Determination of Leaf Area in *Dioscorea alata* L. – A Critical Analysis

KI Asha[1], Maya C Nair[2] and Liji RS[1]
[1]*National Bureau of Plant Genetic Resources, Regional Station, Thrissur (Kerala)*
[2]*Department of Botany, Government Victoria College, Palakkad (Kerala)*

An attempt was made to compare the leaf area factor (F = 0.71) by linear measurement method reported earlier and the regression equation Y = 5.7789 + 0.77x, where 'x' = length × breadth, based on measurements made by Ravi and Chaudhary (1989) on two released varieties and 100 accessions of *D. alata* comprising 19 morphotypes collected from different agro-ecological niches in peninsular India. The results favours the use of the newly identified factor (F_1 = 0.82) and the linear regression equation Y = 100.319 + 22.79x, where x = breadth of the leaf for leaf area estimation in *D. alata* over the previous one. From the critical analysis following different means, it was found that the leaf factor for *D. alata* as 0.82 and the regression equation, Y = 100.319 + 22.79x, where x = breadth of the leaf, showed least percentage of deviation from the actual leaf area.

Key Words: *Dioscorea alata*, Leaf Factor, Morphotype, Percentage Deviation, Regression Equation

Determination of leaf area is an important aspect that matters greatly in preliminary evaluation of any crop germplasm since leaf area influences the canopy structure and, hence, photosynthetic efficiency and productivity of plants. The net dry matter produced by a plant per unit time is more dependent on the size of its total assimilatory system (Watson, 1952). Of the different means for the estimation of leaf area, linear measurement method based on the linear regression relationship between leaf length (L), leaf breadth (B) and product of length and breadth (P) with leaf area (A) has been reported as a simple and reliable method for estimation of leaf area in *Dioscorea alata* (Ravi and Chaudhary 1989). In this method leaf factor for *D. alata* has been reported as 0.71 and the regression equation as Y = 5.7789 + 0.77x, where x = length × breadth based on measurements made only in two varieties.

The present study was undertaken to critically compare the factors obtained and regression equations formulated for the estimation of leaf area based on measurements in 100 different accessions belonging to 19 different morphotypic entities of *D. alata*, with varying morphologic expressions. These morphotypic entities were grouped on the basis of subjective judgement and comparison of qualitative characters of both above ground and underground plant parts (Velayudhan *et al.*, 1991). These morphotypes are logical groups of collections in which individual collections vary very little from one another in major qualitative characters, but with considerable variation in quantitative traits.

Materials and Methods

Based on the subjective morphotypic classification of *D. alata*, 100 different accessions collected from different agro-ecological regions in peninsular India, were grown at the farm of National Bureau of Plant Genetic Resources, Regional Station, Thrissur, during the cropping season 1999-2000. Package of practices as recommended by Kerala Agricultural University, were followed.

Fully-grown and mature leaf samples at 1m height were collected from 100 accessions belonging to 19 distinct morphotypes at fourth month of crop growth. The length (L) of the leaf was measured from the leaf tip to the lamina-petiole joint and maximum width was measured across the margin for breadth (B). The actual area (A) of the leaf was measured by graphical means (Winter *et al.*, 1956).

For critical analysis following steps were computed

1. Product of length (L) and breadth (B) = P
2. Actual area of individual leaves by graphical method = A
3. Linear regression equation Y = a + bx where x = L; x = B; or x = L × B (Snedecor and Cochran, 1967)
4. Leaf factor F_1 = A/P
5. Leaf area with regression equation Y = 5.7789 + 0.77x, (Ravi and Chaudhary, 1989) where x = P
6. Leaf area as P × 0.71 (Ravi and Chaudhary, 1989; F = 0.71)
7. Leaf area as P × F_1 (present study)

The percent deviation over actual leaf area was analyzed by following means.

a. (A – (P x 0.71)/A) × 100

b. (A-(P x 0.82)/A) x 100

c. [(A-(5.7789 + 0.77 x))/A] x 100

d. [(A-(-100.319 + 22.79 x B))/A] x 100

e. [(A-(10.726 + 0.7679 x P))/A] x 100

f. [(A-(-62.896 + 13.57 x L))/A] x 100

Results and Discussion

The estimation of leaf area in 100 accessions belonging to 19 different morphotypes of *D. alata* was carried out and comparative analysis of the present results with the reported linear regression equation and leaf factor (F) (Ravi and Chaudhary 1989) showed significant variation. The calculation of actual area and leaf factor (F_1) for different morphotypes has been given in Table 1 and the average value was found to be 0.82 as against earlier reported value of 0.71 (Ravi and Chaudhary, 1989). The actual area ranges between 63.81 cm^2 and 290.26 cm^2 and a mean value of 175.829 cm^2 in contrast to leaf area of 216.684 cm^2 obtained by multiplying length and breadth.

The computation of regression equation Y = a + bx, where x = L or B or L x B and their coefficient of determination (Table 2) showed maximum r^2 value when breadth was taken into consideration. The maximum r^2 value for this regression equation using breadth as the variable was a significant deviation over the earlier suggested model (Ravi and Chaudhary 1989) using (L × B) as the variable for the leaf area estimation in this species.

The circumspection of the percentage deviation over actual leaf area using six different theoretical formulae ('a' to 'f') are given in Table 3. The minimum percent deviation from actual leaf area (-0.706%) was obtained in the theoretical formula against item 'd' using breadth as the variable in the linear regression equation. But maximum deviation (11.908%) over actual area was shown by the formula 'a' which was based on the earlier reported leaf factor, 0.71 (Ravi and Chaudhary,1989). At the same time the calculated leaf area using leaf factor F_1 (0.82) showed the least and negligible deviation from actual leaf area. The formula 'b' using F_1 showed – 1.74% deviation which is much lesser as compared to 11.908%. The negative value in percentage indicate the decrease in value over actual leaf area. Even though the deviation from actual area is lesser while using the regression equation with product of length and breadth

Table 1. Comparison of leaf measurements in morphotypes of *D. alata*

Morphotype No.	Morphotype name	No. of accessions	Length (L)	Breadth (B)	L × B	Actual area	F_1
1	Chorakkachil	18	16.75	11.553	193.512	155.172	0.80
2	Parakkachil	6	16.517	11.433	188.838	150.438	0.80
3	Rosakampankachil	4	21.25	12.825	272.531	196.353	0.70
4	Kappakkachil	1	18.80	12.400	233.12	163.400	0.70
5	Mudiyankachil	1	24.20	15.000	363.00	241.980	0.67
6	Thonielayankachil	5	15.90	11.900	189.21	183.740	0.97
7	Kuttikkachil	4	15.125	09.825	148.603	125.882	0.84
8	Muzhayankachil	1	180.40	10.500	193.2	143.300	0.74
9	Neelankachil	1	15.00	09.000	135.00	90.090	0.67
10	Neelankachil	2	17.95	11.400	204.63	154.740	0.76
11	Kaiyyankachil	5	13.62	08.680	118.221	097.608	0.82
12	Kulambukachil	9	16.944	11.156	189.027	158.506	0.82
13	Thalavannankachil	27	18.744	13.030	244.234	206.168	0.85
14	Aanikachil	4	19.575	14.700	287.752	222.410	0.77
15	Pachamullankachil	1	15.60	14.000	218.4	195.440	0.89
16	Vattayilakachil	4	16.425	14.075	231.181	220.852	0.95
17	Chuvannamullankachil	1	15.60	13.100	204.36	168.970	0.83
18	Karimpachamullankachil	4	17.20	14.575	250.69	211.225	0.84
19	Thalikayilakachil	2	18.25	13.800	251.85	213.380	0.85

Table 2. Regression Equations and their coefficient of determination

S.No.	Equations	r^2%
1	Y = -62.896 + 13.57L	48.5*
2	Y = -100.319 + 22.79B	89.2*
3	Y = 10.726 + 0.7639 x (LxB)	83.3*

* Significant at 5% level

Table 3. Percentage deviations over actual leaf area

	Range	Mean
Actual leaf area	63.81 – 290.26	175.829
A	- 15.238 – 33. 212	11.980
B	- 33.091 – 22.864	- 1.74
C	- 29.585 – 24.066	0.865
D	- 28.135 – 20.051	- 0.706
E	- 33.19 – 21.266	- 1.956
F	- 56.126 – 37.71	- 4.306

as the variable (formulas 'c' and 'e'), the percent values obtained, viz., 0.865 and-1.956 are higher than the derived by the formula 'd'. Regression equation using length as the variable was neglected because of minimum r^2 value and the percentage deviation calculated over actual area also showed much higher variation (Formula 'e',– 4.306).

The test of significance for the percent deviations using T-test revealed that the deviation 11.908% while using the leaf factor 0.71 was significant over –1.74% obtained while using 0.82, the newly identified factor for *D. alata.* Moreover, the deviations – 0.076% and – 1.956% were not significant over 0.865 obtained while using the earlier reported regression equation.

Even though several methods have been devised for estimating leaf area like destructive, non-destructive, direct and indirect methods, the most common approach is to develop ratio and regression estimators using easily measurable leaf parameters such as length and breadth (Venkateswarlu and Biradar, 1980; Birader *et al.,* 1978). From a comparative study on linear measurement and leaf dry weight methods, it has been reported that linear measurement method is practically feasible and unbiased one for the calculation of leaf area in *Dioscorea* species (Ravi and Chaudhary, 1989).

But in the present study, it has been found that the leaf factor derived for *D. alata* including variable morphological forms grown in tropical humid climate varied from the earlier reported factor (F) for this species. The discrepancy in these value may be attributed to the fact that in the earlier study, measurements were based only on two varieties, which could not account for the extreme extent of morphologic variations occurring in a collection from a wide geographical area. In the present study, the selection of wide form a broad eco-geographic area and regeneration in identical situations might have reduced this deviation.

The critical analysis of deviation over actual leaf area using different means ('a' to 'f') also offered more chances for selection of a better value for leaf factor (0.82) and the regression equation using breadth as the variable with the minimum deviation. From this critical analysis it is clear that the regression equation $Y = -100.319 + 22.79x$, where x = breadth of leaf and the leaf factor 0.82 is more accurate in determination of leaf area in *D. alata.*

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