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Non-destructive Leaf Area Estimation in Peach

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Summary

In this research, a model for predicting the leaf area was developed for peach by using 'Earlyred', 'Dixired', 'Cardinal', 'Redhaven', 'Glohaven' and 'Cresthaven' cvs. by measuring lamina width, length and leaf area without destroying in 2002. Multiple regression analysis for the cultivars was separately performed. The proposed leaf area (LA) prediction model is: $LA=-0.5+0.23*L/W+0.67*L*W$, $R^2=0.9975$, LA is leaf area, W is leaf width, L is leaf length. The model was validated by measuring leaf samples of different peach trees of the six cultivars in 2003.

Zusammenfassung

Zerstörungsfreie Blattflächenschätzung bei Pfirsich. In dieser Untersuchung wurde ein Modell zur Voraussage der Blattfläche von Pfirsich entwickelt, in dem im Jahre 2002 bei den Sorten 'Earlyred', 'Dixired', 'Cardinal', 'Redhaven', 'Glohaven' und 'Cresthaven' die Breite, Länge und Fläche von Blättern gemessen wurde, ohne diese zu zerstören. Die mehrfaktorielle Regressionsanalyse wurde für jede Sorte separat durchgeführt. Das Modell für die Voraussage der Blattfläche lautet: $LA=-0.5+0.23*L/W+0.67*L*W$, $R^2=0.9975$, wobei LA für die Blattfläche, W für die Breite und L für die Länge des Blattes steht. Die Gültigkeit des Modells wurde 2003 durch Messen von Blattproben unterschiedlicher Pfirsichbäume der selben sechs Sorten überprüft.

Key words. Peach – non-destructive leaf area estimation – multiple regression analysis

Introduction

Models for the non-destructive prediction of the leaf area are useful tools for researches in horticultural experiments. For example, such models enable researchers to measure leaf area on the same plants during the plant growth period and that may reduce variability in the experiments (GAMIELY et al. 1991; NESMITH 1991, 1992).

The leaf area can be determined by using instruments or prediction models. Recently, new instruments, such as hand scanners and laser optic apparatuses, were developed for leaf area measurements. However, these are very expensive and complex devices for basic and simple studies. A non-destructive prediction of the leaf area saves time compared with geometric measurements, and no expensive instruments are needed (ROBBINS and PHARR 1987). Although several leaf area prediction models have been developed for plant species, such as grape, avocado, and kiwifruit, in previous studies, a leaf area prediction model is not available for peaches to date. Therefore, we aimed to produce reliable equations for peach that predict leaf area with linear measurements.

Materials and Methods

Six peach cultivars ('Earlyred', 'Dixired', 'Cardinal', 'Redhaven', 'Glohaven' and 'Cresthaven') were used. The trees were six to nine years old and grafted on seedlings. Leaf samples for each cultivar were selected randomly five times from three trees from different locations of the canopy during the summer growing season in 2002. A total of 1800 leaves were measured, 300 leaf samples for each cultivar. Each leaf was copied; then a Placom Digital Planimeter (Sokkisha Planimeter Inc., Model KP-90) was used to measure the actual leaf area. The leaf width (W) and length (L) of the leaf samples were measured for model construction. Leaf width (cm) was measured from tip to tip at the widest part of the lamina and leaf length (cm) was measured from lamina tip to the point of petiole intersection along the midrib. All values were recorded to the nearest 0.1 cm.

Multiple regression analysis of the data was performed for each cultivar separately. For this reason, analysis was conducted with various subsets of the independent variables, namely, leaf length /leaf width (L/W) and leaf width*leaf length (W*L) to develop the best model for predicting the leaf area (LA) by using the Excel 7.0 package program. The multiple regression analysis was carried out until the least sum of squares was obtained.

In addition, leaf samples other than those used for model development, belonging to the tried cultivars in this research, were taken from different peach trees during growing period for validating the developed leaf area prediction model in 2003. Varying between 39 and 75 new leaf samples for each cultivar were used (55, 48, 39, 49, 47 and 73 for 'Earlyred', 'Dixired', 'Cardinal', 'Redhaven', 'Glohaven' and 'Cresthaven', respectively).

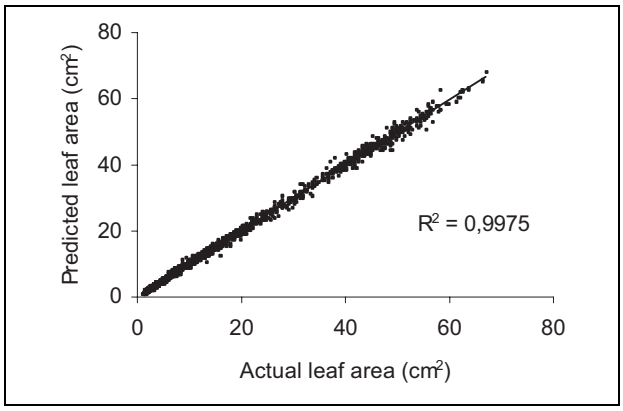

Fig. 1. The overall relationship between actual leaf area (cm^2) and predicted leaf area (cm^2) for the cultivars.

Leaf width, length and actual leaf area of these leaf samples were measured as mentioned in the model production. For validation procedure, leaf area values obtained by using the model were plotted against actual leaf areas measured using a planimeter. The Excel 7.0 Package program was used for this procedure.

Results

For in the studied peach cultivars, regression analysis showed that the most of the variation in leaf area values was explained by leaf length and leaf width. The overall variation explained by the parameters was 99.75% for all the cultivars (Fig. 1). The proposed leaf area (LA) prediction model is LA=–0.5+0.23*L/W+0.67*L*W, here, LA is leaf area, W is leaf width, L is leaf length.

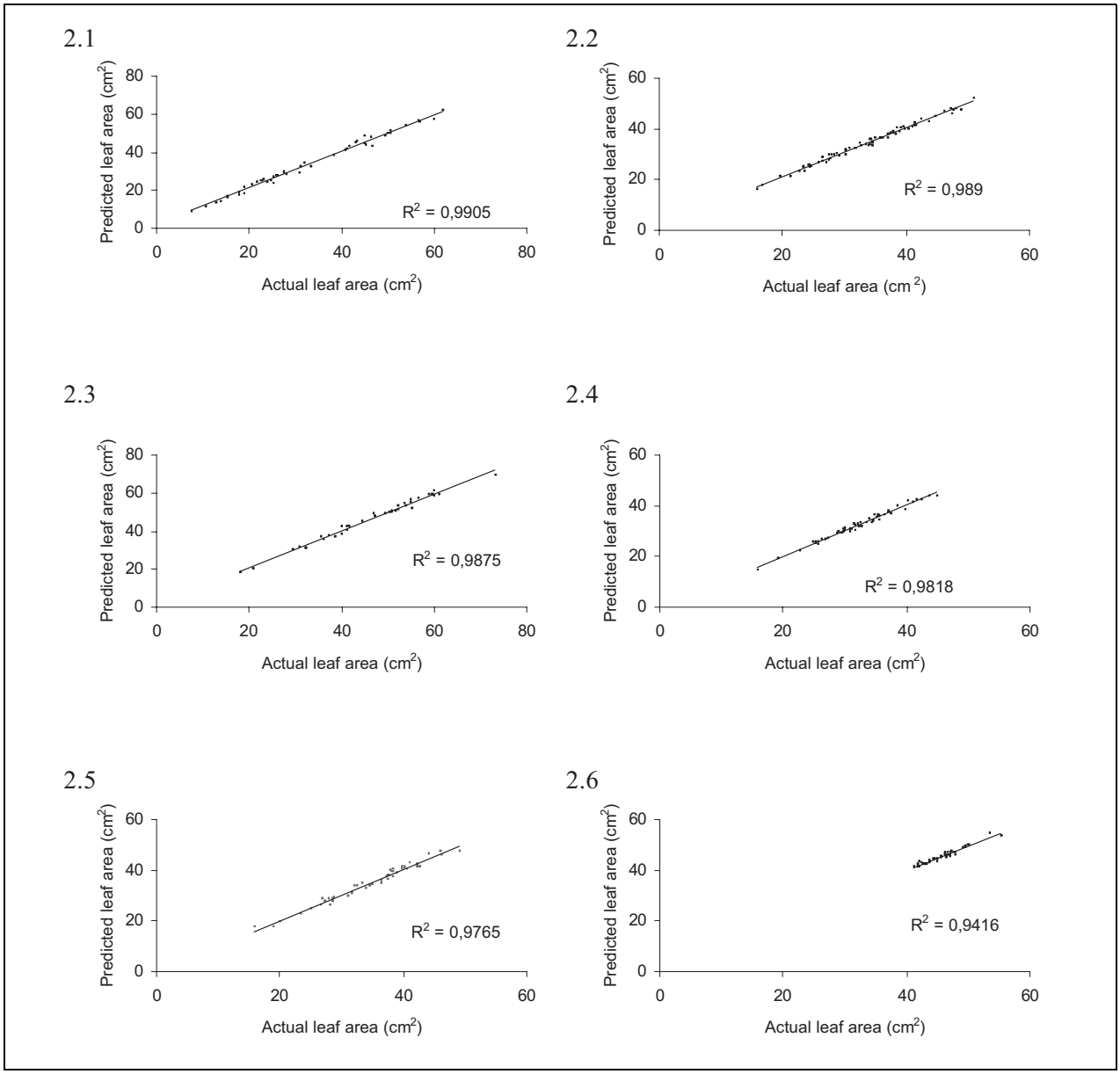

Fig. 2. The relationships between actual leaf area (cm^2) and predicted leaf area (cm^2) for the 'Cardinal' (2.1), 'Cresthaven' (2.2), 'Dixired' (2.3), 'Earlyred' (2.4), 'Redhaven' (2.5) and 'Glohaven' (2.6).

Plotting processes were carried out between actual leaf area values measured by using Placom digital planimeter and predicted leaf areas of the tried cultivars calculated by the developed model in this research to determine the degree of accuracy of the model (Fig. 2). It was found that the relationship (R^2 values) between actual and predicted leaf areas varied from 0.9905 in 'Cardinal' to 0.9416 in 'Glohaven' cv. (from the highest to lowest the value). As it can be seen from the Fig. 2.1, 2.2, 2.3, 2.4, 2.5 and 2.6, the model predicted leaf area of the tried peach cultivars were most reliable for 'Cardinal' (0.9905), 'Cresthaven' (0.989), 'Dixired' (0.9875), 'Earlyred' (0.9818), 'Redhaven' (0.9765) and 'Glohaven' (0.9416).

Discussion

In accordance with the present study, many studies carried out to establish reliable relationships between leaf area and leaf dimensions of different plant species such as avocado, lotus plum, kiwifruit, aubergine, red currant species, squash (UZUN and ÇELIK 1999), cherry (DEMIRSOY and DEMIRSOY 2003), cucumber (ROBBINS and PHARR 1987; TAMAL et al. 1988), grapes (ELSNER and JUBB 1988; UZUN and ÇELIK 1999), onion (GAMIELY et al. 1991), pecan (WHITHWORTH et al. 1992), rabbiteyebluberry (NESMITH 1991) and gooseberry (TAMAL et al. 1988) showed that there were close relationships between leaf width, leaf length and leaf area (For example; r^2= 0.983 for avocado, lotus plum, kiwifruit, aubergine, and pepper; r^2= 0.76 to 0.99 for cucumber; r^2= 0.9841 to 0.9844 for grapes; r^2= 0.95 for cherry; r^2= 0.986 for red currant; r^2=0.976 to 0.986 for squash). Results from the present study were in accordance with some of the previous studies on establishing reliable equations for predicting leaf area through measuring leaf dimensions.

In the study, the simple model for predicting leaf area was developed for peaches. There were not significant differences among the cultivars in terms of being a parameter in the model. Therefore, the model can be used for peaches in the relevant studies.

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