Journal of Global Biosciences
ISSN 2320-1355
Volume 8, Number 5, 2019, pp. 6171-6177
Website: www.mutagens.co.in

Research Paper

METHOD FOR ESTIMATION OF THE LEAF AREA OF *Cordia oncocalix*, MOSSORÓ, RIO GRANDE DO NORTE, BRAZIL

Cleyton Saialy de Medeiros Cunha[1], Ana Valéria Lacerda Freitas[1], Willame da Silva Candido[1], Renan da Cruz Paulino[1], Sandra Sely Silveira Maia[2] and Maria de Fátima Barbosa Coelho[3]

[1]Bolsista PIBIC-Universidade Federal Rural do Semi Árido,
Departamento de Ciências Vegetais. Km 47 da BR110. Pres. Costa e Silva, Mossoró-RN.
[2]Pesquisadora DCR FAPERN/CNPq/Universidade Federal Rural do Semi-Árido (UFERSA),
Departamento de Ciências Vegetais, Km 47 da BR110. Pres. Costa e Silva, Mossoró-RN.
[3] Universidade Federal de Mato Grosso (UFMT),
Faculdade de Agronomia e Zootecnia (FAMEZ), Programa de Pós-Graduação em Agricultura Tropical (PPGAT),
Av. Fernando C. da Costa, nº 2367 – Cidade Universitária - 78060-900. Cuiabá – Mato Grosso, Brasil Telefone/Fax +55(65) 36158618.

Abstract

Cordia oncocalix is a tree species of the caatinga with antioxidant, anti-inflammatory, antidematogenic, antinociceptive and anticancer activity. To follow the development of nursery seedlings are important non-destructive measures of leaf area. With the objective of obtaining a mathematical equation that, through linear dimensional parameters of the leaves, that allows the estimation of the leaf area of *Cordia oncocalix*, relationships between the real leaf area (A) and dimensional parameters of the leaf limb were studied, as the length along the main vein (C) and the maximum width (L) perpendicular to the main vein, in 200 leaf limbs. Statistical models were used: linear $Y = a + bx$; geometric $Y = ax^b$ and exponential $Y = ab^x$. From the practical point of view, it is suggested to choose the simple linear model, involving the product C x L, with linear coefficient equal to 0.71 since it does not change the sum of squares of the residue and presents satisfactory residue analysis. The leaf area can be estimated using the regression equation Af = 0.71 (C x L), which is equivalent to taking 61% of the product between the length along the main vein and the maximum width, with a coefficient of determination of 0.9872.

Key words: Boraginaceae, statistical models, linear regression.

INTRODUCTION

Cordia oncocalix (Allemão) Taub.- Boraginaceae, popularly known as white wood, is a small tree that occurs in the state of Ceará and Rio Grande do Norte, Brazil, endemic to the caatinga region [1] . Wood is widely used in construction, carpentry and joinery, because it is heavy, of good quality, resistant to attack by fungi and termites. The tree, for the beauty of its flowers, white and dense terminal panicles, is used in landscaping, in the ornamentation of squares and avenues [2].

A species of importance in popular medicine, *A. oncolalix*, presents astringent shells used in baths in wound and cut treatments [3], and can also be used in the treatment of ectoparasitoses in domestic animals (mites and ticks) according to [2]. Flowers are rich in allantoin and can be used in ointments or as tincture and baking for local treatment of wounds, ulcers and burns [4].

There is a need for basic studies involving aspects related to the propagation, growth and development of the species and knowledge of the leaf area is fundamental. This is one of the most difficult characteristics to measure because it usually requires expensive equipment or destructive techniques [5].

Methods to measure leaf area accurately are classified as destructive and non-destructive, direct or indirect [6]. The importance of using a non-destructive method allows to follow the growth and the foliar expansion of the same plant until the end of the cycle, besides being fast and precise. Thus, the leaf area can be estimated, using dimensional parameters of leaves, which have good correlations with the leaf surface. One of the most used non-destructive methods is the estimation of leaf area through regression equations between the actual leaf area and linear dimensional parameters of the leaves. This method has already been successfully used for other species in the caatinga [7].

In view of the above, this study aimed to describe for each equation through parameters lineares dimensionais of the allowance of the foliar of *Cordia oncocalix*.

MATERIALS AND METHODS

The work was carried out at the Federal University of the Semi-Arid (UFERSA) campus, located at the geographical coordinates of 5º11'31" S and 37º20'40" W, with an average elevation of 18 m. The climate of the region, in the Köeppen classification, is BSwh 'type (hot and dry), with fairly irregular rainfall, annual average of 673.9 mm; temperature of 27 °C and relative humidity of 68.9% [8].

Seedlings measuring 3 to 5cm in height were transferred to bags of 20x30cm filled with sand and composed of earthworm. These seedlings were obtained from germinated seeds in the crown area of the trees located in the Center for the Study of Wild Animals at UFERSA. The seedlings were kept in the home for five months, when 200 leaves were collected, numbered from 1 to 200 and taken to the laboratory for linear determination of length (C) and width (L) and leaf area (A) dimensions. The length was defined as the distance between the insertion point of the petiole in the leaf blade and the opposite end of the leaf and the width as the largest dimension perpendicular to the axis of the length. These measurements were obtained with a digital caliper.

Leaf area (AF) was calculated as the product of the two dimensions, length (C) and width (L), according to the model expressed in table 1. The area of the sampled leaves was determined, through a model leaf area integrator Liquor LI 3100.

Nine theoretical models were idealized using the measures (C and L) obtained and using linear, quadratic and potential models. For each model, the coefficients that best fit the equation and the determination coefficients (R^2) were calculated. The best equations were chosen by objective criteria, such as the highest determination coefficient and the lowest standard error. It was also considered the easiness to obtain the measures.

RESULTS AND DISCUSSION

The leaf limbs of *Cordia oncocalix* had an average length of 14.76 cm, width of 9.8 cm and leaf area of 83.15 cm^2 (Table 1).

Table 1. Maximum, minimum, mean values and standard deviation of the length along the central rib, width and leaf area of 200 leaves of *Cordia oncocalix*. UFERSA, Mossoró, State of Rio Grande do Norte, Brazil. 2016.

Characteristic	Higher value	Lower value	Mean value
Lenght (cm)	18.9	10.5	14.76 ± 1.95
Maximum width (cm)	13.6	7.2	9.8 ± 1.45
Leaf area (cm^2)	155.4	47.8	83.15 ± 15.80

The leaf sample characterization of the actual and estimated leaf area is shown in Table 2. The estimated mean leaf area ranged from 5.7 to 121.9 cm^2. We can observe in this table that the averages of the estimated areas are similar or very close to the real areas when the equations are linear, indicating that these proposed regression equations are excellent leaf area estimators for *C. oncocalix*.

All the equations presented allowed to obtain satisfactory estimates of the *Cordia oncocalix* leaf area, with determination coefficients above 0.70, indicating that 70% of the observed variations in leaf area were explained by equations obtained.

Table 2. Characterization of the sample, size, minimum, maximum, mean and confidence interval for average of the real (Af) and estimated area of leaves of *Cordia oncocalix*. UFERSA, Mossoro, State of Rio Grande do Norte, Brazil. 2016.

Equations	Actual leaf area				Estimated leaf area			
	max	m	min	IC 95%	max	m	min	IC 95%
A= – 31.28 + 8.28C	155.5	83.1	47.8	0.67	124.0	88.1	49.9	0.578
A= – 47.58 + 15.11L	155.5	83.1	47.8	0.68	128.0	87.1	42.9	0.587
A= 1.36 + 0.71CL	155.5	83.1	47.8	0.44	139.8	76.2	43.8	0.545
A = 0.7103 CL	155.5	83.1	47.8	0.66	141.9	86.9	42.8	0.667
$A= 0.30C^{1.41}$	155.5	83.1	47.8	0.69	19.4	10.3	9.1	0.398
$A= 0.38L^{1.63}$	155.5	83.1	47.8	0.69	19.1	13.3	7.9	0.635
$A=5.0 \times 1.21^{C}$	155.5	83.1	47.8	0.64	133.9	72.8	35.5	0.447
$A=1.09 \times 0.094^{L}$	155.5	83.15	47.8	0.69	29.6	26.8	23.6	0.791

The results of the regression analysis relating the actual leaf area (A) and the linear measures of length (C), width (L) and product of length by leaf width (C x L), are presented in Table 3.

Table 3. Estimated equations and determination coefficients as a function of linear measurements of the leaf are of *Cordia oncocalix*. UFERSA, Mossoro, State of Rio Grande do Norte, Brazil. 2016.

Linear measurements	Types of equation	Determination coefficient (R^2)	Estimated equation
C	linear	0.78	A= – 42.28 + 9.18 C
L	linear	0.98	A= – 57.59 + 17.31 L
CL	linear	0.88	A= 1.76 + 0.83 CL
CL	linear	0.99	A = 0.81 CL
C	geometric	0.79	$A= 0.40\ C^{1.41}$
L	geometric	0.89	$A= 0.48\ L^{1.63}$
C	geometric	0.97	$A=6.0 \times 1.81^{C}$
L	geometric	0.88	$A=2.09 \times 0.09^{L}$

The value of R^2 ranged from 0.78 to 0.99, with the lowest value corresponding to the linear and geometric models in which the leaf length was used as the basis for calculating the individual leaf area of *Cordia oncocalix* leaves, while the largest value of R^2 was obtained with the product data of length by leaf width (0.99), multiplied by the adjustment factor (Table 3).

There was little dispersion of the data in relation to the line obtained, suggesting that the equation A = 0.7103CL can represent the actual leaf area satisfactorily (Figure 1), which from the practical point of view would be the most recommendable. Similar models were obtained to estimate the leaf area of *Manihot pseudoglaziovvi* and *Manihot piauhyensis* (Af = 0.53CL) by [10], *Ageratum conyzoides* (Af = 0.6789 CL) by [8]., *Ziziphus joazeiro* (Af = 0.931CL) by [11] and *Combretum leprosum* (Af = 0.6131CL) by [12].

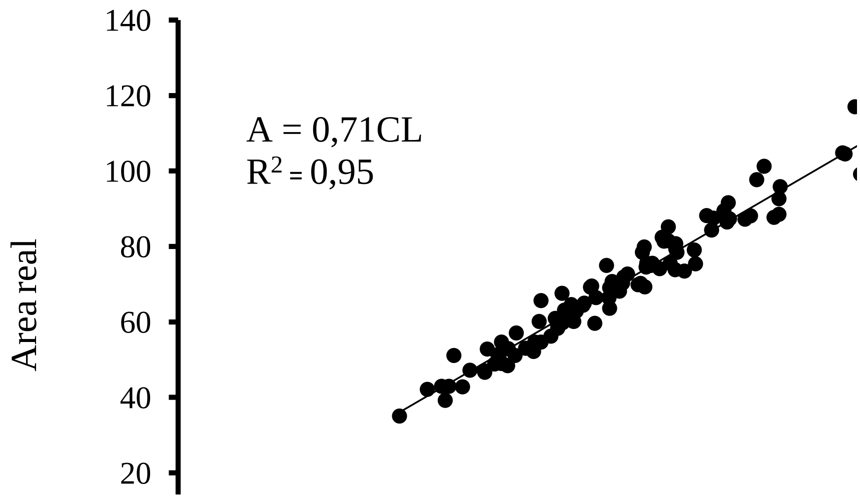

Figure 1. Relationship between real leaf area of *Cordia oncocalix* of the regression equation indicated for leaf area estimation, as a function of the product of length (C) by the maximum width (L) of the leaf area.

It was verified that, in the forest species of the caatinga *Amburana cearensis*, *Caesalpinia ferrea*, *Caesalpinia pyramidalis*, *Schinopsis brasiliensis* and *Tabebuia aurea*, linear and potential regressions show that there is a close correlation between the leaf area and the linear dimensions of leaflets of all species studied [13]. The use of linear dimensions, length and width, provided an also satisfactory estimate for the acerola tree (R^2 = 0.91), as verified by [14].

In the present study it was verified that linear equations using only length (C) or width (L) measurements can be used to estimate the area of leaves of *Cordia oncocalix*. The leaf area estimates of *Cordia oncocalix* plants are more accurate when both limbo length and width dimensions are used. The equation C x L x 0.71 was the one that provided greater precision to the estimates, besides simplifying the calculations.

REFERENCES

[1] MAIA, G.N. **Caatinga**: árvores e arbustos e suas utilidades.1ªed. Leitura & Arte Editora. São Paulo, 413p.

[2] COSTA, J.G.M.; PESSOA, O.D.L.; MONTE, F.J.Q. Benzoquinonas, hidroquinonas e sesquiterpenos de *Auxemma glazioviana*. **Química Nova**, 28(4):591-595, 2005.

[3] BRAGA, R. **Plantas do Nordeste Especialmente do Ceará**, Coleção Mossoroense, 3ª ed., RN, 1976, p. 395

[4] PESSOA O.D.L.; LEMOS, T.L.G. Allantoin and fatty acid composition in *Auxemma oncocalyx*. **Revista Brasileira de Farmácia**, 78:9-10, 1997.

[5] TAIZ, L.; ZEIGER, E.; MOELLER, I.M.; MURPHY, A. **Fisiologia e Desenvolvimento Vegetal**. São Paulo:Artmed, 6ª Ed. 2017, 888p.

[6] MARSHALL, J.K. Methods of leaf area measurement of large and small leaf samples. **Photosynthetica**, 21: 41-47, 1968.

[7] LIMA, C. J. G.S.; OLIVEIRA, F.A.; MEDEIROS, J.F.; OLIVEIRA, M.K.T.; OLIVEIRA FILHO, A.F. Modelos matemáticos para estimativa de área foliar de feijão caupi. **Caatinga**, 2(11):120-127, 2008.

[8] CARMO FILHO, F.; OLIVEIRA, O.F. **Mossoró**: um município do semi-árido nordestino, caracterização climática e aspecto florístico. Mossoró: ESAM, (Coleção Mossoroense, série B).1995. 62p.

[9] PINTO, M.S.C.; ANDRADE, A.P.; PEREIRA, W.E.; ARRUDA, F.P.; ANDRADE, M.V.M. Mo+delo para estimativa da área foliar da maniçoba. **Revista Ciência Agronômica**, 38(4):391-395, 2007.

[10] BIANCO, S.; BIANCO, M.S.; CARVALHO, L.B. Estimativa da área foliar de *Ageratum conyzoides* usando dimensões lineares do limbo foliar. **Acta Scientiarum Agronomy**, 30(4):519-523, 2008.

[11] MARACAJÁ, P. B. *MADALENA, J.A.S.; ARAÚJO, E.; LIMA, B.G.; LINHARES, P.C.F.* Estimativa de área foliar de juazeiro por dimensões lineares do limbo foliar. **Revista Verde de Agroecologia,** v. 3, n. 4, p. 1-5, 2008.

[12] CANDIDO, W.S; COELHO, MFB.; MAIA, S.S.S.; CUNHA, C.S.M.; SILVA, R.C.P. Modelo para estimar a área foliar de *Combretum leprosum* Mart. **Acta Agronomica**, 62(1):37-41, 2013,

[13] SOUZA NETO, A.G. **Avaliação da área foliar de cinco espécies florestais ocorrentes no semiárido paraibano**. 2009. Monografia (Graduação) Curso de Engenharia Florestal. CSTR/UFCG, Patos - PB, 2009.

[14] LUCENA, R.F.M.; BATISTA, T.M.V.; DOMBROSKI, J.L.D.; LOPES, W.A.R.; RODRIGUES, G.S.O. Medição de área foliar de aceroleira. **Revista Caatinga**, 24(2):40-45, 2011.