J. Phytol. Res. 8 (2): 123-128, 1995

AN ALTERNATIVE METHOD OF LEAF AREA MEASUREMENTS IN SOME DESERT PLANTS

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Leaf breadth has maximum relation with area in *Aerva persica, Bougainvillia spectabilis, Heliotropium subulatum, Lantana camara, Salvadora oleoides, Salvadora persica* and *Ziziphus mauritiana.* Whereas in *Cordia gharaf, Pulicaria crispa* and *Vernonia cinerea,* length has maximum relation with area. Based on the r-value, the best fitting regression equations are selected. The instantaneous and/or the integrated models developed can be used for the measurement of leaf area.

Keywords: Desert plants; Leaf area.

Introduction

Leaf area measurements are required for the assessment of photosynthetic activity and transpiration regulations, the important phenomena for productivity and water use efficiency studies. Leaf area can be measured using graph paper or leaf area meter. The former is a cumbersome, time consuming and a method with a low precision. Whereas the later is expensive and unafordable in Indian scenario. An alternative and indirect way of measuring leaf area is by using suitable regressions between leaf length, breadth, dry weight and area. The developed regression equations are used for leaf area measurements in pearl millet crop[1], *Artocarpus chaplasha*[2], *Anthocephalus cadamba, Duabanga sonneratioides, Dillenia pentagyna*[3]. In the present study, both instantaneous and integrated models are developed for the leaf area measurement of ten desert plants viz., *Aerva persica* (Burm.f.) Merrill, *Bougainvillea spectabillis* Willd. (var. local), *Cordia gharaf* (Forsk.) Ehrenb & Aschers, *Heliotropium subulatum* Hochst. ex DC., *Lantana camara* L., *Pulicaria crispa* (Cass.) Benth & Hook F., *Salvadora oleoides* Decne., *Salvadora persica* Linn., *Vernonia cinerea* (Linn.) Less. and *Ziziphus mauritiana* Lamk.

Instantaneous regressions between leaf length, breadth and dry weight with area are developed individually. In addition integrated regression analysis is done in order to understand the contribution of each factor to leaf area.

Materials and Methods

Matured leaves of hundred for each species are random sampled during September-November 1994. Leaf length and breadth(maximum value) are measured using graph paper. Area is meaured using Systonic's leaf area meter-211. Leaf dried at 80°C for 36 hours and the weight thus obtained, is considered as dry weight. Instantaneous regressions between length and area, breadth and area, dry weight and area are developed.

Integrated regression model considering leaf length, breadth and dry weight as independent variables of leaf area is developed using stepwise regression procedure so as to understand the contribution of the variables to the variation of leaf area[4].

Results and Discussion

Leaf area index (LAI) is the ratio between total leaf area and ground surface. LAI is maximum in the tropical forest and minimum

Table 1. Central tendency values of leaf length (cm), breadth (cm), dry weight (g) and area (cm^2) of some desert plants.

Species	Range/ Mean±SD	Length	Breadth	Dry weight	Area
Aerva	Range	5.2-9.3	0.7-3-2.3	0.045-0.96	2.3-18.7
persica	Mean±SD	7.273±	1.575±	9.185 E-2±	7.916±
		0.827	0.324	9.012 E-2	2.555
Bougainvillea	Range	5.2-10	4.3-8.3	0.066-0.9	11.7-47.3
spectabillis	Mean±SD	6.917±	5.828±	0.150±	24.572±
		1.132	0.817	9.78 E-2	7.779
Cordia	Range	6.4-13.6	3.0-6.3	0.044-0.37	9.5-54.2
gharaf	Mean±SD	9.765±	4.359±	*0.152±*	*25.829±*
		1.4927	0.7151	*7.023 E-2*	*9.603*
Heliotropium	Range	1.6-5.7	1.0-2.1	0.018-0.058	1.8-6.6
Subulatum	Mean±SD	4.446±	1.475±	3.334 E-2	3.906±
		0.6017	0.2745	9.711 E-3	1.0303
Lantana	Range	4.1-8.0	3.0-6.8	0.03-0.63	6.4-27.6
camara	Mean±SD	6.1666±	4.601±	0.105±	17.8802±
		0.8515	0.6369	6.817 E-2	4.8459
Pulicaria	Range	2.4-4.7	0.7-1.9	0.007-0.032	0.60-4.5
crispa	Mean±SD	3.3383±	1.0697±	1.325 E-2 ±	2.056 ±
		0.6384	0.2153	4.883 E-3	0.8092
Salvadora	Range	5.0-11.1	0.7-2.0	0.034-0.245	2.7-12.9
oleoides	Mean±SD	8.455±	1.369±	0.122±	7.449±
		1.0992	0.2356	3.774 E-2	2.4781
S. persica	Range	4.2-8.1	1.5-3.4	0.058-0.196	4.1-15.4
	Mean±SD	5.777±	2.428±	0.122±	9.7629±
		0.7787	0.3572	3.103 E-2	2.2686
Vernonia	Range	3.9-7.9	2.8-5.9	8.99E-3-0.046	7.7-30.7
cinerea	Mean±SD	5.558±	4.136±	0.022±	15.732
		0.9201	0.7349	9.082 E-3	5.3256
Ziziphus	Range	3.1-7.8	2.8-5.6	0.03-0.209	4.2-27.2
mauritiana	Mean±SD	5.8219±	4.234±	9.798 E-2 ±	14.704±
		1.1849	0.7036	4.031 E-2	5.8112

E= To the power ten

Table 2. The selected instantaneous regression models for estimating leaf area (Y) of some desert plants.

Species	Parameter (X)	Equation fitted
Aerva persica	Length	Y= -4.4175 + 1.69579 x (r = 0.549)
	Breadth	Y= 2.16873 e 0.788272 x (r = 0.766)
	Dry weight	Y= 25.00598 ^ 0.48147x(r=0.527).
Bougainvillea spectabillis	Length	Y= -19.68598 + 6.39843 x (r = 0.931)
	Breadth	Y= -28.6767 + 9.13671 x (r = 0.960)
	Dry weight	Y= 2.67728 + 185.5757 x -188.1934 x^2 (R^2=0.813)
Cordia gharaf	Length	Y= -31.33907 + 5.8606 x (r = 0.911)
	Breadth	Y= -26.09392 + 11.91189 x (r = 0.887)
	Dry weight	Y= 8.80713 + 111.9189 x (r = 0.819)
Heliotropium subulatum	Length	Y= 9.64476 E-2 + 0.85677 x (r = 0.50)
	Breadth	Y= 0.074302 + 2.596469 x (r = 0.692)
	Dry weight	Y= 2.15432 + 52.53626 x (r = 0.495)
Lantana camara	Length	Y= -11.19186 + 4.71426 x (r = 0.828)
	Breadth	Y= 1.14292 ^ 1.7867 x (r = 0.851)
	Dry weight	Y= 42.7028 ^ 0.38605 x (r = 0.566)
Pulicaria crispa	Length	Y= -1.51521 + 1.06991 x (r = 0.844)
	Breadth	Y= -1.32792 + 3.1639 x (r = 0.842)
	Dry weight	Y= 10.9622 + 2.03247 log x (r = 0.835)
Salvadora oleoides	Length	Y= -6.812256 + 1.686724 x (r = 0.748)
	Breadth	Y= -3.702656 + 8.145841 x (r = 0.775)
	Dry weight	Y= 2.331754 + 41.86913 x (r = 0.638)
S. persica	Length	Y= -15.82405 + 14.6609 log x (r = 0.84)
	Breadth	Y= -3.6125 + 5.50886 x (r = 0.867)
	Dry weight	Y= 1.91607+64.0304 x (r = 0.876)
Vernonia cinerea	Length	Y= -15.17024 + 5.55995 x (r = 0.961)
	Breadth	Y= -13.03089 + 6.95427 x (r = 0.960)
	Dry weight	Y= 3.183887 + 571.4076 x (r = 0.975)
Ziziphus mauritiana	Length	Y= 1.768495 e 0.348913 x (r = 0.960)
	Breadth	Y= -18.9467 + 7.947753 x (r = 0.962)
	Dry weight	Y= 1.57851 + 133.9473 x (r = 0.929)

e = to the exponential; ^ = to the power; E = to the power ten.

Table 3. Percent variation explained and standardized coefficient for leaf length, breadth and dry weight for the area measurement of some desert plants in the integrated models.

Species	% Variation Explained	S.D of the residuals	Standardized b Coefficient for		
			Length	Breadth	Dry weight
Aerva persica	65.4662	1.53217	0.37278	0.62019	-3.7052 E-2
Bougainvillea spectabillis	94.7295	1.82279	0.361039	0.63664	0.01688
Cordia gharaf	92.2619	2.72634	0.50397	0.39889	0.13395
Heliotropium subulatum	56.36317	0.69479	0.30819	0.59177	-1.35395 E-2
Lantana camara	80.413	2.19079	0.49897	0.44585	9.46372 E-2
Pulicaria crispa	87.0107	0.29771	0.42209	0.44834	0.16586
Salvadora oleoides	63.829	1.52113	0.34332	0.49236	-4.34205 E-3
S. persica	90.3425	0.71955	0.39707	0.46463	0.19505
Vernonia cinerea	97.9806	0.7724	0.20374	0.32714	0.48242
Ziziphus mauritiana	97.5755	0.92349	0.35167	0.38938	0.28876

Table 4. Integrated regression models for computing leaf area (Y) using leaflenght (X_1), breadth (X_2) and dry weight (X_3) of some desert plants.

Species	Equation Fitted
Aerva persica	$Y = -8.0716 + 1.521\ X_1 + 4.8917\ X_2 - 1.0492\ X_3$
Bougainvillea spectabillis	$Y = -28.1069 + 2.481\ X_1 + 6.0596\ X_2 + 1.3426\ X_3$
Cordia gharaf	$Y = -31.9645 + 3.2422\ X_1 + 5.3563\ X_2 + 18.3167\ X_3$
Heliotropium subulatum	$Y = -1.6699 + 0.5277\ X_1 + 2.2209\ X_2 - 1.4365\ X_3$
Lantana camara	$Y = -15.946 + 2.8395\ X_1 + 3.3919\ X_2 + 6.7272\ X_3$
Pulicaria crispa	$Y = -1.8961 + 0.5349\ X_1 + 1.685\ X_2 + 27.4847\ X_3$
Salvadora oleoides	$Y = -6.1483 + 0.774\ X_1 + 5.1773\ X_2 - 0.285\ X_3$
S. persica	$Y = -5.8315 + 1.1568\ X_1 + 2.9506\ X_2 + 14.2584\ X_3$
Vernonia cinerea	$Y = -6.8393 + 1.1792\ X_1 + 2.3706\ X_2 + 282.8691\ X_3$
Ziziphus mauritiana	$Y = -13.0327 + 1.7246\ X_1 + 3.216\ X_2 - 41.6245\ X_3$

in the desert. LAI has direct correlation with biomass, productivity and canopy reflectance. Leaf area measurement is an integral parameter in productivity and adaptive biology studies. And thus, an attempt is made to develope regression equations for the measurements of leaf area.

Among the plants studied *Cordia gharaf* exhibited maximum leaf length (13.6 cm) and area (54.2 cm^2), *Lantana camara* maximum breadth (6.8 cm) and *Aerva persica* maximum dry weight (0.96 g) per leaf (Table 1). Correlation coefficients viz., linear, exponential, logarithmic, power and fitness of equation of parabola computed reveals that breadth has maximum relation with area in *Aerva persica, Bougainvillia spectabillis, Heliotropium subulatum, Lantana camara, Salvadora oleoides, S. persica* and *Ziziphus mauritiana*. Whereas in *Cordia gharaf, Pulicaria crispa* and *Vernonia cinerea*,length has maximum relation with area. The instantaneous regression models viz., linear, exponential, logarithmic power and parabola for length with area, breadth with area, and dry weight with area are developed and based on the r-value, the best fitting equations are selected (Table 2).

The integrated regression anaylsis considering leaf length, breadth and dry weight as a function of leaf area variation revealed that higher (98%) percent variation explained in *Ziziphus mauritiana* and *Vernonia cinerea.* Whereas in *Heliotropium subulatum* percent variation explained is low (56%). The lower values of residuals illustrate the best fitness of equations (Table 3). The instantaneous regression models (Table 2) and/or the finally developed integrated regression models (Table 4) can be used for the measurement of leaf area.

Acknowledgements

We are grateful to the Professor and Head, Department of Botany for facilities and to Dr. S.P. Bohra for making the leaf area meter available. Financial assistance from DBT, New Delhi is gratefully acknowledged.

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