PREDICTION MODEL FOR ESTIMATING PEACH FRUIT WEIGHT AND VOLUME ON THE BASIS OF FRUIT LINEAR MEASUREMENTS DURING GROWTH

Hüsnü Demirsoy* and Leyla Demirsoy

Ondokuz Mayıs University, Faculty of Agriculture, Department of Horticulture
55139-Kurupelit, Samsun, TURKEY

*Corresponding author. tel.: +00903623121919-1385
e-mail: husnud@omu.edu.tr

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ABSTRACT

Fruit sizes are important quality criteria in marketing. Also, they are used as morphological indices for identification of the cultivars. In this research, models for predicting fruit weight and volume on the basis of measurements done at different times during fruit growth, were developed for 6 peach cultivars (‘Earlyred’, ‘Dixired’, ‘Cardinal’, ‘Redhaven’, ‘Glohaven’ and ‘Cresthaven’) using multiple regression analysis.

Key words: peach, fruit weight, fruit volume, modeling

INTRODUCTION

Fruit weight and volume are important quality criteria for horticultural crops. They are also used as indices for identification of the cultivars. Models which would allow predicting fruit weight and volume at harvest can be useful in horticultural practice. They can find application in research as well. Normally fruit volume is determined by water displacement. This process is not convenient and the fruits must be harvested. Also, weighting fruits in the field conditions may be troublesome. Thus, the fruit weight and volume prediction models based on simple, nondestructive measurements can be useful. Since the data needed to construct a model are collected nondestructively, the measurements can be taken from the same plants during entire plant growth period, which shall reduce variability in experiments (Gamiely et al., 1991; NeSmith, 1991, 1992).

The objective of this work was to design a reliable model for predicting peach fruit weight and volume on the basis of fruit width, length and height measurements.

MATERIAL AND METHODS

This study was carried out on 6 peach cultivars: 'Earlyred', 'Dixired', 'Cardinal', 'Redhaven', 'Glohaven' and 'Cresthaven' grafted on peach seedling and grown in Carsamba Plain in Turkey. During the experiment the trees were 7-9 year old. 150 fruits were randomly sampled from three trees of each cultivar at the stage of pit hardening, one month after pit hardening and at harvest maturity. Fruit weight, volume and fruit size (width, length and height) values were recorded to the nearest 0.1 g, 1 cm^3 and 0.1 cm, respectively.

Multiple regression analysis of the data was performed for each cultivar separately. To develop a model for predicting fruit weight (FW), analysis was conducted with various subsets of the independent variables, namely: fruit width (W), $width^2$, $length^2$ (L^2), $cultivar^2$ ($Cv.^2$) and fruit height*fruit width/fruit length (H*W/L). To develop a model for predicting fruit volume (FV), analysis was also conducted with various subsets of the independent variables, namely: fruit width (W), length (L), height (H), $width^2$ (W^2), $length^2$ (L^2), fruit width*fruit length (W*L), fruit width*fruit length*fruit height (W*L*H), fruit height*fruit width/fruit length (H*W/L), cultivar (Cv.), cultivar*fruit height*fruit width/fruit length (Cv.*H*W/L). For model construction, Excel 7.0 package program was used. In the both FW and FV, the multiple regression analysis was carried out until the least sum of squares was obtained.

RESULTS AND DISCUSSION

Regression analysis for the studied cultivars showed that most of the variations in the fruit weight values were linked to fruit width, length, height and the cultivar. The total variation due to the selected parameters was 99.24% for all the cultivars tested (Tab. 1). A highly reliable relationship between actual and predicted fruit weight for the cultivars was obtained (Fig. 1).

Regression analysis showed that most of the variations in the fruit volume values were linked to fruit width, length and height. The overall variation explained by the selected parameters was 99.58% for all the cultivars (Tab. 2). A highly reliable relationship between actual fruit volume and predicted fruit volume was found for all the cultivars evaluated (Fig. 2).

The results obtained are in accordance with some of the previous studies on establishing reliable equations for predicting fruit weight and fruit volume through measuring fruit dimensions. For instance, strong relationships (r^2=0.98) were observed between fruit diameter, fruit volume and fruit weight in apricot (Arzani et al., 1999). In pears, Ortega et al. (1998) found a relationship between fruit diameter and fruit size (r^2=0.85-0.97).

T a b l e 1. The relationship between actual fruit weight and the independent variables used in the fruit weight prediction model

Model	r^2
$FW = 61{,}541 - 5{,}661\ast\mathbf{W} + 0{,}027\ast\mathbf{L}^2 + 0{,}140\ast[\mathbf{Cv.}^2] + 0{,}059\ast\mathbf{W}^2 + 1{,}306\ast\mathbf{H}\ast\mathbf{W}/\mathbf{L}$	0.9924
SE 2,694*** 0,125*** 0,001*** 0,022*** 0,001*** 0,065***	

FW: Fruit weight, W: Fruit width, L: Fruit length, H: Fruit height, Cv.: Cultivar coefficient [1] for 'Early Red', [2] for 'Dixired', [3] for 'Cardinal', [4] for 'Redhaven', [5] for 'Glohaven', [6] for 'Cresthaven', SE: Standard error
***Significant at the level of 0.1%

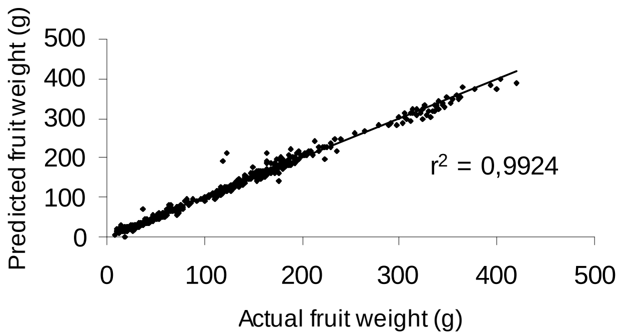

Figure 1. The overall relationship between actual fruit weight (g) and predicted fruit weight (g) for the cultivars

T a b l e 2. The relationship between actual fruit volume and the independent variables used in the fruit volume prediction model

Model	r^2
$FV = 46{,}575 - 10{,}392\ast\mathbf{W} + 7{,}479\ast\mathbf{L} - 5{,}692\ast\mathbf{H} - 0{,}055\ast\mathbf{W}^2 - 0{,}111\ast\mathbf{L}^2 + 0{,}216\ast\mathbf{W}\ast\mathbf{L}$	0.9958
SE 4,086*** 1,101*** 0,992*** 0,628*** 0,014*** 0,014*** 0,019***	
$+0{,}0002\ast\mathbf{W}\ast\mathbf{L}\ast\mathbf{H} + 5{,}865\ast\mathbf{H}\ast\mathbf{W}/\mathbf{L} - 2{,}115\ast[\mathbf{Cv.}] + 0{,}063\ast[\mathbf{Cv.}]\ast\mathbf{H}\ast\mathbf{W}/\mathbf{L}$	
SE 0,034*** 0,000*** 0,678*** 0,009***	

FV: Fruit volume, W: Fruit width, L: Fruit length, H: Fruit height, Cv.: Cultivar coefficient [given in the brackets] [1] for 'Early Red', [2] for 'Dixired', [3] for 'Cardinal', [4] for 'Redhaven', [5] for 'Glohaven', [6] for 'Cresthaven', SE: Standard error
***Significant at the level of 0.1%

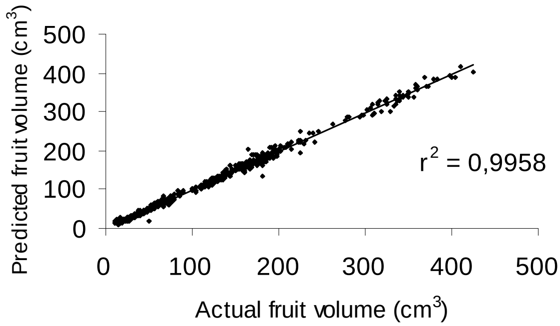

Figure 2. The overall relationship between actual fruit volume (cm^3) and predicted fruit volume (cm^3) for the cultivars

CONCLUSION

Models for predicting fruit weight and volume for 6 economically valued peach cultivars were developed. It was found that there were significant differences among the cultivars in terms of being a parameter in each model. For this reason, coefficients related to a given cultivar must be used in all the developed models for the most reliable result. Peach researchers can use the models produced for the cultivars used in this research. However, the models must be validated at different regions.

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MODEL DO PRZEWIDYWANIA WAGI I OBJĘTOŚCI BRZOSKWINI NA PODSTAWIE POMIARÓW LINIOWYCH OWOCU PODCZAS WZROSTU

Hüsnü Demirsoy i Leyla Demirsoy

S T R E S Z C Z E N I E

Wielkość owocu jest ważnym wskaźnikiem jakości w handlu. Jest ona także używana jako marker morfologiczny przy identyfikacji odmian. W niniejszej pracy przedstawiono model pozwalający przewidzieć wagę i objętość owoców sześciu odmian brzoskwini (‘Earlyred’, ‘Dixired’, ‘Cardinal’, ‘Redhaven’, ‘Glohaven’ i ‘Cresthaven’) na podstawie pomiarów wykonanych w różnych okresach ich rozwoju. Model jest oparty na analizie regresji wieloczynnikowej.

Słowa kluczowe: brzoskwinia, waga i objętość owocu, modelowanie matematyczne