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Estimative of Black Pepper leaf area with basis on the leaf blade linear dimension

Estimativa da área foliar de pimenta do reino a partir de dimensões lineares do limbo foliar

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- NOTA -

ABSTRACT

*This research was aimed at establishing regression equations to estimate black pepper (**Piper nigrum**) leaf area based on linear leaf measures. Different black pepper varieties where growth on the field, four different size leaves were collected per plant with a total of 52 leaves to establish the regression equation and 28 to validate the equation for each variety (Bragantina, Laçará, Guajarina e Cingapura). Leaf midrib length (LML), maximum leaf broad width (MLBW) and leaf area (LA) were measured. Pearson's linear correlation coefficients were determined between observed and predicted measures with the observed LA, besides estimating the linear regression equation for each variety. The equations best-fitted to estimate LA based on circumscript rectangle were: 1) LA = 2.2689 + 0.6900 x LML x MLBW; 2) LA = 1.6402 + 0.6816 x LML x MLBW; 3) LA = 1.4942 + 0.6215 x LML x MLBW and 4) LA = 0.7467 + 0.6735 x LML x MLBW, for Bragantina, Laçará, Guajarina and Cingapura varieties respectively. For all equations predicted values had high correlation coefficient with observed values thus showing that these equations must be variety specific and that they are appropriate for black pepper leaf area estimative.*

Key words: ***Piper nigrum***, *morphologic characters, leaf length and width, circumscript rectangle*.

RESUMO

*O objetivo deste trabalho foi estabelecer equações de regressão para estimar a área foliar de diferentes variedades de pimenta-do-reino (**Piper nigrum**) cultivadas no campo, a partir de medidas lineares de folhas. Foram coletadas quatro folhas por planta, de tamanhos diferentes, totalizando 52 folhas, para estabelecer a equação de regressão e 28 para validar a equação para cada variedade (Bragantina, Laçará, Guajarina e Cingapura). Procederam-se às medições do comprimento da nervura central (LML), da maior largura do limbo foliar (MLBW) e da área foliar (LA). Determinaram-se os coeficientes de correlação linear de Pearson entre as medidas mensuráveis e preditas com a LA observada, além de estimarem-se as equações de regressão linear para cada variedade. As equações que melhor se ajustaram para estimar LA com base no retângulo circunscrito foram: LA = 2.2689 + 0.6900 x LML x MLBW, para Bragantina; LA = 1.6402 + 0.6816 x LML x MLBW, para Laçará; LA = 1.4942 + 0.6215 x LML x MLBW, para Guajarina e LA = 0.7467 + 0.6735 x LML x MLBW, para Cingapura, para as quais os valores preditos apresentaram elevada correlação com os valores observados, indicando que as equações devem ser específicas para cada variedade e que são coerentes para estimar a área foliar de pimenta do reino.*

Palavras-chaves: ***Piper nigrum***, *características morfológicas, comprimento e largura foliar, retângulo circunscrito.*

Black pepper is an economically important culture in Brazil, cultivated in more than a hundred cities and with a total average production of 65,800 ton/year and 26,718 ha planted in 2004 (IBGE, 2006). It also has economical and social importance since it is an exportation product.

Plants with a bigger leaf area have a greater light interception surface that may result in higher photosynthetic rate (TAIZ & ZEIGER, 2002), however higher leaf transpiration may also occur (VILLA NOVA et al., 2002). This fact, among others, show that leaf area measurement is important to help in evaluating plant physiological status and management.

There are various procedures for leaf area measurement including destructive methods (planimeter, scanners, photogravimetry, leaf disc and leaf mass) and non destructive methods using leaf linear measures (TAVARES JÚNIOR et al., 2002; BIANCO et al., 2003; MONTEIRO et al., 2005). Destructive methods

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of measurement enable to obtain fast and precise LA values, but in order to perform measurements the sample is destroyed. That is why the search for non destructive measurement methods of LA, as leaf length and width measurement, becomes very important. This is specially important with experiments on the field and for growth and developmental evaluation purposes where efficient LA measurement is required (CAMPOSTRINI & YAMANISHI, 2001; NASCIMENTO et al., 2002; BIANCO et al., 2003; QUEIROGA et al., 2003; MONTEIRO et al., 2005). The validation of a proposed equation is part of the leaf area estimative methodology and it has great importance to verify the efficiency of the established equation since it shows this method can be efficiently used (MONTEIRO et al., 2005).

Regarding to black pepper (***Piper nigrum***) varieties, the search for a method to determinate LA without destroying the sample is very important, because there is not any specific mathematical equation described on literature that will allow to determinate LA on them. The objective of this research was to establish regression equations to estimate LA from different varieties of black pepper growth on the field based on data form linear measures of leaves.

Black pepper leaf sampling was carried out at Vila Valério in Espírito Santo State, Brazil. This area has a typical tropical climate, warm and wet on summer and dry in winter with an average annual precipitation of 1200mm and average temperature of 23^{o}C. The plots were located on typical Oxisol (ANA, 2004) and were submitted to specific cultural treatments for black pepper (SERRANO et al., 2006).

Four different size leaves per plant were collected with a total of 52 leaves, with 13 plants per variety (Bragantina, Laçará, Guajarina and Cingapura). After collected, leaves were wetted and conditioned in expanded polystyrene boxes before transported to the laboratory where measures of leaf midrib length (LML) and maximum leaf broad width (MLBW) were made. Then, the area of each leaflet was obtained with a LI-3100 (Li-cor, Lincoln, NE, USA) area meter.

From the leaflet area measured on area meter and from linear measures, differences between varieties dimensions were verified by 't' test at 5% probability. Then it was coherent to estimate the Pearson's linear correlation coefficient and to establish linear equations for each variety (SOUZA, 1998).

For validation procedures of the adjusted equations, 28 different size leaves were collected from seven plants of each variety. Leaf area was determined in laboratory according to the procedures mentioned above and estimated by means of the specific equations. Latter, Pearson's linear correlation was estimated between predicted and observed values.

All correlation coefficients showed high and positive associations on data bank used to estimate equations and between observed and predicted values generated by their respective equations (Table 1). Thus, the equation using the product of two dimensions (LML x MLBW) was chosen because of its higher correlation in all situations studied (estimation and validation of equations).

For all four varieties studied, the dispersion diagram between LA and the product of LML x MLBW (Table 1) shows that it is possible to use a basic mathematical model of simple linear structure with the use of two variables (circumscript rectangle) confirming the results obtained for different plant species as mentioned by BARROS, (1973), PIRES et al. (1999), BIANCO et al. (2003) e MONTEIRO et al. (2005).

The equations that better fitted for leaf area estimative based on LML and MLBW black pepper values were: 1) LA = 2.2689 + 0.6900 x LML x MLBW, for Bragantina; 2) LA = 1.6402 + 0.6816 x LML x MLBW, for Laçará; 3) LA = 1.4942 + 0.6215 x LML x MLBW, for Guajarina and 4) LA = 0.7467 + 0.6735 x LML x MLBW, for Cingapura variety. For these equations predicted values showed higher correlation with observed values (Figure 1 and Table 1) when compared with other

Table 1 – Pearson's linear correlation coefficient (r) between leaf area (LA) and variables: leaf midrib length (LML), maximum leaf broad width (MLBW) and LML x MLBW product (circumscript rectangle) from different black pepper leaf varieties, used to estimate and validate linear regression.

	Pearson's linear correlation coefficients (r)							
	Bragantina		Laçará		Guajarina		Cingapura	
Variable	Estimative	Validation	Estimative	Validation	Estimative	Validation	Estimative	Validation
LML	0.9595	0.9740	0.9706	0.9740	0.9766	0.9801	0.9671	0.9647
MLBW	0.9883	0.9841	0.9789	0.9667	0.9889	0.9833	0.9793	0.9947
LMLxMLBW	0.9951	0.9983	0.9952	0.9828	0.9980	0.9990	0.9990	0.9992

All coefficients were significant at 5% probability of error.

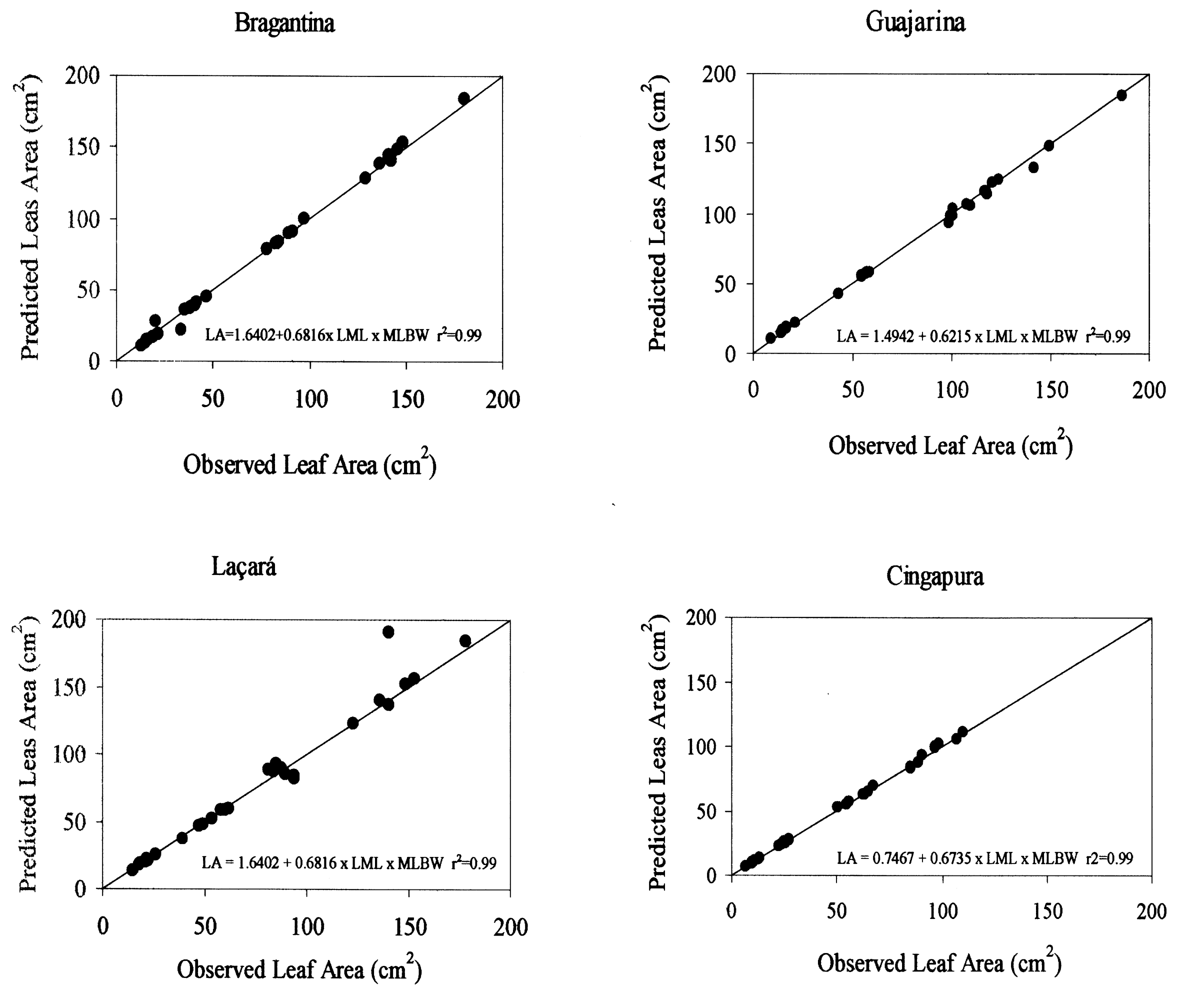

Figure 1 - Relation between predicted leaf area (equation that uses leaf lenght x leaf width) and observed values from different black pepper varieties

equations (data not showed), thus indicating that equations must be specific and that these are well adjusted equations to estimate leaf area of black pepper varieties.

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