Predicting red cypress vine leaf area by a linear equation

Elise Antero Alves¹ and Leonardo Bianco de Carvalho^{1,2*}

¹ Santa Catarina State University, Lages, SC, Brazil.

² São Paulo State University, Dracena, SP, Brazil.

ABSTRACT

We aimed to determine a linear equation to predict the leaf area of *Ipomoea quamoclit* L. (red cypress vine), an important weed infesting perennial crops in Brazil and worldwide, as a function of leaf blade length and width. Leaves with no injuries were collected in several ecosystems. We electronically measured leaf blade maximum length through principal nervure (LBL), leaf blade maximum width perpendicular to principal nervure (LBW), and leaf blade area (LA), and then we calculated the product of LBL and LBW. A linear regression analysis performed to test the relation of LA and LBLxLBW. In addition, the Shapiro-Wilk test performed to test normality of regression residuals. The leaf area of red cypress vine could be calculated as a function of the product of leaf blade length and leaf blade width, by using the equation $LA = 11.987 + 3.6439 \cdot LBL \cdot LBW$.

Keywords: *Ipomoea quamoclit*, Leaf area, Non-linear estimation, Plant growth, Biometry.

*Corresponding author
E-mail: lbcarvalho@dracena.unesp.br

INTRODUCTION

Leaf area is one of the most common parameters measured in green house and field ecophysiological studies (Wang and Zhang 2012). Most of the techniques used to predict leaf area require excising leaves from plants and scanning them in the lab, interfering on physiological and phenological responses due to canopy reduction (Chabot and Hicks 1982) and on the results of other experiments that are sharing the same group of plants (Souza and Amaral 2015). Therefore, equations derived from non-destructive models represent a fast method providing leaf area estimates with no leaf excisions (Norman and Campbell 1989). Linear models based on length and width leaf measurements have been considered the most simple and efficient models to estimate the leaf area of some species in that, for a better practical use, researchers can choose the simple linear model ($Y=a*X$), considering the product of length and width as the variable "X", as described by Carvalho et al. (2011). The objective of this research was to determine a linear equation ($Y=a*X$) to predict the leaf area of *Ipomoea quamoclit* L. (red cypress vine), an important weed infesting perennial crops in Brazil and worldwide, as a function of leaf length and leaf width.

MATERIAL AND METHODS

We collected 100 leaves with no injury caused by insects, fungi or weather conditions were randomly gathered from red cypress vine plants under flowering stage. Collection performed on March 2015 in a variety of ecosystems (annual and perennial crops, non-agricultural fields and urban conditions), regarding several ecological conditions where the species grows.

We measured leaf blade length through principal nervure (LBL), leaf blade maximum width perpendicular to principal nervure (LBW) and leaf blade area (LA), by using a Portable Area Meter (Licor, Mod. L1-3000, USA), and then we calculated the product of LBL and LBW.

In sequence, we proceeded with a linear regression analysis ($Y=a+bX$), assuming Y as LA and X as LBLxLBW to establish an equation to predict the leaf area of red cypress vine. In addition, we performed the Shapiro-Wilk test to verify the normality of regression residuals.

RESULTS AND DISCUSSION

We found leaf area of red cypress vine can be predicted by the equation $Y=11.987+3.6439X$, where Y

indicates the predicted leaf area and X represents the product LBLxLBW (Figure 1). Souza and Amaral (2015) discussed the normal distribution of residuals is required for an accurate equation adjustment, as observed in this research. So, our result indicates the equation described can be used to predict accurately the leaf area of red cypress vine.

Non-destructive measurements to predict leaf area are more interesting to be used because no collection of plant material is required (Bianco et al. 2011). Linear equations are the easiest way to determine leaf area (Carvalho et al. 2011). In addition, the use of regression equations is a simple, fast, accurate, and reliably method to predict leaf area, allowing to monitor leaf growth and expansion from the same plant until the end of life cycle or experiment (Gemiely et al. 1991). So, our result can be used in further researches involving red cypress vine regarding on analysis of plant growth to study plant biology, plant ecology, plant physiology, plant-plant interactions, etc. In addition, the use of that equation would enable researches to make non-destructive and repeat measurements in the same leaf, with no use of expensive electronic equipment.

Figure 1. Relation between leaf area (LA) and the product of leaf blade length and leaf blade width (LBLxLBW) and the respective residual distribution (Shapiro-Wilk Normality Test) for red cypress vine (*Ipomoea quamoclit* L.).

CONCLUSION

The leaf area of red cypress vine can be predicted as a function of the product of leaf blade maximum length and leaf blade maximum width, by using the equation $LA=11.987+3.6439*LBLxLBW$ in a simple, efficient, and reliable way.

Acknowledgements

Authors thank to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the Research Productivity Scholarship of LBC (Proc. CNPq #304855/2015-4).

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RESUMO

Estimativa da área foliar de esqueleto-de-jardim por equação linear. O objetivo foi determinar uma equação linear para estimar a área foliar de *Ipomoea quamoclit* L. (esqueleto-de-jardim), uma importante planta daninha que infesta culturas perenes no Brasil e no mundo, em função do comprimento e da largura do limbo foliar. Coletaram-se folhas sem injúria em diversos ecossistemas. Mediram-se eletronicamente o comprimento máximo do limbo foliar através da nervura principal (LBL), a largura máxima do limbo foliar perpendicular à nervura principal (LBW) e a área do limbo foliar (LA), e então se calculou o produto de LBL e LBW. Para testar a relação entre LA e LBLxLBW, procedeu-se análise de regressão linear. Além disso, para testar a normalidade dos resíduos da regressão, procedeu-se o teste de Shapiro-Wilk. A área foliar de esqueleto-de-jardim pôde ser calculada em função do produto do comprimento e da largura do limbo foliar, usando a equação $LA=11,987+3,6439*LBL*LBW$.

Palavras-chave: *Ipomoea quamoclit*, Área foliar, Estimativa não-linear, Crescimento de plantas, Biometria.