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Non-Destructive Leaf Area Prediction Model for "Kiraz" Cherry Laurel (*Laurocerasus officinalis* Roem.)

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ABSTRACT

The objective of the present study was to develop a leaf area prediction model for "Kiraz" cherry laurel (*Laurocerasus officinalis* Roem.). To achieve this objective, a total of 200 leaves were selected randomly from "Kiraz" cherry laurel in Turkey. Leaf width, length and leaf area were measured. The actual leaf area of the plant was measured by a PLACOM Digital Planimeter and multiple regression analysis with SAS was performed. The leaf area model developed was LA= (-55,5877) + (19,98318 x W) + (-0,83723 x W^2) + (0,143132 x L^2) where LA is leaf area, L is leaf length, and W is leaf width. The R^2 value (0.95) and standard error were found to be significant at $p<0.001$.

Keywords: leaf width and length, mathematical modeling, plant physiology

INTRODUCTION

Cherry laurel (*Laurocerasus officinalis* Roem.) is a member of the Rosaceae family, native to west Asia and cultivated throughout northern Anatolia for its edible fruits (Browicz 1972; Bostan 2001; Islam 2002). Fruits are popular, dark purple or black when mature, mainly distributed in the coasts of the Black Sea region of Anatolia and are locally called *taflan* or *karayemis* (Liyana-Pathirana *et al.* 2006). Mature fruits of cultivated cherry laurel can be used fresh or dried, in various alcoholic drinks, *pekmez*, jam, pickles, marmalade and fruit juice products. The fruits are also consumed as additives such as flavoring (Ayaz *et al*. 1997; Colak *et al*. 2005). Fruits, leaves and seeds of cherry laurel are well known as traditional medicines in Anatolia and have been used for many years for the treatment of stomach ulcers, digestive system complaints, bronchitis, eczemas, haemorrhoids, and as a diuretic agent, among others (Baytop 1984).

Many biological studies require the measurement of leaf area and defoliation (O'Neal *et al.* 2002). Leaves are one of the most important organs of cherry laurel. Leaf area (LA) is an indicator of crop growth and productivity, and many methods are available with which to estimate it (Kandiannan *et al.* 2002). Non-destructive estimation of plant leaf areas offers researchers reliable and inexpensive alternatives in field experiments. Non-destructive leaf area or plant growth measurements are often desirable because continued use of the same plants over time can reduce variability in experiments as compared with destructive sampling. Additionally, the use of simple linear measurement for predicting the leaf area of plants eliminates the need for expensive leaf area meters. For these reasons, the development of mathematical models and equations from linear leaf measurements for predicting total or individual leaf area have been shown to be very useful in studying plant growth and development (Uzun and Celik 1999).

Common measurements for predicting equations in some models carried out previously have included leaf width, leaf length, petiole length, main and/or lateral vein length, and different combination of these variables. Some researchers have tried to use new equipment and tools such as hand scanner or laser optic apparatuses for predicting plant growth non-destructively, but these are very expensive investments for basic and simple research (Ebert 1996; Tsonev and Segiev 1996).

This study has focused on developing a leaf area model for cherry laurel. For this, a mathematical model has been developed by considering linear measurements on cherry laurel leaves.

MATERIALS AND METHODS

Leaf samples (400) in different growing stages were randomly collected from "Kiraz" cherry laurel trees growing in Samsun Province (N 41° 25.181′ ; E 36° 09.907′), western part of the Black Sea Region, Turkey. "Kiraz" cherry laurel has 67.9 g average cluster weight, 19 berries/cluster and 4.8 g berry weight. Berries have 15.4% soluble solids, pH 4.8 and 0.23% malic acid (Islam 2002).

A total of 200 leaves were measured in the experiment. Each leaf was processed in the following manner. First, they were placed on a photocopier desktop by holding them flat and secure and copied onto an A4 sheet (1:1) one by one. Second, a Placom Digital Planimeter (SOKKISHA Planimeter Inc., Model KP-90) was used for actual leaf area. In addition, a series of linear measurements was also performed. The measurements were leaf width (W) measured from tip to tip at the widest part of the lamina, and leaf length (L) measured from lamina tip to the point of petiole intersection along the lamina midrib (**Fig. 1**).

Fig. 1 "Kiraz" cherry laurel leaf showing the position of leaf length (L) and width (W).

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Research Note

Model construction

Multiple regression analysis of the data was performed for all leaves. A search for the best model to predict the leaf area modeling was conducted with various subsets of the independent variables, namely leaf length (L) and leaf width (W).

The best estimating equation for the leaf area model was determined with SAS (SAS 1999) and formulized as LA = (a) + (b x W) + (c x W^2) + (d x L^2) where LA is leaf area, L is leaf length, W is leaf width and a, b, c, and d are coefficients of the produced equation.

Multiple regression analysis was carried out until the least sum of squares was obtained.

Model validation

Without proper experimental and statistical validation, models which attempt to predict any variable of plant growth must be viewed with caution (Celik and Uzun 2002). The data were used to develop equations through multiple linear regression techniques. The best models were chosen according to a set of statistics considering the following: a) Coefficient of determination (R^2), b) Statistical significance of the coefficients, c) SAS, statistical software for statistical analysis (Carus and Cicek 2007).

RESULTS

Multiple regression analysis used to determine the best fitting equation to estimate the LA of "Kiraz" cherry laurel showed that most of the variation in LA values was explained by the selected parameters (length and width) (**Table 1**). The variation explained by the parameters was 95%. Standard errors (SE) were shown and they were found to be significant at the p<0.001 level. We found that there was a very close relationship between actual and predicted leaf area for "Kiraz" cherry laurel (**Fig. 2**).

To validate the model developed in this study an equation of the selected parameters (L and W) produced the highest coefficient of determination R^2 = 0.9461 (**Fig. 3**). This result indicates statistical acceptability of the equation.

Table 1 "Kiraz" cherry laurel leaf area prediction model.

LA=	(-55.5877) +	(19.98318 x W) +	(-0.83723 x W^2) +	(0.143132 x L^2)
SE=	5.88***	1.79***	0.09***	0.008***
R^2=	0.95			

LA: Leaf area, L^2: Leaf length square, W: Leaf width, W^2: Leaf width square, SE: Standart errors, R^2 and SE values are significant at p<0.001.

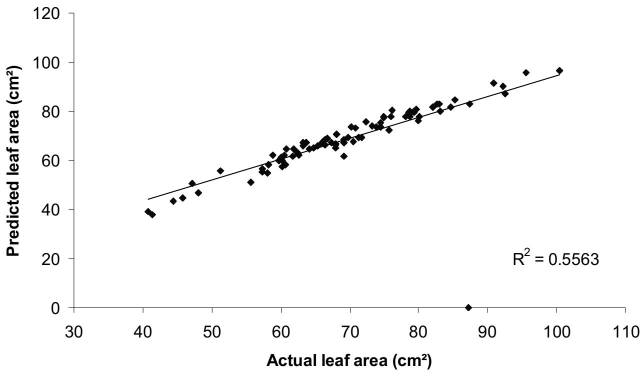

Fig. 2 Relationship between actual and perdicted leaf area of "Kiraz" cherry laurel.

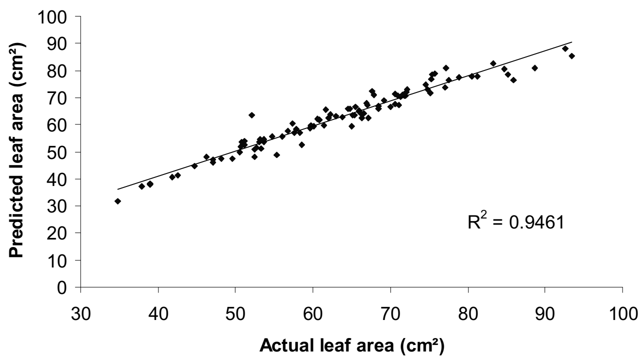

Fig. 3 After validation on relationship between actual and predicted leaf area of "Kiraz" cherry laurel.

DISCUSSION

LA is commonly evaluated in experiments of plant physiology and routinely measured for some physiological phenomenon such as light, photosynthesis, respiration, plant water consumption and transpiration. LA would also affect quality and yield in cherry laurel.

Many researchers have reported that LA can be estimated by linear measurements such as leaf width and leaf length in the following plants with R^2 values of 0.76 to 0.99 in *Cucumis sativus* L. (Robins and Pharr 1987), 0.89 to 0.93 in *Citrus aurantium* L. (Arias *et al.* 1989; Ramkhelavan and Brathwaite 1992), 0.99 in *Phaseolus vulgaris* L. (Rai *et al.* 1990), 0.95 to 0.98 in *Cocos nucifera* L. (Mathes *et al.* 1990), 0.98 in *Vitis vinifera* L. (Uzun and Çelik, 1999), 0.99 in *Vicia faba* L. (Odabaş 2003) and 0.98 in chestnut (Serdar and Demirsoy 2006).

LA measurements, especially under field conditions, are often destructive and time consuming. In this study, a simple, non-destructive model for predicting leaf area was developed for cherry laurel. The model can be reliably used in cherry laurel in physiological studies and research aimed at developing more productive and efficient pruning and training methods.

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