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Leaf Area Prediction Model For Some Kiwifruit (*Actinidia chinensis* Planch.) Cultivars

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Abstract: A total of 1000 leaves were selected randomly from five different Kiwifruit (Bruno, Hayward seedling, Matua, Tomuri and Hayward) plants that are widely grown in Rize-Turkey, were used in this research. Their lamina leaf width, length and area of the leaves were measured. The actual leaf areas were measured by PLACOM Digital Planimeter and multiple regression analysis with The Excell 7.0 was performed. The leaf area model developed for kiwifruit was $LA = 124.56 - (18.3\times L) - (14.68\times C) + (0.416\times L^2) + [1.26\times(L\times W)] - [0.011\times(L^2\times W\times C)] + [0.23\times(L\times W\times C)] - 0.18\times W^2)$ where LA is leaf area (cm^2), L is leaf length (cm), W is leaf width (cm), C is Kiwifruit cultivars (1 Bruno, 2 Seedling, 3 Matua, 4 Tomuri, 5 Hayward). R^2 value (0.97) and standard error were found to be significant at the $p<0.001$ level.

Key words: Kiwifruit (*Actinidia chinensis* Planch.), leaf area, modelling

INTRODUCTION

Kiwifruit belongs to the family Actinidiaceae and comprises 76 species (Huana, 2006) with very diverse fruit and vine characteristics. The best known species are *A. deliciosa* (green-fleshed variety, for example Hayward) and *A. chinensis* (golden-fleshed variety, for example Hort 16A, commercialised as Zespri Gold) from which most commercial kiwifruit varieties have been developed (Anonymous, 2006).

Turkey has been economically growing most of the commercial fruit species, which are grown all over the world, owing to its suitable ecological conditions. Kiwifruit has been added to the fruit species grown in Turkey and many studies on kiwifruit growing in Turkey showed it's successful adaptation ability in this country (Zenginbal *et al*., 2007).

The world kiwifruit production has shown a rapid increase especially after The Mediterranean countries started to compensate to kiwifruit growing. However, Turkey, which is one of the important Mediterranean countries, has not yet taken place in this production entirely due to lacking in showing its true potential. The reasons for this can be counted as; late start for researches and growing of kiwifruit, lack of introduction studies and slow increase in domestic consumption and difficulties in propagation of grafted-seedlings of kiwifruit, accordingly. The Black Sea and The Marmara Regions have pioneered during the last fifteen years to kiwifruit production of Turkey (Özcan and Zenginbal, 2003).

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

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the leaf area of field crops eliminates the need for expensive leaf area meters. For these reasons, the development of mathematical model and equation from linear leaf measurement for predicting total or individual leaf area has been shown to be very useful in studying plant growth and development (Uzun and Çelik, 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 using 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, 1994). In the present study, it was aimed to develop estimation of leaf area model for kiwifruit by linear leaf measurement.

MATERIALS AND METHODS

Leaf samples used in this research selected randomly from five different kiwifruit plants cultivated in Rize, Turkey ecological area during the summer of 2004. A total of 1000 leaves were measured for five cultivars and 200 leaf samples were used for each cultivar in the experiment. Each leaf was processed in the following manner. First, they were placed on the photocopier desktop by holding flat and secure and copied on A4 sheet (1:1) one by one. Second, Placom Digital Planimeter (SOKKISHA Planimeter Inc., Model KP-90) was used for estimation of leaf area. In addition to the leaf area measurements, a series of linear measurements was also performed. The linear dimensions were shown in Fig. 1. 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.

The best estimating equation for the Leaf Area (LA) of Kiwifruit was determined with the Excel 7.0. Multiple regression analysis was carried out until the least sum of square was obtained.

Characterization of kiwi fruit cultivars tested are as follows:

BRUNO (1)

This variety flowers at the same time as or slightly later than Abbott. The cylindrical fruit is fairly large and elongated and cannot be confused with any other current variety. Usually a darker brown than other varieties, it is covered with very dense, short, rather bristly hairs. Some processors in the fruit canning industry have shown a preference for Bruno because a large number of even slices can be obtained from each elongated fruit. It is a heavy cropper (Sale, 1985).

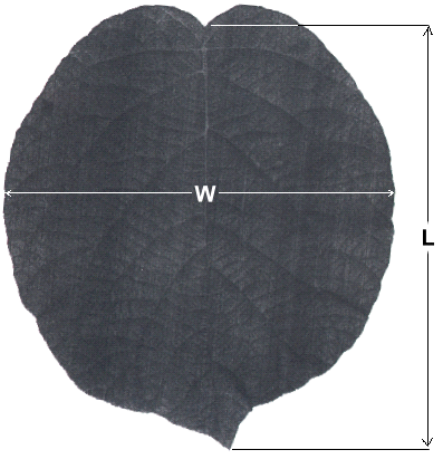

Fig. 1: Diagram of Kiwifruit plant leaves showing the positions of leaf Length (L), Leaf Width (W)

SEEDLING (2)

These seedlings were obtained from germinated seeds of Hayward cultivars which was source of leaves used.

MATUA (3)

Matua is male kiwifruit and its have a long flowering type (Sale, 1985).

TOMURI (4)

Tomuri is male kiwifruit and have a late flowering type. Tomuri was selected as a pollinators for Hayward, it is now considered that Matua or other long flowering types are the best pollinators for all commercial fruiting varieties, including Hayward. A search for better strains is continuing (Sale, 1985).

HAYWARD (5)

The Hayward variety is easily identified by its large, broadly oval fruit. Very late flowering, it is pale greenish brown and densely covered with fairly fine, silky hairs. This variety is superior in flavour and keeps better than any other variety presently available. Yield from Hayward is not usually as heavy as from other named varieties and it is prone to certain deformities or aberrations of fruit shape, such as Hayward mark, flats, fans and dropped shoulder. There seems little doubt that Hayward is the same as the Californian variety Chico for in the 1930s the United States Department of Agriculture Plant Introduction Station at Chico received a selection from Hayward Wright's Auckland nursery (Sale, 1985).

RESULTS AND DISCUSSION

Multiple regression analysis was performed to comstract a leaf area estimation model. A search for the best model for predicting Leaf Area (LA) was conducted with various subsets of the independent variables namely Length (L), Width (W), Cultivar (C), Length square * Width (L * W) and formulised as;

$$LA = 124.56 - (18.3\times L) - (14.68\times C) + (0.416\times L^2) + [1.26\times(L\times W)] - [0.011\times(L^2\times W\times C)] + [0.23\times(L\times W\times C)] - 0.18\times W^2)$$

SE = (7.39)*** (1.13)*** (1.39)*** (0.05)*** (0.03)***
(0.0008)*** (0.017)*** (0.0025)***

$R^2 = 0.97$

Multiple regression analysis was used for determination of the best fitting equation for estimation of leaf area in Kiwifruit showed that most of the variation in leaf area values was explained by the selected parameters (Length and width) (Fig. 2). The variation explained by the parameters was 97%.

Many researchers have also reported that leaf area can be estimated by linear measurements such as leaf width and leaf length in the following plants: Cucumbers (*Cucumis sativus* L.) (Robins and Pharr, 1987), orange (*Citrus aurantium* L.) (Arias *et al*., 1989; Ramkhelawan and Brathwaite, 1992), French bean (*Phaseolus vulgaris* L.) (Rai *et al*., 1990), coconut (*Cocos nucifera* L.) (Mathes *et al*., 1990), Grape (*Vitis vinifera* L.) (Uzun and Çelik, 1999) and Broad bean (*Vicia faba* L.) (Odabaş, 2003). The same authors found that there were close relationship between leaf area value, leaf length and leaf width for these plants ($R^2 = 0.76$ to 0.99 for cucumber, $R^2 = 0.89$ to 0.93 for orange, $R^2 = 0.99$ for French bean, $R^2 = 0.95$ to 0.98 for coconut, $R^2 = 0.98$ for grapes and $R^2 = 0.99$ for broad bean). It is found that there was very close relationship between actual and predicted leaf area for Kiwifruit (Fig. 2).

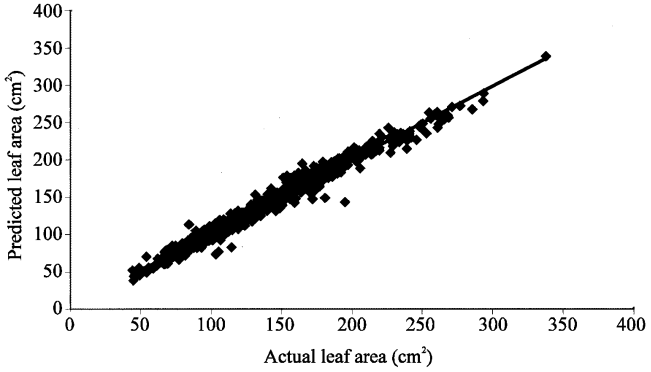

Fig. 2: Relationship between actual leaf area (cm^2) and predicted leaf area (cm^2) for kiwifruit

The present model can be evaluated with leaf samples gathered from different growing periods. As the understanding of plant growth and development has been increasing, such mathematical models as this shown in Fig. 1 will be very useful tools for prediction of leaf area for many plants without using of expensive devices. Model developing processes of this sort may be used for other field crops, plantation crops, vegetables and ornamentals.

REFERENCES

Anonymous, 2006. Actinidia (Kiwifruit) Post-Entry Quarantine Testing Manuel. Biosecurity New Zealand. Ministry of Agriculture and Forestry. Plant Health and Environment Lab, IDC-Tamaki, 231 Morrin Road, St Johns, P.O. Box 2095, Auckland, New Zealand.

Arias, E., M. Fernandez and T. Telleria, 1989. Modified method for determining foliar area in leaf samples of Valencia orange. Hortic. Abst., 59: 9508.

Ebert, G., 1996. Leaf area measurement with laser optics. Hortic. Abst., 66: 2808.

Huana, H.W., 2006. Actinidia in China: Natural diversity, phylogeographical evolution, interspecific gene flow and gene discovery for kiwifruit cultivar improvement. 6th ISHS International Kiwifruit Symposium Abstract, Rotorua, New Zealand.

Mathes, D., L.V.K. Liyanage and G. Randeni, 1990. A method for determining leaf area of one, two and three year old coconut seedlings (Var. CRIC60). Hortic. Abst., 60: 9366.

Odabaş, M.S., 2003. The quantitative effect of temperature and light on growth , Development and yield of Broad Bean (*Vicia faba* L.) University of Ondokuz Malyis, Samsun, Turkey.

Özcan, M. and H. Zenginbal, 2003. Current situation and potential of kiwifruit growing in the Black Sea Region, Turkey. National Kiwifruit and Berry Symposium. 23-25 October, Ordu /Turkey, pp: 23-28.

Rai, A., P.V. Alipit and M.B. Toledo, 1990. Estimation of leaf area of French bean (*Phaseolus vulgaris* L.) Using linear measurements. Hortic. Abst., 60: 3405.

Ramkhelawan, E. and R.A.I. Brathwaite, 1992. Leaf area estimation by non-destructive methods in Sour orange (*Citrus aurantium* L.). Hortic. Abst., 62: 2557.

Robbins, N.S. and D.M. Pharr, 1987. Leaf area prediction model for cucumber from linear measurement. Hortic. Sci., 22: 1264-1266.

Sale, P.R., 1985. Kiwifruit Culture. Dle Ashenden Williams (Eds.). V.R. Word, Goverment Printer, Wellington, New Zealand.

Schinazi, R.F., C.K. Chu, J.R. Babu, B. Oswald, V. Saalman, D.L. Cannon and B.F. Erickson, 1990. Anthraquinones as a new class of antiviral agents against AIDS. Antiviral Res., 13: 265-272.

Tsonev, T. and I. Segiev, 1994. Leaf area measurement using hand scanner, Hortic. Abst., 64: 9165.

Uzun, S. and H. Celik, 1999. Leaf area prediction models (Uzçelik-I) for different horticultural plants., Tr. J. Agric. Fore., 23: 645-650.

Zenginbal, H., M. Özcan, A. Haznedar and T. Demir, 2007. Comparisons of methods and time of budding in kiwifruit (Actinidia deliciosa, A. Chev). Int. J. Nat. Eng. Sci., 1: 23-28.