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A NON-DESTRUCTIVE METHOD FOR DETERMINING THE AREA OF UNSPLIT LEAVES OF COCONUT SEEDLINGS

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ABSTRACT

A rapid, non-destructive and accurate method for determining the leaf area of unsplit leaves of coconut seedlings (var. CRIC 60 and CRIC 65) is proposed using two regression models $y = 25.85 + 0.99\ x$ (for CRIC 60) and $y = 38.36 + 1.04\ x$ (for CRIC 65) with reliabilities of 99.3% and 96.9 %, respectively, where y is the area of the leaf and $x = (c + d)\ \{(e + \sqrt{(f^2 + g^2 / 4)})/2\}$, c, d, and g are the breadths while e and f are lengths at different positions of the leaf.

INTRODUCTION

Leaf is the major plant organ responsible for photosynthesis, transpiration and consequently, the total plant productivity (Linder, 1985). Therefore, it is of utmost importance to study the leaf area development of a plant. The vigor of a coconut (*Cocos nucifera* L.) seedling is also to some extent indicated by the length and width of a leaf and the number of leaves. These parameters are in effect related to the total leaf area of a seedling. In studies done by the plant physiologists, botanists and agronomists, leaf area of a young coconut seedling is frequently used as an index of the plant's response to environmental changes (Ranasinghe *et al.*, 1999).

Coconut seedlings are often used in research studies. Very often destructive sampling is not possible. For such situations, the most common method of determining the leaf area is by mathematical regression equations using easily measurable leaf parameters. Several acceptable non-destructive methods are available for determining the leaf area of split leaves in coconut seedlings (Mathes *et al.*, 1989; Satheesan *et al.*, 1983) and adult coconut palms (Jayasekara and Mathes 1992; Ramadasan and Jacob Mathew (1987). However, a method to determine the leaf area of seedlings with unsplit leaves in which the leaflets are not separated is yet to be developed. Hence it has become necessary to find a method of estimating the leaf area of such seedlings by a non-destructive method.

There is a large variation in the morphology of leaves among the cultivars and hybrids of coconut (Ramadasan and Kasturi Bai, 1999). This may necessitate developing different regression equations to determine the leaf

area of seedlings of Tall and Dwarf Green x Tall varieties. The aim of this study was to develop a common equation or different equations to estimate leaf area of unsplit leaves of seedlings of Tall Dwarf Green x Tall varieties.

MATERIALS AND METHODS

Eight-month-old seedlings from Tall x Tall (CRIC 60) and Dwarf Green x Tall (CRIC 65) varieties were randomly selected for the study from two coconut nurseries, Kirimatiyana and Thabbowa. From each nursery, 15 seedlings of each variety were selected and six unsplit leaves from each seedling were taken for measurements. The most mature leaf of each seedling was numbered 1 and the other leaves were numbered in the descending order of maturity. Measurements were taken at different positions of each leaf in order to develop a suitable equation to estimate the total area of a unsplit leaf. The measurements finally used for the development of the most efficient regression equation or equations were *c, d, e, f* and *g* (Fig. 1).

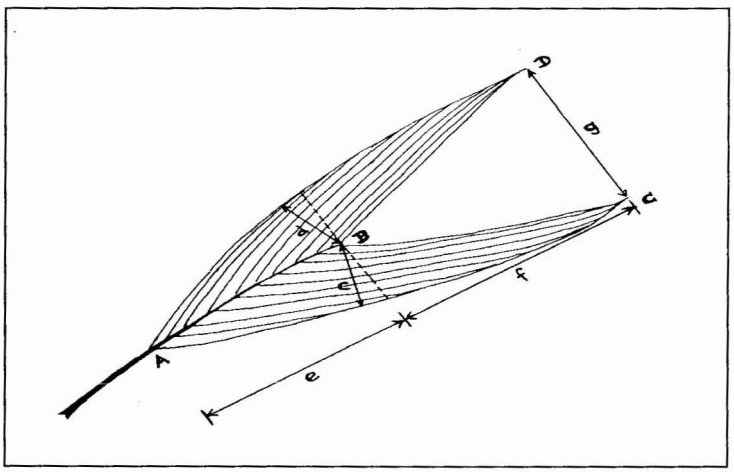

Fig. 1: *Diagram of an unsplit leaf showing the measured parameters c, d, e, f and g.*

The model takes the form; $y_i = a + bx_i$

Where, y_i is the actual area of the leaf and x_i to describe later, *a* and *b* are constants. The actual area of each leaf was measured destructively using an electronic leaf area meter (LI-COR 3000, USA).

Statistical analytical procedure

Consider the area ABC of the unsplit leaf in Fig. 1. This area is best described as proportional to one half the area defined by,

$$c \{(AB + BC) / 2\}$$

ie; $c \{(AB + BC) / 2\} = c \{(e + \sqrt{(f^2 + e^2/4)}) / 2\}$.

Similarly the area of ABD is proportional to, $d \{(e + \sqrt{(f^2 + g^2/4)}) / 2\}$

Thus the total area $x = (c + d) \{(e + \sqrt{(f^2 + g^2/4)}) / 2\}$

Let $x = (c + d) \{(e + \sqrt{(f^2 + g^2/4)}) / 2)$

Let y = the actual leaf area of each leaf measured by leaf area meter

Thus for each leaf, the leaf area (y_i) and calculated value (x_i) will be available and the regression equation developed accordingly.

RESULTS

Separate regression equations were developed for the varieties CRIC 60 and CRIC65 and are described below.

CRIC 60 : $y = 25.85 + 0.99\ x$, $r^2 = 99.3\%$
CRIC 65 : $y = 38.36 + 1.04\ x$, $r^2 = 96.9\ \%$

Where y = actual leaf area

$$x = (c + d) \{(e + \sqrt{(f^2 + g^2 / 4)}) /2\}$$

The regression coefficients showed significant (p=0.001) dependency of y on x. The high r^2 values indicate the prediction value of the two equations and the extent to which the variation in y is explained by x.

A further test was carried out to see whether a common equation could be fitted for the two varieties. The test however showed that there is a significant difference between the '*a*' values and the '*b*' values. This suggests that leaf area of the seedlings of the two varieties is best described by the two regression equations.

DISCUSSION

Leaves are the most important organs for plant production due to their role in intercepting and absorbing radiant energy and building this energy into organic substances through the processes of photosynthesis. The physiological aspects such as rates of photosynthesis and transpiration of a plant are commonly expressed as CO_2 uptake and H_2O loss per unit leaf area. The value of leaf area in the study of plant growth and other physiological aspects is so significant that researchers from time to time had tried various methods in evaluating the leaf area of coconut seedlings by non-destructive methods. Mathes *et al* (1989) developed a regression equation to estimate area of the leaves of coconut seedlings up to three years of age and observed that the third leaf could be used as the representative leaf to measure the total leaf area of seedlings. However, their method could not be applied for seedlings with unsplit leaves. Based on results of the present study, the following non-destructive method could be proposed for obtaining the area of the unsplit leaves of seedlings in the 'field planting stage'. The measurements of *c, d, e, f* and *g* of each unsplit leaf have to be taken, irrespective of the age of the leaf, and used in the equation developed to estimate the area of each leaf. Total leaf area of the seedling can thus be estimated by adding individual leaf areas.

In conclusion, the equations developed from this study could be used to determine the leaf area of unsplit leaves of Tall and Dwarf Green x Tall seedlings and applied to studies of growth analysis and in the evaluation of cultivars at the seedling stage for their potential to adopt to different environmental conditions.

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