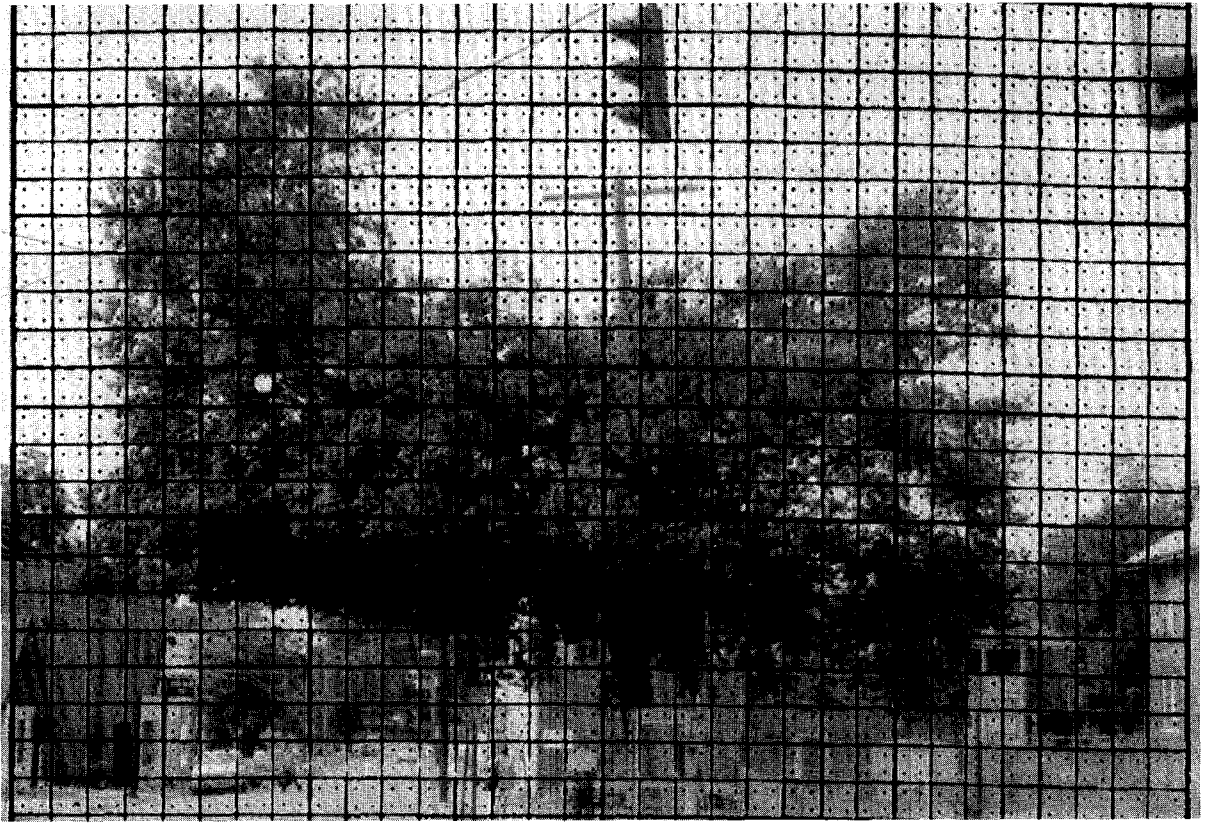


Figure 1. Norway maple in Roanoke, Virginia. White reference board being held to the left of tree trunk is one foot in height. Dot grid has been overlaid so that distance between dots is equal to one foot. The number of dots intersecting the tree crown (excluding trunk) is then counted. This count is equal to the dimensional (projected) surface area of the crown. The surface area of this tree counted by three people was 1102 ± 39 square feet.

heights and width of the crown at its widest portion were also estimated using the dot grid. These estimates were then compared to independent estimates of tree height using a height pole, and crown width using a 100 foot tape. We also tested projecting the crown shapes onto paper, tracing the crown, and then measuring the cut out image using a leaf surface meter. This step was found to take much longer and results were highly variable depending on how accurately the trace was made.

Samples for accuracy assessment were collected from a variety of species on the Virginia Tech campus. Tree species tested included red maple (*Acer rubrum*), white birch (*Betula alba*), European beech (*Fagus sylvatica*), white oak (*Quercus alba*), pin oak (*Quercus palustris*) red oak (*Quercus rubra*), American sycamore

(*Platanus occidentalis*) and sweetgum (*Liquidambar styraciflua*). Repeatability of the technique was assessed by making several estimates of the same photograph. To test the feasibility of the technique in an urban setting, photographs were taken in the Roanoke, Virginia with the assistance of Appalachian Power Company. No independent ground estimates were made of tree dimensions in Roanoke.

Results and Discussion

The technique worked well on open-grown trees when there was a clear view of the crown on all sides. When tree crowns overlap, an especially clear image of crown color and texture is necessary for accurate estimates. Often a quick field sketch of the sample tree's crown can be used to

later help delineate the crown edges. If trees are closely spaced in the row, it is impossible to get images on two sides. For future testing of tree growth regulators, we suggest that sample trees be selected carefully so that photographs can be taken from two sides. In our sampling in Roanoke, many trees were not suitable candidates due to neighboring trees, fenced yards, and adjacent buildings which hinder photograph collection. We did, however, have no difficulty in collecting adequate numbers of sample trees in a short period of time.

On average, each count of dot grid area took about twelve minutes. This includes the setup for each photograph. Time required increased with crown size and amount of interference from surrounding trees. Photographic estimates of crown width and tree height agree well with independent field estimates. The average percent error for crown width estimates was 1.8 percent (Figure 2a). Tree height estimates varied by 3.2 percent (Figure 2b). Projected crown surface area cannot be independently estimated but were reasonable given the crown widths and lengths. For example, a tree with an estimated area of 502 square feet had a width of 31.5 feet and a height of 35 feet. This tree was basically triangular in shape and using a crude estimate of area as $1/2$ (width x height) yields an area of 551 square feet.

Growth of individual shoots within a crown is not measured with this technique. Some branches will almost certainly be hidden within the photographs. Irregular growth, such as single stem leader breaks, are accounted for in the overall crown area if visible in the image. On average if a pruned tree treated with chemical growth regulators has less regrowth of individual shoots it will almost certainly be accounted for in a smaller projected crown surface area. Changes in crown vigor over time due to any number of factors could also be documented.

Summary

Repeatable measures of projected tree crown area can be obtained with this technique. Based on comparisons with field height and crown width measurements, the estimates appear to be accurate. The technique is best used on trees with

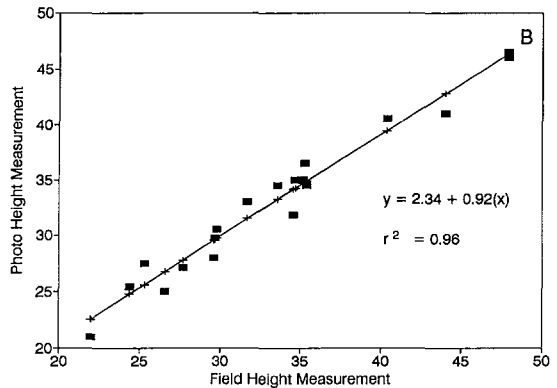
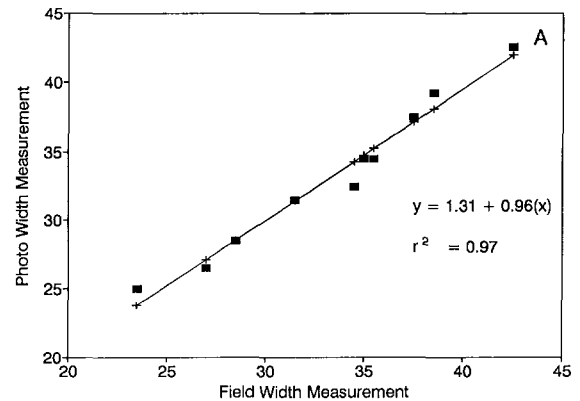


Figure 2. Photographic estimates of crown width (A), and total height (B) compared with field measurements. Plotted line represents predicted values from associated regression equation.

clear views on two sides (at a 90° angle) This limits use of the technique in some urban settings. When sample trees are selected carefully this technique will yield accurate, quantitative assessments of tree crown size in studies evaluating growth regulators.

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Résumé. Une technique simple et rapide d'estimation de la surface de projection de la cime d'un arbre était mise à l'épreuve. Cette technique emploie des photos de cimes d'arbres prises de deux directions avec un objet d'échelle connue sur chaque photo. Les photos sont, par la suite, disposées sous une grille de points cotés et la projection (en deux dimensions) de la surface de la cime est estimée en pieds carrés. Les estimés concordaient bien avec les mesures sur le terrain de la largeur et de la hauteur de la cime. Avec cette technique, les réductions de croissance dues à l'élagage, l'application d'un régulateur de croissance ou la perte de vigueur peuvent être quantifiées.

Zusammenfassung. Eine einfache und schnelle Methode für die Beurteilung der Kronenmantelfläche wurde bewertet. Die Methode verwendet Fotografien der Baumkrone, die aus zwei verschiedenen Richtungen aufgenommen werden und einen Gegenstand bekannten Ausmaßes beinhalten. Die Fotografien werden dann auf einem Raster abgelichtet und die Größe des projizierten, nun zwei dimensional Kronenmantels wird in Quadratfuß geschätzt. Die Schätzungen stimmten gut mit den Messungen der Höhe und Kronenbreite vom Boden aus überein. Mit dieser Methode können Wachstumsvermindierungen aufgrund von Astung, Anwendung von Wachstumsregulatoren und Vitalitätsverlust quantifiziert werden.