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A NON-DESTRUCTIVE METHOD TO ESTIMATE LEAF AREA IN CASHEW SEEDLINGS

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ABSTRACT

The area of an individual leaf in a three month old cashew (*Anacardium occidentale* L.) seedling can be estimated by simple linear functions, leaf area $A = -17.194 + 4.607\ L$ using length (L) alone or $A = 0.74 + 0.668\ P$ where P is the product of both the linear measurements (L and B). The latter equation is superior with a predictive ability (R^2) of 90.73% to the former ($R^2 = 78.14\%$). Employing the total number of leaves (N) and the product of linear measurements (L and B) of the median leaf (P_{med}), another equation is derived to compute the total leaf area (TLA) of the seedling, $TLA = 2.63\ N^{1.23}\ P_{med}^{0.5579}$ with R^2 as high as 86.71%.

INTRODUCTION

The leaf area gives a simple and an approximate measure of plant's photosynthetic potential. In fact, leaf area tends to be a more common determinant of plant growth and yield than the photosynthetic capacity of individual leaves in a crop community (Watson, 1952). In perennial crops like cashew, the rate of leaf production and thus the establishment of minimum photosynthetic frame may determine the duration of the juvenile phase as well as the subsequent bearing ability. Preliminary studies showed that the total leaf area has a high positive relationship with seedling vigour in cashew (Bhagavan and Subbaiah, 1979). However, the cumbersome and destructive procedures adopted in the measurement of actual leaf areas can be avoided only by evolving reliable prediction equations (Marar and Papachan, 1964; McKee, 1964; Sepaskhash, 1977; Wiersma and Bailey, 1975). A rapid and non-destructive method was standardised based on linear measurements in cashew and is reported here.

MATERIALS AND METHODS

Three month old seedlings of cashew (*Anacardium occidentale* L.) raised from mixed seed population maintained at Central Plantation Crops Research Institute, Regional Station, Vittal were used for the study. Twenty five uniform and healthy seedlings were randomly selected. The seedlings were generally unbranched and had 8–14 leaves on the main stem other than the 3–4 embryonic leaves or the prophylls. The maximum length and breadth of all the leaves in each seedling were recorded. The

actual leaf area of each leaf was measured using an electronic area meter (Li-Cor, USA).

For the non-destructive procedure of estimation of leaf area, modelling prediction equations by regression analysis has been reported to be the most suitable methodology (Marar and Papachan, 1964; McKee, 1964; Sepaskhash, 1977; Wiersma and Bailey, 1975). Following are the five models tried :

(i) $A_i = a + b\ L_i$, where L_i is the maximum length of i^{th} leaf

(ii) $A_i = a + b\ B_i$, where B_i is the maximum breadth of i^{th} leaf

(iii) $A_i = a + b\ P_i$, where P_i is the product of L_i and B_i

(iv) $A_i = a + b_1\ L_i + b_2\ B_i$ and

(v) $Ai = a\ L_i^{b_1}\ B_i^{b_2}$

In these equations A_i, the leaf area of i^{th} leaf is the dependent variable, P_i, L_i, B_i, are the independent variables and a, b, b_1, b_2 are the constants.

For evolving a suitable equation to predict the total leaf area; actual total leaf area of each of the 25 seedlings $(TLA)_i$, number of leaves (N_i) in each seedling were recorded and the following exponential model was attempted :

$$(TLA)_i = a\ N_i^{b_1}\ (P_{med})_i^{b_2}$$

where $(P_{med})_i$ is the product of length and breadth of the median leaf (middle leaf when the total number of leaves on the seedling was an odd number or average of the two middle leaves in the case of even number of leaves) in the i^{th} seedling.

RESULTS AND DISCUSSION

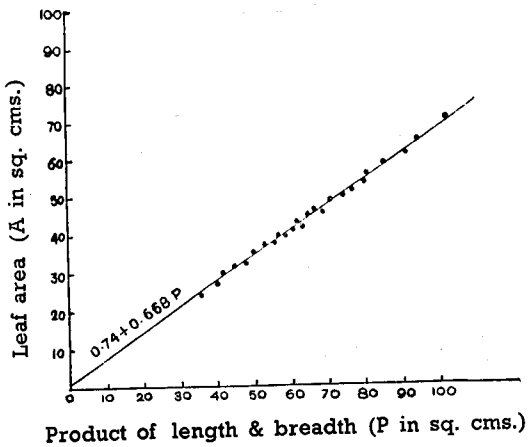
The equations along with the co-efficient of regression (R^2) are presented in Table I. The co-efficient of regression, R^2 is a measure of predictive ability of the model. As per this, the data indicated that the area of an individual leaf on a cashew seedling could be estimated by leaf area = 0.74 + 0.668 P in cm^2 with predictive ability as high as 90.73%. The leaf area obtained from this equation has a close approximation ($\chi^2 = 2.32 < \chi^2\ 252;\ 0.05$) with the actual leaf are measured by using the electronic area meter (Fig. 1).

Table I. *Leaf area prediction equations and co-efficient of regressions (R^2)*

Prediction equations	R^2 (in %)
$A = -17.194 + 4.607\ L$	78.13
$A = -37.797 + 17.064\ B$	60.86
$A = 0.740 + 0.668\ P$	90.73
$A = -43.518 + 3.391\ L + 8.945\ B$	89.42
$A = (0.692)\ L^{0.968}\ B^{1.001}$	94.00

Further it was noticed that (Table I) the exponential model of the type $A = a\ L_i^{b_1}\ B_i^{b_2}$ is the best suited model with more predictive ability (94%) in estimating the leaf area. Since this model involves cumbersome computations, it is preferable to choose the model cited above with a very little

FIG. 1. ACTUAL LEAF AREA MEASURED BY ELECTRONIC AREA METER (DOTS) AND THE PREDICTED LEAF AREA (STRAIGHT LINE)



loss in predictive ability. Moreover a close look at the exponential model constants, confirms that the product of length and breadth is a better argument (independent variable).

Wiersma and Bailey (1975) have reported in soyabean that only length or breadth of the leaf can be used for rapid estimations of the leaf area. The results obtained from this study also indicated that considerable time can be saved in cashew too, by taking length alone ($A = -17.194 + 4.607\ L$) with only a 12% loss in predictive ability.

An attempt was also made to test whether there is any positional effect in determining leaf area. For this purpose, the linear regressions of the form $A_{ij} = ai + b_i P_{ij}$ were fitted, where A_{ij} and P_{ij} denote the area and product of maximum length and maximum breadth of the i^{th} leaf of the j^{th} seedling and a_i, b_i the constants associated with the i^{th} leaf equation. The numbering of the leaves in each seedling was made from top to bottom. The regression equations were tested for coincidence and found that all these equations were identical as $F = 0.45 < F_{48, 204;0.05}$. The combined equation suggested earlier *viz.*, leaf area $= 0.74 + 0.668$ P will be sufficient to estimate the area of any individual leaf over the cashew seedling. Further, as the shape of the seedling leaf was typically lanceolate with little difference within the available germplasm, the above equation would be valid irrespective of the genotype and the agro-climate.

The expontial model of the type $Y = a\ N^{b_1}\ P_{med}^{b_2}$ worked out is suitable for predicting the total leaf area of a seedling with predictive ability 86.71%. Therefore, total leaf area of any three month old cashew seedling can best be estimated using $TLA = 2.63\ N^{1.23}\ (P_{med})^{0.5567}$.

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