A note on the estimation of leaf area in coconut seedlings

BY

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INTRODUCTION

IN the course of studies on the development of coconut seedlings in relation to spacing it became necessary to estimate leaf area. In the early stages of growth of the seedling in the nursery the leaves are mostly entire with two wings on each side of the mid rib. The leaves would not have begun to split into separate leaflets, a characteristic feature of the leaves produced beyond the seedling stage.

A reference to literature showed that several methods have been devised by research workers to determine the surface area of leaves in plants. Some methods involve the reproduction of the outlines of leaves on paper by tracing, blue printing, photographing or otherwise and measuring the area with a planimeter, grid or template. At times this tracing is cut out and area computed from the relationship of weight of tracing to the weight of known area of similar paper. Leaf area has also been measured with the aid of optical comparators or with photo-electric, air flow or hydraulic planimeters.

Mathematical relationships between leaf area and one or more linear measurements has also been made use of in estimating leaf area. This method is simple, rapid, does not require any costly or sophisticated equipments and can be conveniently adopted in the field itself without removing the leaf from the plant. From the points of view of simplicity and ease of working it was finally decided to try this method in determining the leaf area of coconut seedlings. The study involved the working out of the relationship of area with length and width measurements and in the computation of a mean leaf area coefficient. The equation,

leaf area = leaf length (L) x leaf width (W) x a mean leaf area coefficient factor (F) has been used recently with success by Shekler *et al.*, (1961), Ashley *et al.*, (1963) and McKee (1964).

MATERIALS AND METHODS

To study the effect of spacing of seednuts in the nursery on the growth and development of seedlings, 100 seednuts had been sown under each of the spacing 1'x1', 2'x2' and 3'x3'. When the seedlings are a little over one year old, 10 seedlings were selected at random and one fully opened leaf from each seedling again selected at random. The outlines of the selected leaves were carefully traced on graph paper and the areas calculated by taking count of the squares enclosed within the tracing. The length and width measurements of the leaves were also taken at the positions indicated in the figure (Fig. 1). The length was measured from the base of the leaf to its tip and width as a perpendicular to this line at its widest point. The data were then analysed for each of the spacings with the following objectives.

(i) To determine the relationship between leaf area and length and width measurements separately and together as independent factors by correlation and regression analyses.

(ii) To compute a factor (F) for individual leaves by the

$$F = \frac{\text{Area}}{(\text{Length} \times \text{Width})}$$

RESULTS AND DISCUSSION

The data in respect of area and length and width of the leaves of the seedlings are furnished in Appendix. The correlation and regression coefficients and factor (F) worked out separately for each of the three spacings were not significantly different from one another and therefore only the results of analysis of the pooled data are presented and discussed here.

Factors correlated	Correlation coefficient	Regression equation
Area of leaf (A) and length of leaf (L)	0.9172**	$A = 1.32L - 10.99$
Area of leaf (A) and width of leaf (W)	0.8466**	$A = 4.91W - 23.04$
Area of leaf (A) and length (L) and width (W) as independent factors	0.9490** (R)	$A = 1.292L + 0.832W - 18.83$

**Significant at one per cent level

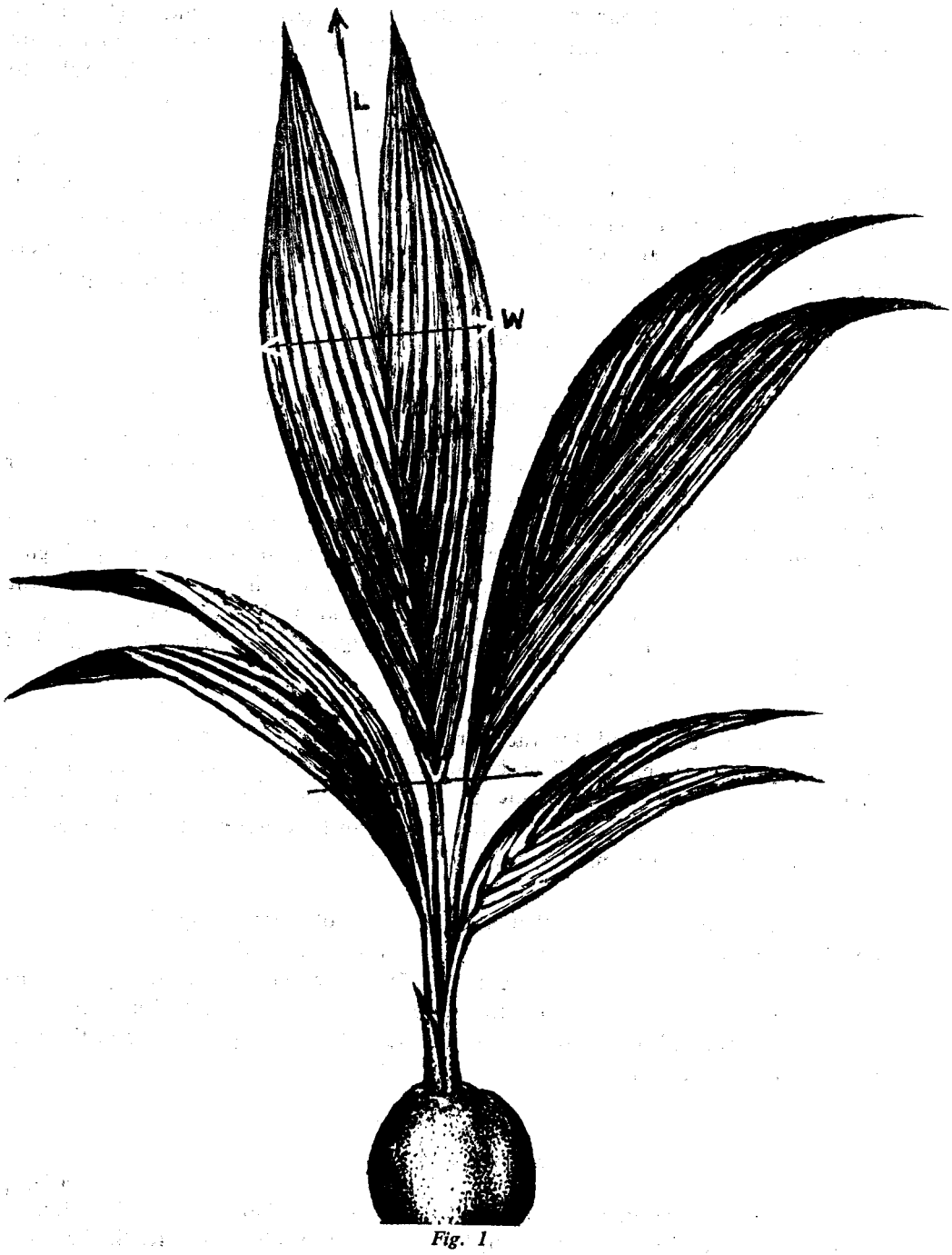

Fig. 1

Leaf of a coconut seedling showing where length (L) and width (W) measurements are taken.

It is seen that area of the leaf of the seedling is highly correlated with each of the linear measurements, length (L) and width (W) taken separately. The relationship is still closer when both measurements are taken simultaneously into consideration. Length (L) alone is able to explain 84.1 per cent of the variation in leaf area and in this respect is better than width (W) which by itself accounts only for 71.3 per cent of the variation. Both variables taken together explain 90.0 per cent. When 15.9 per cent of the variation is left unexplained when length alone is considered, only 10.0 per cent is left unexplained when both length and width are considered together. That is, adding the variable width has increased the accountable variance by 5.9 per cent or 37 per cent of the variance left unexplained by length is found to have been associated with differences in width.

The mean leaf area coefficient (F) of undifferentiated leaves of coconut seedlings worked out to 0.0878. Accurate estimates of leaf area using this factor in the equation leaf area = length (L) x width (W) x factor (F) require a high correlation between actual leaf area and length x width product. In the data under discussion the correlation between leaf area and the product of length x width was 0.9411, a very highly significant figure. This correlation coefficient is of the same order as the multiple correlation obtained when length and width are taken together as independent variables. The regression equation in this case is leaf area = .0844 x L x W + 0.96.

The areas estimated by the three methods are given along with the actual areas in Appendix. The estimated values were tested to see whether they differred significantly from the actual measurements. None of the values except one was found to be significantly different from the actual values in each of the methods used.

It may thus be seen that the method of estimating leaf area of unsplit leaves of coconut seedlings by multiplying the produt of L x W by the mean leaf area coefficient 0.0878 is equally satisfactory as the regression methods. How far this equation will be valid for leaves of different stages of development or under different growth conditions is being investigated further.

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APPENDIX

Leaf area of coconut seedlings–actual and estimated

Sl. No.	Length of leaf (L) (inches)	Width of leaf (W) (inches)	Actual leaf area measured (sq. inches)	Estimated leaf area (sq. inches)			Remarks
				Method 1	Method 2	Method 3	
1	15.0	7.0	9.16	9.2	9.8	6.3	
2	18.0	7.0	10.03	11.1	11.6	10.2	
3	19.0	8.0	12.85	13.3	13.8	12.3	
4	21.0	9.0	13.37	16.6	16.9	15.7	
5	22.0	8.0	13.98	15.5	15.8	16.2	
6	21.0	7.5	14.83	13.8	14.3	14.5	
7	22.0	9.0	17.10	17.4	17.7	17.0	
8	30.0	9.0	17.45	23.7	23.77	27.3	
9	20.0	8.0	17.63	14.0	14.4	13.6	
10	31.0	9.0	24.14	24.5	24.5	28.6	
11	27.0	11.5	24.33	27.3	27.2	25.5	
12	31.0	11.0	24.95	29.9	29.7	30.3	
13	26.0	10.0	25.22	22.8	22.9	23.0	
14	32.0	11.0	25.29	30.9	30.7	31.6	
15	27.0	9.0	25.40	21.3	21.5	23.5	
16	30.0	12.0	28.21	31.6	31.3	29.8	
17	28.0	10.0	28.73	24.6	24.6	25.6	
18	31.0	11.0	27.86	29.9	29.7	30.3	
19	32.0	12.0	30.33	33.7	33.4	32.4	
20	31.0	13.0	30.47	35.4	35.0	32.0	
21	32.0	12.0	33.47	33.7	33.4	32.4	
22	34.0	10.5	33.61	31.3	31.1	33.7	
23	36.0	11.0	34.84	34.8	34.4	36.7	
24	33.0	13.0	38.10	37.7	37.2	34.5	
25	32.0	12.0	39.93	33.7	33.4	32.4	
26	40.0	14.0	41.96	49.2	48.2	44.4	
27	36.0	11.0	41.19	34.8	34.4	36.7	
28	40.0	10.0	45.33	35.1	34.7	41.0	
29	46.0	13.0	52.58	52.5	51.4	51.3	
30	46.0	14.0	56.21	56.5	55.3	52.1	

Method 1 – $\hat{\overline{A}} = 0.0878 \times L \times W$

Method 2 – $\hat{A} = 0.0844 \times L \times W$

Method 3 – $\hat{\overline{A}} = 1.29L + 0.83W - 18.83$