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CORRELATIONS BETWEEN FRUIT QUALITY PARAMETERS AND DA-METER INDEX IN SEVERAL APPLE CULTIVARS

Butcaru Ana Cornelia[1*], Matache Robert[1], Mihai Cosmin Alexandru[1], Asănică Adrian Constantin[1], Hoza Dorel[1], Stănică Florin[1]
[1] University of Agronomic Sciences and Veterinary Medicine of Bucharest
* *Corresponding author. E-mail*: anabutcaru@gmail.com

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ABSTRACT

This study presents the first results on the non-destructive, DA meter-based optimum harvest maturity model for some disease-resistant apple cultivars, cultivated in the Bucharest area. Seven scab-resistant cultivars (Iris, Generos, Remar, Redix, Rebra, Ciprian, and Florina) were analyzed. The results bring important details about the pre-harvest and harvest maturation of the studied cultivars using the IAD index. Given the climate changes, this instrument can be accurately used to assess the maturity level of fruits, taking into account the particularities of each cultivar. In order to establish an optimal model for each cultivar, further researches are needed to correlate the optimal harvesting period index (IAD) with the required post-harvest period. DA-meter could be an important instrument to estimate the optimal parameters for self-life, also.

INTRODUCTION

One of the methods to determine fruit maturity based on measurements of chlorophyll content can be easily used in the field and laboratories with an absorbance (DA) meter. More researches are focused on using a DA-meter to measure on-the-tree or immediate post-harvest fruit maturity, to distinguish post-harvest and/or post-storage maturity as a means of segregating fruit into market-relevant quality categories (Scalisi et al., 2021; DeLong et al., 2020).

DA-meter for apple measurements was created by the former Department of Fruit Tree and Woody Plant Sciences of the University of Bologna (Turoni, Italy). The equipment allows to define the ripening stage reached by the fruits, defining a new ripening index, "Absorbance Difference index" (IAD), related to fruit ethylene emission and chlorophyll content degradation (Costamagna et al., 2013; Peifer et al., 2018). The DA-meter measures the difference in absorbance between two wavelengths (A670 nm, A720 nm) near the upper absorption peak of chlorophyll a, which is then used to calculate the index of absorbance difference (Torres et al., 2018; DeLong et al., 2020; Wang et al., 2021).

This study presents the preliminary results on the non-destructive, DA meter-based optimum harvest maturity model for several scab disease-resistant apple genotypes, cultivated in the Bucharest area.

MATERIAL AND METHODS

The research was conducted at the Research center for studies of food and agricultural products quality, Laboratory of Fruit Growing (University of Agronomic Studies and Veterinary Medicine of Bucharest). The tested apple fruits were monitored and harvested from the Experimental field of the Faculty of Horticulture in Bucharest, located in the North part of the town.

Seven scab-resistant cultivars (Iris, Generos, Remar, Redix, Rebra, Ciprian, and Florina) were analyzed (Table 1).

Table 1

Biological material used in the experiment

Cultivar	Genitors	Ripening period
Iris	Prima (seeds irradiation)	September
Generos	(Parmain d'or x M. Kaido) x (Jonathan x Frumos de Voinești)	September
Remar	Prima (free pollination, seed irradiation)	September
Rebra	Florina x Idared	Late September - October
Redix	Goldspur x Prima (free pollination)	Late September - October
Ciprian	Prima x Starkrimson	Late September - October
Florina	*M.floribunda* 821, Rome Beauty, Golden Delicious, Starking Simpson'S Giant Limb, Jonathan	Late September - October

Source: Ghena et al., 2004; Braniște et al., 2008; Braniște and Uncheașu, 2011.

Pre- and post-harvest monitoring with Da-meter and biochemical analyses

I_{AD} index was determined for each variant beginning to middle August. Two weeks after harvesting, the I_{AD} index was determined for each fruit, from each variant consumption maturity. The basic analyses like average fruit weight, length and diameter, total soluble solids, total acidity, dry matter, and firmness were determined and correlated with the I_{AD} index. Total soluble solids were determined for each genotype, with a refractive device Kruss DR301-95 (° Brix). Fructose (%) and glucose (%) were determined using Milwaukee refractive devices. The dry matter and water content of the samples were determined by oven drying for 24 hours at 105°C using a UN110 Memmert oven. Firmness was determined with a digital penetrometer TR Turoni 53205, the results were expressed in kg f/cm^2. An automatic titrator was used to determine total acidity in fruits (Bezdadea Cătuneanu et al., 2018).

RESULTS AND DISCUSSIONS

This study presents the preliminary results regarding the efficiency of I_{AD} index using on apple fruits maturation evaluation at the seven cultivars monitored. Climate changes bring important challenges in the apple technologies, one of them being the evaluation of the optimum harvesting moment, correlated with the desired quality fruit parameters and post-harvest length period. Firmness and total soluble solids can fail in the prediction models (Wang et al., 2021).

Beginning with August, fruits were monitored, I_{AD} index was analyzed periodically (Fig. 1). According to the cultivar specificity, the fruits were harvested to a specific I_{AD} index interval value (ex. Rebra, Remar).

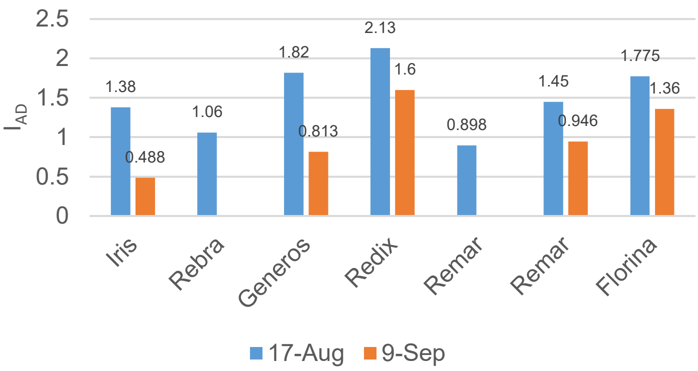

Figure 1. Evolution of I_{AD} index during the pre-harvest period at some of the monitored cultivars (2021)

Correlations between fruit firmness and I_{AD} were analyzed. Some of the cultivars presented strong to low correlations (Table 2), others had un-significant values (Iris, Remar, and Florina).

Table 2

Correlation between fruit analyzed parameters and I_{AD}

Cultivar	Correlation		Regression equation
Ciprian	Firmness – I_{AD}	Very strong (R^2 = 0.913)	y = 1.1068x + 1.6946 y =firmness, x= I_{AD}
Rebra	Firmness – I_{AD}	Strong (R^2 = 0.7016)	y = 0.7223x + 2.4085 y =firmness, x= I_{AD}
Redix	Firmness – I_{AD}	Medium (R^2 = 0.5942)	y = 0.6107x + 1.8108 y =firmness, x= I_{AD}
Generos	Firmness – I_{AD}	Low (R^2 = 0.3431)	y = 1.178x + 2.3418 y =firmness, x= I_{AD}

Total soluble solids is another important parameter in fruit maturity evaluation for harvesting moment establishment. Some of the cultivars presented significant correlation values (Redix, Rebra, and Florina) and the others un-significant values.

For the entire group of cultivars, a low correlation is maintained between firmness and I_{AD} (R^2=0.267), for total soluble sugars and I_{AD} (R^2 = 0.292), fructose and I_{AD} (R^2 = 0.416) and glucose with I_{AD} (R^2 = 0.450) (Table 3 and Figures 2-4).

The results are similar to Peifer et al. (2018), Costamagna et al. (2013), DeLong et al. (2020) and Cocetta et al. (2017).

CONCLUSIONS

New technologies require new knowledge and new equipment. The DA-meter instrument proved its efficiency in evaluating the optimal harvesting moment for apples and also, the fruit stage in the post-harvest period.

Given the climate changes, this instrument can be accurately used to assess the maturity level of fruits, taking into account the particularities of each cultivar. In order to establish an optimal model for each cultivar, further researches are needed to correlate the optimal harvesting period index (I_{AD}) with the required post-harvest period. DA-meter could be an important instrument to estimate the optimal parameters for self-life, also.

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Table 3

Fruit quality basic parameters analyzed

	Fruit weight (g)	Fruit lenght (mm)	Fruit diameter (mm)	Firmness (kg f/cm2)	TSS (°Brix)	Fructose (%)	Glucose (%)	TA (g malic acid/ 100fw)	TA/TSS	I_{AD}	SUT
Iris	129.550	54.463	69.230	1.775	13.233	14.633	14.933	0.454	0.034	0.187	0.157
Rebra	177.243	66.013	83.235	2.458	13.367	13.867	13.733	0.328	0.025	0.079	0.121
Generos	156.446	60.654	74.100	2.485	13.260	13.620	13.200	0.390	0.029	0.122	0.146
Redix	131.487	62.354	68.663	2.373	13.580	13.800	13.640	0.358	0.026	0.921	0.149
Remar	124.418	50.248	67.543	3.275	15.980	16.500	16.120	0.861	0.054	0.296	0.177
Ciprian	89.382	48.350	59.962	3.357	11.520	11.800	11.440	0.332	0.029	1.502	0.137
Florina	168.810	63.932	74.027	3.524	13.400	13.660	13.220	0.356	0.027	0.741	0.164

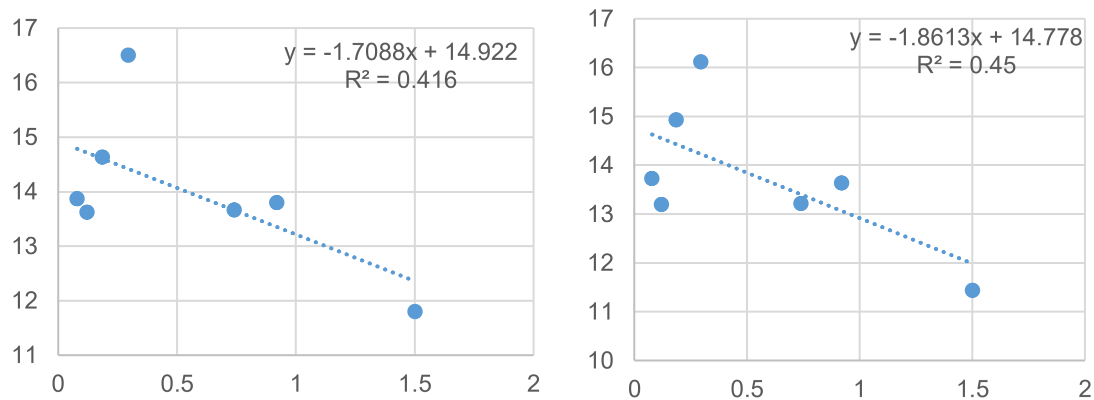

Figure 2. Correlation between fructose (left) and glucose (right) with I_{AD} index two weeks after harvest

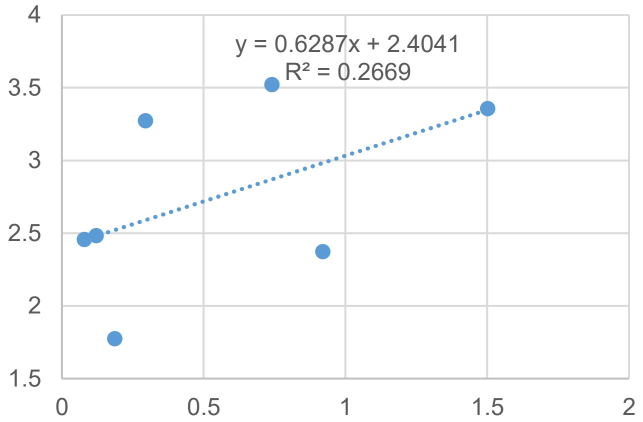

Figure 3. Correlation between firmness and I_{AD} index two weeks after harvest

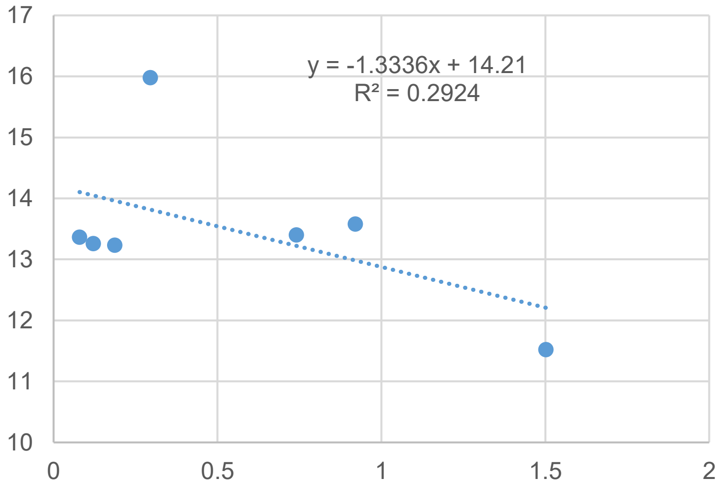

Figure 4. Correlation between total soluble solids and I_{AD} index two weeks after harvest