ESTIMATION OF *Leucaena leucocephala* LEAF AREA BASED ON ITS DRY MATTER

P. P. del Pozo✉ and A. Alvarez

ABSTRACT. With the objective of estimating the leaf area of *Leucaena leucocephala* cv. Ipil ipil from foliar dry matter, simple linear regressions were conducted between the actual foliar area (FA) measured by an electronic planimeter and the foliar dry matter variable (FDM). A split plot random block with four replications was used. Fertilization levels were the main plots and regrowth ages (from the third to the twelfth week) the subplots. Ten plants were selected at random in each replication per treatment to measure leaf area and its dry matter. During the dry period (January-March) each sample was composed of the foliar matter from each plant while in the rainy season (July-October) up to 30 representative leaves of the strata were collected within each plant. In both periods of the year, leaf area was linearly related ($p<0.001$) with its dry matter, but with different coefficients of determination. The regressions of fertilization levels did not improve adjustments and the parameters were not significant ($p>0.05$), which means that the initial grouping of data to estimate the models per season was valid. Results indicate that the equations FA=16256.9 +8132.63(±636.50)FDM and FA=6558.49 + 15455.1(±496.3) FDM can be used for the estimation of leaf area of Leucaena based on the values of dry matter of leaves under similar conditions to those studied here.

RESUMEN. Con el objetivo de obtener expresiones que permitan estimar el área de la hoja de la *Leucaena leucocephala* cv. Ipil ipil a partir de la masa seca foliar, se realizaron regresiones lineales simples entre el área real (AF) medida en un planímetro electrónico y la variable masa seca foliar (MSF). Se utilizó un diseño de parcela dividida con cuatro repeticiones. La parcela principal fue el nivel de fertilización y las subparcelas las edades de rebrotes (desde la tercera hasta la duodécima semana). Se seleccionaron 10 plantas al azar en cada réplica por tratamiento para medir el área de las hojas y su masa seca. Durante el período seco (enero-marzo) cada muestra estuvo compuesta de la masa foliar de cada planta, mientras que en la estación lluviosa (julio-octubre) se cosecharon hasta 30 hojas representativas de los estratos dentro de cada planta. En ambas épocas del año, el área de las hojas se relacionó linealmente ($p<0.001$) con la masa seca foliar, pero con coeficientes de determinación diferentes. Las regresiones por niveles de fertilización no mejoraron los ajustes y los parámetros de las expresiones no presentaron deferencias ($p>0.05$), lo cual nos indica que el agrupamiento inicial de los datos para la estimación de los modelos por época fue válido. Los resultados indican que las ecuaciones AF=16256.9+8132.63 (±636.50)MSF y AF=6558.49 + 15455.1(±496.3)MSF pueden ser utilizadas para la estimación del área foliar de la *Leucaena* a partir de los valores de masa seca de sus hojas en condiciones semejantes a las estudiadas.

Key words: *Leucaena leucocephala*, leaf area, statistical methods

Palabras clave: *Leucaena leucocephala*, área foliar, métodos estadísticos

INTRODUCTION

The estimation of leaf area of the arboreal plants in the silvopastoril systems is an essential morphostructural variable for the analysis and interpretation of the changes that take place in the herbaceous strata due to shade effects (1, 2, 3).

The estimation of leaf area of leucaena is extremely difficult due to its morphological characteristics (4), which are conformed of four to nine 10-cm-long pinnas in pairs with a number of variable leaflets depending on its growth state (5). Generally, electronic meters are used, requiring great care and especialized personnel and equipment. This has limited their inclusion as variables in the morphological and agronomic studies for this species.

The utilization of models for the estimation of leaf area from the linear measurement of leaves has demonstrated to be a useful method in those plants whose geometric form allows a high relationship between variables (6, 7).

On the other hand, the use of dry matter as independent variable was more limited, due to the different results obtained with the species where adjustments were made (8, 9, 10). Nevertheless, this can be an applicable method under field conditions, where the models have a high prediction capacity.

The objective of the present study is to estimate the leaf area of Leucaena based on its dry matter.

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MATERIALS AND METHODS

The study was developed in a sowing area with 20 x 50 cm between plants and rows of *Leucaena leucocephala* cv. Ipil ipil, in a red typical Ferralitic soil (11), managed to be cut in the rainy and dry seasons with and without the application of P and K ranging from 60 to 80 kg per hectare P_2O_5 and K_2O as a single application.

Treatment and design. A split plot random block with four replications was used. Fertilization levels were the main plots whereas regrowth ages (from the third to the twelfth week) the subplots. Plots were 6 m^2 with a harvestable area of 3 m^2.

Procedure. Ten plants were selected at random in each replication per treatment to measure leaf area and its dry matter. During the dry period (January-March) each sample was composed of the foliar matter from each plant while in the rainy season (July-October) up to 30 representative leaves of the strata were collected within each plant.

Each leaf area was measured by an electronic TMK-2 equipment with 1 % accuracy. Later, all the leaves were dried in an oven at 60°C up to its constant weight. The extreme values and means of each measurement and the conditions studied are shown in Table I.

Table I. Extreme values and means of leaf area (mm^2) and dry matter (g) of *Leucaena leucocephala* for both periods of the year

Season	Measurements	Values Minimum	Mean	Maximum
Dry	Area	9454	61157.9	179691
	Dry matter	0.61	3.53	10.7
Rainy	Area	19714	33938	51903
	Dry matter	0.81	2.17	3.94

The values of leaf area (dependent variable) and its dry matter (independent variable) were plotted this time of the year as initial element for model selection representing its distribution.

The Statgraphics Version 2.1 (1994) was used to estimate the indicators of regression models. Results are presented per season for total data and fertilization conditions.

RESULTS AND DISCUSSION

In Figure 1 the values of leaf area are shown according to its dry matter in both seasons of the year. They are expressed according to their relationship (Table II). The dry season showed the best adjustment (R^2 0.95).

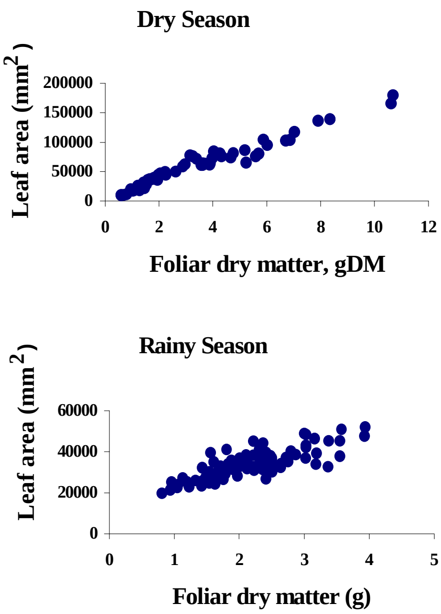


Figure I. Relationships of the Leucaena leaf area (mm^2) and its dry matter (g) in both seasons

Table II. Regression equations relating leaf area with its dry matter in both periods and experimental conditions

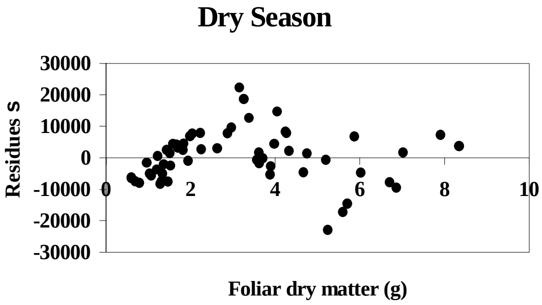
Season	Equations	R^2	Significance
Rainy	FA=16256.9+8132.63 (±636.54)FDM	0.70	***
Dry	FA=6558.49+15455.1 (±496.30)FDM	0.95	***

*** p < 0.001

The lowest value of the coefficient of determination in the rainy season could be accounted for by the variability showed in the dry matter of leaves through the growth period during this season of the year. This was probably related to the highest variation of the physiological ages of the vegetative material within the same chronological age in the plant, independent of the climatic changes.

On the other hand, as leaf area measured by the planimeter was carried out with fresh samples, a certain loss of humidity could occur by handling the samples, that can increase the variability of measurements. Nevertheless, residues show homogeneity (Figure 2).

The adjustments of functions did not improve and indicators of expressions were not different (p>0.05), when fertilization levels in both seasons were applied (Table III). A similar behavior according to season was observed, which indicates that the initial grouping of data for the estimation of models per season was valid.



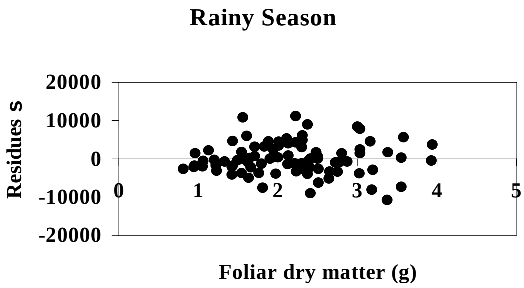


Figure II. Distribution of leaf area residues according to the dry matter of the total *Leucaena leucocephala* leaves in both seasons

Table III. Regression equations relating leaf area with its dry matter in both seasons and experimental conditions

Season	Equations	R^2	Significance
Rainy	(1) FA=17110.3+8287.9 (896.01) FDM	0.70	***
	(2) FA=13273.5+8038.5 (853.52) FDM	0.72	***
Dry	(1) FA=3260.7+13842 (496.3) FDM	0.97	***
	(2) FA=8964.9+14932 (810.3) FDM	0.92	***

*** P<0.001
(1) fertilized with 50 kg P_2O_5 and 100 kg K_2O/ha
(2) nonfertilized

In both cases, the values of specific foliar area (mm^2/gDM) in the dry season showed the highest values. This can be considered a physiological response compensating the low values of the net photosynthesis. This latter was related to a reduction in the number of leaves (12) and to a poor lighting, which is common in this season of the year. Under these conditions, plants develop thinner leaves with wider foliar area, so as to increase the intersection capacity of light and in turn reduce the respiration rate (1, 13, 14).

That is probably one of the reasons which explains the highest values in the specific foliar area of Leucaena under these conditions.

Results indicate that the equations FA = 16256.9+ 8132.63(±636.54) FDM and FA=6558.49 + 15455.1 (±496.3) FDM are valid for the estimation of leaf area of Leucaena based on dry matter values. This allows the estimation of leaf area, for ecophysiological and bioproductivity studies under similar conditions to those studied here for this species.

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