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ASSESSMENT OF HARVEST TIME FOR RED DELICIOUS CV. THOUGH HARVEST INDEXES IN ALBANIA

P. ICKA and R. DAMO
University Fan S. Noli, Department of Agronomy, Bulevardi Rilindësit 11, Korca, Albanian

Abstract


The apple fruits are one of the most profitable crops in Albania. The increase to the number and surface of orchards during last decade is accompanied by storage problems. One of the major problems in apple storage is the determination of optimal harvest time. The traditional maturity indicators do not give the clear situation of maturity processes, for this reason usage of maturity indexes contribute in the determination of optimal harvest time for apple orchards. Calculated values of the indexes Streif (0.075 – 0.10), De Jager (5.0 – 6.0), FARS (0.2 – 0.3) and Thiault (150) indicate that the optimal harvest time for Red Delicious apples in Korça region is from 20th September up to 1st October. This harvest time is indicated also by the proposed Ripening index (-1 – 1), while Sugar/acidity ratio (40 – 50) and Perlim index (4.3 – 4.6) give an approximate harvest time but these indexes show the trend of fruit maturity.

Kew words: apple, Red Delicious, maturity index, harvest time, Ripening index

Introduction

Apple (Malus × domestica Borkh.) belongs to the main fruit species and they are the most important fruit in Europe (Patzak et al., 2012), and one of the most consumed in Albania with 19 kg/year/capita (USAID, 2008). Korça region produces almost 70% of the apples grown in Albania, with approximately 40,000 tons fruits per year. Therefore it is very important to evaluate and to suggest the harvest indexes in accordance with consumer’s tastes and preferences.

Apples are subjected to major quality loss during harvest and postharvest treatments (Ozturk et al., 2012). Storage conditions determine the longevity of storage life of apples (Blážek et al., 2003), and to ensure maximum storability, apples should be picked when mature, but not fully ripe. Later picked apples often are over mature and all physiological processes are underway what complicate storage, even under optimal conditions (Kvikklené et al., 2008). Apples picked at right stage have the organoleptic qualities, which enable them to survive more than six months storage. If the optimal harvest period could be predicted well prior to harvest, it would also allow the grower to maximise harvest labour use efficiency (Peirs et al., 2001).

Establishing the optimum harvest date is an important factor in obtaining quality fruits. The best way to provide customers with good quality apples is to select the most appropriate harvest date to guarantee consumer acceptance (Streif, 1996; Peirs et al., 2001; Molina et al., 2006). Quality of apple is consisted of a combination of visual appearance, flavor and texture (Ozturk et al., 2012). The maturity level, color, size, mechanical defect (Ozturk et al., 2012), and firmness (Ozturk et al., 2011; Ozturk et al., 2012) are important factors for apple marketing, because in apples, fruit appearance is very important factor (Kacal and Koyuncu, 2012.). Measurements of soluble solid content and titratable acidity are often included in assessments of the postharvest quality of apples (Goliáš et al., 2008). Therefore it is necessary to assess the quality of apple fruit picked on different dates. It is hoped that these findings will help the apple growers a lot to pick their fruits at proper time and store them in cold storage with minimum losses to present the fruits of best qualities to consumers too (Ullah et al., 2004). The determination of optimum harvest date has become more severe since storage facilities are getting precisely controlled requiring adequate fruit material (Zude-Sasse et al., 2000).

E-mail: pirroicka@yahoo.com
Maturity is the harvest index most widely used in fruits. However, physiological maturity needs to be distinguished from commercial maturity (Camelo, 2004). The most widely used maturity indicators for apples include flesh firmness, starch content, sugar content (“Brix), fruit colour, and internal ethylene concentration. The following attributes are also used as supplemental maturity indicators: titratable acidity content, days from full bloom, and temperature accumulation. Fruit harvested at optimum maturity and handled properly has good storability and good eating quality (Bai et al., 2009).

To stabilize the best harvest date it is good practice to refer not only on one indicator, but to consider different at the same time. Some indicators may be combined together to obtain the harvest indexes (Bufacchi et al., 2000). Among these the most important are: Streif index, De Jager index, Thialut index, FARS index etc.

In this study we have measured four indicators, total soluble solids (TSS), titrable acidity (A), starch degradation (S) and firmness (F), to compute six indicators for the optimum harvest date determination as well as prediction of fruit quality in Red Delicious apple.

Materials and Methods

Korça Field is located in South East of Albania with an altitude 820 – 950 m above sea level. It has a Mediterranean continental clime, with dry and hot summer and cold and wet winter. It is the driest (760 mm rainfall per year) and coldest (up to – 27°C) region of Albania.

The orchard in the study is located 3 km on south-west of Korça city (40°35’35’’ N and 20°45’52’’ E) with an altitude 885 m above sea level. The soil texture of orchard is clay and soil quality index according Visual Soil Assessment is 18, classified as moderate (Damo and Icka, 2011). According the Standardized Precipitation Index evaluation the hydrological situation during the study period is mainly a normal situation except the year 2009 that is characterized by rainfall events (Icka et al., 2011).

The major apple cultivars growing in the Korça region are Red Delicious 52% and Golden Delicious 42% of apple orchards (USAID, 2008), for this reason it is very important to determine the best harvest time using the indexes for Red Delicious apples in this region. The evaluation of indicators to calculate the indexes was made during three years period study 2007 – 2009, for each estimated harvest date, 1st September, 20th September and 10th October. At least 40 fruit of Red Delicious are analyzed for four indicators:

Starch iodine test (S) indicates the gradual change of starch into sugars in the fruit. The starch iodine index was determined according the EUROFRU with 1 – 10 score comparing the iodine treated fruits with the given figure. The iodine solution is prepared according Chu, 2000.

Total soluble solids (TSS), are determined by using the WYA-2W ABBE refractometer at room temperature (20°C), the TSS is given as “Brix.

Flesh firmness (F) of peeled apple tissue is measured on both sides of fruits with Effegi penetrometer (FTX 30) fitted with 11 mm diameter probe, the F is given as kg/cm².

Acidity (A) of fruit juice (given in g/L malic acid) is determined by titration of 10 ml apple juice with 1.0 M NaOH at pH=8.2.

Evaluation of the harvest time is made by using six harvest indexes that combine the above indicators:

Streif index (Streif, 1996; Hägg et al., 1999; Zude-Sasse et al., 2000; Peirs et al., 2001; Ullah et al., 2004; Alegre et al., 2006; Róth et al., 2007; Kviklené et al., 2008; Kviklys 2012)

\[
\text{Streif index} = \frac{F}{TSS \times S}
\]

De Jager index (De Jager, Roelofs, 1996; Bufacchi et al., 2000; Molina et al., 2006; Alegre et al., 2006):

\[
\text{FARS index} = \frac{F \times A}{TSS \times S}
\]

Perlim index (Hägg et al., 1999):

\[
\text{Perlim index} = (F \times 0.5 + TSS \times 0.67 + A \times 0.67) - 10
\]

Thialut index (Hägg et al., 1999; Bufacchi et al. 2000; La Iacona et al., 2009):

\[
\text{Thialut index} = TS + A \times 10
\]

Total (Total Sugar) = (TSS\times10.6) - 20.6

Total Sugar/Acidity ratio (Bufacchi et al., 2000; OECD, 2005, 2009; Molina et al., 2006; Brown et al., 2006; Skrzyński et al., 2006; Dhatt et al., 2007; AA. VV., 2010):

\[
\text{Total Sugar/Acidity ratio} = \frac{TSS \times 10}{A}
\]

ANOVA was performed on the results of calculated indexes to determine the harvest time, and Fisher’s least significant difference (LSD) intervals, at 95% and 99% confidence limits, are computed for each parameter.

Results and Discussion

During three harvest times are evaluated the four indicators: total soluble solid (“Brix), acidity (g/l), starch iodine (1 –
The mean values of indexes in three harvest dates for the Red Delicious Apple.

<table>
<thead>
<tr>
<th></th>
<th>Streif index</th>
<th>De Jager index</th>
<th>FARS index</th>
<th>Perlimindex</th>
<th>Thiaultindex</th>
<th>TS/A index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Sep</td>
<td>0.350±0.059a</td>
<td>8.975±0.917</td>
<td>1.231±0.226</td>
<td>4.930±0.383</td>
<td>137.21±4.631</td>
<td>33.007±1.662</td>
</tr>
<tr>
<td>20-Sep</td>
<td>0.104±0.013</td>
<td>5.992±0.608</td>
<td>0.328±0.052</td>
<td>4.646±0.486</td>
<td>149.11±6.646</td>
<td>41.526±3.444</td>
</tr>
<tr>
<td>10-Oct</td>
<td>0.048±0.006</td>
<td>3.468±0.494</td>
<td>0.127±0.018</td>
<td>3.658±0.373</td>
<td>153.69±4.544</td>
<td>52.437±5.282</td>
</tr>
<tr>
<td>*P&lt;0.05</td>
<td>0.01</td>
<td>0.336</td>
<td>0.067</td>
<td>0.458</td>
<td>4.375</td>
<td>1.538</td>
</tr>
<tr>
<td>**P&lt;0.01</td>
<td>0.017</td>
<td>0.557</td>
<td>0.11</td>
<td>0.758</td>
<td>7.239</td>
<td>2.544</td>
</tr>
</tbody>
</table>

* Standard deviation
harvest date. According our conditions we recommend that the value for TS/A index should be 40 – 50.

Evaluation of harvest time according the harvest indexes show that the optimal period of harvest for Red Delicious in Korça region is between 20th September and 1st October, which coincide with 150 – 160 day after blooming. The values of indexes Streif, De Jager, FARS, Perlim and Thiault, show a harvest time limited close the 20th September, while TS/A index indicate a wider period. The total sugar/malic acid ratio can be used to determine the trend of fruit ripening, but cannot be used as a single index for evaluating the harvest time for apples.

The proposed harvest index

As far as the maturity of apple fruits are accompanied by the diminution of firmness values and by incense to the starch degradation values, we can put this data in a graphical situation to get the break point of the starch degradation ($I_a$) and firmness ($F$) curves (Graphic 1). This break point in our study case is around 7 – 8 days after the second harvest date 20th September. This is the optimal harvest date estimated by the indexes above for the Red Delicious apples.

Table 2
Recommended maturity indexes values and harvest time for Red Delicious in Korça region

<table>
<thead>
<tr>
<th>Indexes</th>
<th>Red Delicious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streif</td>
<td>0.075 – 0.10</td>
</tr>
<tr>
<td>De Jager</td>
<td>5.0 – 6.0</td>
</tr>
<tr>
<td>FARS</td>
<td>0.2 – 0.3</td>
</tr>
<tr>
<td>Perlim</td>
<td>4.3 – 4.6</td>
</tr>
<tr>
<td>Thiault</td>
<td>150</td>
</tr>
<tr>
<td>Sugar/Acidity</td>
<td>40 – 50</td>
</tr>
<tr>
<td>Ripening index ($I_p$)</td>
<td>-1 – 1</td>
</tr>
</tbody>
</table>

Recommended harvest time 20 September – 1 October

If these two harvest indicators are given as their difference, we can reach a new harvest index, the Ripening index ($I_p$). As the values of firmness decrease and the starch index is increase, in one given moment the difference of these values is zero (in the breaking point). This value should be the best harvest time according the $I_p$ index. This alternative index can formulate in the following expression:

$$I_p = \text{Ripening index}$$
$$I_a = \text{Starch index (1 – 10)}$$
$$F = \text{Firmness kg/cm}^2$$

A single value of the index usually is not easy to be estimated for the optimal harvest time, for this reason we propose that the interval of $I_p$ value for a mature Red Delicious apples should be -1 – 1. This is an easy index to calculate because it takes only two simple indicators to be evaluated. For this region the Ripening index should be one of the most used harvest index in Korça region and further.

Conclusion

Using the maturity indexes (Streif, De Jager, FARS, Thiault, Perlim, sugar/acidity ratio, Ripening index) is the best way to determine the harvest time for apples due to the consideration of two or more indicators for the calculation. According the values of calculated indexes the optimal harvest time for Red Delicious apple in Korça region is from 20th September till 1st October (Table 2). Sugar/acidity ratio and Perlim index are indexes that can be used to determine the maturity tendencies and the consumption maturity of fruits.

The proposed Ripening index may be one of most practical index due to its easiness on measuring and calculation. However this index should be studied to have the right values for harvest time in Korça region. For a continuous evaluation of the maturity indicators and indexes during the maturity period it is necessary to determine the right harvest time. This will help for a good storage and good practices on the orchards.

References


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