CHANGES IN CHERRIES SIZE AND QUALITY ACCORDING TO COLOR

MODIFICĂRI ALE DIMENSIUNII ŞI CALITĂŢII CIREŞELOR ÎN FUNCŢIE DE CULOARE

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Abstract.*The objective of the current research was to investigate the changes during maturation of cherries (Prunus avium L.). The studies were conducted in the commercial orchard of the Republic of Moldova, at Vindex-Agro SRL, Orhei (47 ° 46'S, 29 ° 13'E) during the three and four years of cherry tree fructification. The orchard was established in autumn 2011 with cherry trees of Ferrovia and Regina varieties, grafted on Gisela 6 rootstock, at a planting distance of 4x2.5 m. The trees are formed according to the Slender Spindle Ameliorated system. Experience includes four rehearsals of eight trees each (n = 32). Fruit recording and evaluation was performed during the ripening period, according to the color of the skin, according to the CTIFL Colored Color (Yellowish-pink, Very light red, Red Bright red color, Dark red, Dark brown-red, Dark brown) and the content of soluble solids content (SSC). By deduction and calculation, the notion of calculating the cherry diameter was introduced in fruit growing knowing their mass. The last weeks before harvest, from the time the fruits begin to mature and the color of the skin changes from green to yellowish, a period determines fruit development and orchard productivity. In this period, as the fruit grows, their diameter increases, but with a much lower rhythm.*
Key words: cherry, variety, soluble substances, fruit mass and diameter, harvest

Rezumat *Obiectivul cercetării actuale a fost de a investiga modificările în timpul maturizării cireşelor (Prunus avium L.). Studiile s-au efectuat în livada comercială din zona pomicolă de centru a Republicii Moldova, la SRL Vindex-Agro, r. Orhei (47° 46'S, 29° 13'E) pe parcursul anului trei şi patru de fructificare a pomilor de cireş. Livada s-a înfiinţat, în anul 2011 toamna, cu pomi de cireş din soiurile Ferrovia, Regina, altoite pe portaltoiul Gisela 6, la distanţa de plantare de 4x2,5 m. Pomii sunt formaţi după sistemul Fus subţire ameliorat. Experienţa include 4 repetiţii a câte 8 pomi fiecare (n=32). Evidenţa şi aprecierea fructelor s-a efectuat în perioada de maturare, după culoarea pieliţei, conform fişei de culori CTIFL (Roz-gălbuie, Roşu foarte deschis, Roşie, Rumănă aprinsă, Roşie închisă, Brună-roşietică închisă, Cafeniu-închis) şi a conţinutului de substanţe uscate solubile. Prin deducţie şi calcul s-a introdus în pomicultură noţiunea de calcul a diametrului cireşelor ştiind masa lor. Ultimele săptămâni înainte de recoltare, din momentul când fructele încep să se matureze şi culoarea pieliţei se transformă din culoarea verde în roz-gălbuie, este o perioadă care determină dezvoltarea fructelor şi productivitatea livezilor. În această perioadă, pe măsura creşterii masei fructelor se măreşte şi diametrul lor, dar cu un ritm mult mai mic.*
Cuvinte cheie: cireş, soi, substanţe uscate solubile, masa, diametrul, recolta

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INTRODUCTION

Cherry is a high-value crop where fruit quality is essential for competitive production and particularly important for economic sustainability in a high production cost situation. To maximize efficiency, fruit must be large and firm, with high sugar levels. The moment of harvesting has the greatest impact for the production of fruits with the desired qualities (Serrano *et al.*, 2005; Long, 2014). Fruit color seems to be the best indicator for deciding when to harvest (Tudela *et al.*, 2005), but it is also necessary for the sugar content of dry soluble substances (SSC), titratable acidity (TA), the mass and diameter of the fruit (Predieri *et al.*, 2004).

For export, it is very important for cherries to be harvested at the right time, to be firm, to have a uniform color and to be very resistant to crushing and scratching. Cherries that are dark red in reddish brown are more resistant to mechanical damage than other stages of development (Romano *et al.*, 2006). For cherries to remain firm, trees must have enough water in the soil to allow the fruit to regain its turgidity quickly, especially immediately before harvesting. During this period, cherry plantations irrigate more frequently, but with lower doses (Long *et al.*, 2014; Neilsen *et al.*, 2014). In the last two weeks of cherry development, the total dry fruit weight is increased 3 times, and a quarter of the weight accumulates during the week immediately preceding the harvest (Keller and Loescher, 1989). This is one of the basic reasons for correctly determining the harvest time and the fruit growing technology.

MATERIAL AND METHOD

The studies were conducted in the commercial orchard of the Republic of Moldova, at Vindex-Agro SRL, Orhei (47 ° 46'S, 29 ° 13'E) during the three and four years of cherry tree fructification. The orchard was established in autumn 2011 with cherry trees of Ferrovia and Regina varieties, grafted on Gisela 6 rootstock, at a planting distance of 4x2.5 m. The trees are formed according to the Slender Spindle Ameliorated System. The soil is maintained by the natural way, the orchard drip irrigation, and Watermark transducers are used to monitor the soil moisture. The water is distributed through drilled bridges fixed 40 cm from the ground in the direction of the row. The strips between the 2.5 m wide rows, with spontaneously growing weeds, are mown to necessity and remain as mulch.

Experience includes four rehearsals of eight trees each (n = 32). Measurements were performed in field and laboratory conditions according to approved research methods in fruit growing. Fruit recording and evaluation was performed during the maturing period, according to the color of the skin, according to the CTIFL color card (Long, 2014) and the SSC. The harvesting for each variety was done individually by weighing the fruits of 32 trees in the variant.

The diameter and mass of the cherries in the period of fruit development and maturation was identified by means of a calipers and a template with holes of 26, 28, 30, 32, 34 and 36 mm corresponding to the mass of 8.5; 10; 11.5; 13; 14.5; 16 g corresponding. These analyzes were recorded from the time the fruit began to change the color of the skin from green to yellowish to full ripening every 3 days according to the CTIFL color chart (Yellowish-pink, Very light red, Red Bright red color, Dark red,

Dark brown-red, Dark brown) on 20 cherries in four identical samples (n = 80) of each variety. The content of SSC was determined in the orchard by using the portable ATAGO N-20E refractometer, which expresses values in Brix%.

RESULTS AND DISCUSSIONS

Cherry varieties Ferrovia and Regina, grafted on Gisela 6, entered the fruit from the third year after planting and the harvest recorded average values of 400-500 kg/ha. The harvest in the second year of fructification recorded average values of 4900-5000 kg/ha, and in the third year of fructification (2016) the harvest is three times higher compared to the second year, constituting 11890-13290 kg/ha. In 2017, the cherry harvest decreased due to unfavorable conditions at the time of the flowering of trees, expressed by low temperatures on April 19 and abundant snow on 20-21 April (tab. 1).

Table 1

Fruit harvest on cherry trees *(Cerasus avium L.)*, kg/ha

Variety	Years				Average (2014-2017)
	2014	2015	2016	2017	
Ferrovia	500	4900	13290	7933	6656
Regina	400	5000	11890	7573	6216
DL, 5%	-	-	1053	682	-

For the correct assessment of the time of cherry harvesting, the color, mass and diameter of the fruit was evaluated from three to 3 days during fruit maturation. The growth rate of the fruit mass during the cherry maturing period was different (tab. 2). When fruit begins to mature and the color of the skin changes from green to pink, the growth rate is higher compared to the following maturation periods. For example, in Ferrovia variety, the color of the rosé skin, the cherry mass was 5.15 g, in the very light red color - 6.53 g or 15.7% more. The fruit table, from the very light red color, grew by 4.4% in the red color and by 4% in the light brown color. The change of color from roasted red to dark red was manifested by a growth rate of fruit weight by 8.5%, and from the light brown to dark brown color, the growth rate of the fruit weight was 12.7 %. From the moment, the fruits begin to change their color from green to yellowish to the dark brown and dark brown color, the Ferrovia fruit mass increases by 40.3%.

Table 2

The weight and the diameter of cherries *(Cerasus avium L.)* according to their variety and color

Nr.	The color of the skin	Ferrovia variety		Regina variety	
		Fruit weight, g	Fruit diameter, mm	Fruit weight, g	Fruit diameter, mm
1	Yellowish-pink	5.15	20.87	6.05	22.13
2	Very light red	6.53	22.79	7.55	24.21
3	Red	6.91	23.32	7.75	24.49
4	Bright red color	7.26	23.81	8.30	25.26
5	Dark red	8.01	24.85	9.10	26.37
6	Dark brown-red	8.35	25.32	9.21	26.52
7	Dark brown	8.62	25.70	9.51	26.93

The same findings also arise for the Regina variety in the sense that, as soon as the color of the fruit skin becomes yellowish, the fruit mass grows rapidly to the dark brown-red color, then the rhythm of fruit growth decreases. It follows that determining the optimal harvesting period for cherries is the first step in obtaining quantitative and qualitative fruits.

With regard to the diameter of the fruit, it is observed that from the moment the cherries turn green in color, the diameter of the fruit at Ferrovia increases considerably from 20.87 mm to 25.7 mm. Thus, at Ferrovia since the color change of the yellowish-red fruit very open, the cherries increased in diameter by 7.6%. In the next stages of pulp ripening, color change from red very light to red and then to the brightly colored rosemary, the fruit diameter growth rate is slower and is 1.8-2.1%. Changing the color of the rust skin in the dark red has resulted in a 4.1% increase in the fruit diameter. In the fruit-ripening stages, which follow from dark red to dark brown and dark brown, the growth rate of the cherry diameter is only 1.5-1.8%.

Ripening the pulp of the Regina variety is marked by an increase in fruit diameter of 22.13 mm when the skin is a yellowish color at 26.93 mm when the fruits are dark brown. In the Regina variety, the higher fruit growth rate was recorded when the color of the skin from reddish yellowish to very light red (7.6%) and from red to brownish brown (4.8%).

We mention that in the first two weeks prior to harvest the cherry diameter increased to Ferrovia variety from 20.87 to 25.7 mm and Regina variety from 22.13 to 26.93 mm or on average by 17.7-18.8%.

The color of the fruit, their size and their mass determine the right time to harvest the quality export cherries. Cherries that are dark red in reddish brown are more resistant to mechanical damage than other stages of development (Long *et al.,* 2014). Cherries intended for export are harvested at full maturity or 2-3 days earlier when the fruits are dark brown and red because they do not continue the maturing process.

The last weeks before harvest, from the time the fruits begin to mature, and the color of the skin turns from greenish to yellowish, a period determines fruit development and orchard productivity. During this period, the Ferrovia variety accumulating 40.3%, and in the Regina variety 39.5% of the total fruit weight. Obviously, as the fruit grows, their diameter increases, but with a much lower rhythm. Thus, in the Ferrovia variety during the curing of the fruit, the diameter of the cherries increases by 18.8% and the Regina variety by 17.7%.

Here it is appropriate to specify that although the quality of cherries has different meanings for different stakeholders in the value chain of fruit (producers, distributors, consumers etc.), consumer acceptance seems to be the most important factor to be taken into account.

Regardless of consumer preferences, firmness is a key issue for marketing cherries abroad. However, the factors that define fruit productivity and quality are the variety, rootstock, planting distance, crown form, pedoclimatic conditions, and agro-technical conditions that require a full assessment of the current situation to quality standards (Balan, 2015).

Research has shown significant relationships between the size of the fruit and its mass (fig. 1). Analyzing the values of the diameter and the mass of the cherries was determined by deduction and calculation the following formula:

$$Y = 1.39x + 13.72$$

where:
Y - Cherry diameter, mm;
X - The mass of cherries, g.

The experimental data show that the relationship between the diameter and the mass of cherries at harvesting is linear. The researches undertaken have allowed introducing in fruit growing the notion of calculating the diameter of the cherries knowing their mass.

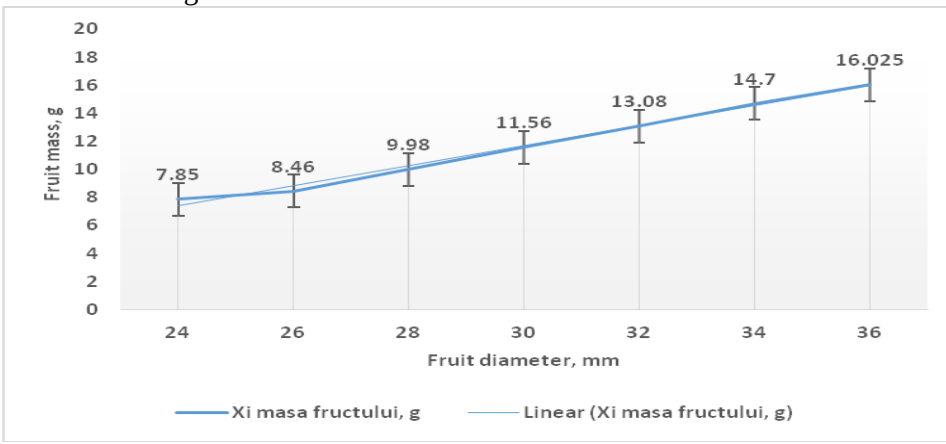

Fig. 1 Relationship between the diameter and the mass of cherries at harvest

The dry substance soluble in cherries was determined from the moment the fruits flushed until the time of harvesting (tab. 3). From the moment the fruit skin is red SSC in the fruit grows considerably. Thus, in the Ferrovia variety in 2016, the cherry SSC increased from 4.3 Brix% to red to 18.5 Brix% dark brown and Regina variety to 3.9 Brix% To 18.3 Brix%. The same findings also arise for the year 2017 in the sense that, from the moment the color of the fruit skin becomes red, the SSC in the fruit grows rapidly until the dark red-brown color, then the SSC rhythm decreases. Therefore, the SSC concentration is approaching the maximum during the fast color change period. Hence, skin color change could be used to determine the optimal harvest date.

Table 3

Dry cherry-soluble substance according to color, %

Variety	The color of the skin									
	Red		Bright red color		Dark red		Dark brown-red		Dark brown	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Ferrovia	4.3	3.5	6.8	6.4	12.8	13.4	17.5	17.2	18.5	18.8
Regina	3.9	3.5	7.0	6.0	13.3	13.8	17.0	17. 4	18.3	18.5

Fruits of the Ferrovia and Regina varieties were harvested at dark brown-red stadiums, with SSC in fruits being 17.0 -17.8 Brix% in 2016 and 17.2-17.4 Brix% in 2017.

Early harvesting can affect not only the biochemical characteristics but also the size of the crop as it has been found that in the last two weeks of cherry development, the fruit mass has increased by 39.5-40.3% of the total fruit weight, and the SSC has increased with 14.2-15%.

CONCLUSIONS

From the moment the fruits begin to mature and the color of the skin turns from green to yellowish, the fruit mass grows rapidly to the brown-red color, then the growth rate of the fruit decreases.

By deduction and calculation, the notion of calculating the diameter of the cherries was introduced in fruit growing, knowing their mass by the formula: $Y = 1.39x + 13.72$, where Y - cherry diameter, mm; X - the mass of cherries, g.

The last weeks before harvest, from the time the fruits begin to mature and the color of the skin changes from green to yellowish, a period determines fruit development and orchard productivity. During this period, the Ferrovia variety accounted for 40.3% and for Regina 39.5% of the total fruit weight, and the cherry diameter increased by 18.8% and 17.7%, respectively.

From the moment the color of the skin becomes red, the dry substance soluble in fruit grows rapidly to the dark red-brown color, then the SSC accumulation rate decreases.

Fruit color is the main indicator of maturity and it is important to establish the relationship between the skin color and the SSC to identify the color of the skin, as the cherries are harvested to meet the requirements of consumers.

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