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The effect of genotype on table grapes soluble solids content

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Abstract. Sugar concentration in fresh consumed table grapes is mainly connected with technological maturity and primarily expressed by soluble solids content. The EU Regulation has laid down maturity requirements for *Vitis vinifera* L. cultivars (OJ L 157, 15.6.2011). The lowest allowed soluble solids content is 13 °Brix for seeded cultivars and 14 °Brix for seedless cultivars. In cool climate there are mainly cultivated grape hybrid cultivars which refractometric index is not regulated with this regulation. The aim of the present experiment was to investigate the accumulation dynamics and content of soluble solids from the beginning of veraison to harvest in table grapes with protected cultivation condition. The research was conducted with 3 black ('Osella', 'Kosmonavt', 'Mars'), 3 red ('Swenson Red', 'Somerset Seedless', 'Canadice') and 2 white ('Arkadia', 'Supaga') vine cultivars in 2013 and 2014. The results of the study indicated, that fruits of all table grape cultivars achieved the minimum content of soluble solids required for table grapes. Two years mean of soluble solids content varied among black, red and white grape cultivars respectively from 15.0 to 22.1 °Brix, from 15.6 to 22.5 °Brix and from 13.9 to 18.9 °Brix. The highest soluble solids content was observed in both years among black cultivars in Osella, among red cultivars in Somerset Seedless and among white in Supaga.

Key words: Brix, *Vitis* sp., hybrid cultivars.

INTRODUCTION

The grapes (*Vitis* sp.) are used for making wine, raisin and for fresh consumption, intended for table use. In Europe traditional grape growing region lies between 30° and 50° N (Gustafsson & Mårtensson, 2005). But in spite of the harsh climate grapes are also cultivatied in cool climate condition above 50° N. In Estonia grapes are cultivated in open field contitions and protected areas. Table grapes for commercial consumption are mainly grown on protected areas because in northen countries there is a problem with late spring and early autumn frost. Protected cultivation helps to decrease frost injuries and also helps to get earlier yield (the temperature is higher than on open field).

Grapes should not be harvested until mature, because they do not ripen after harvest (Nelson, 1985). Indicator of grape maturity is the sugar content, determined as the total soluble solids content in the berry juice and it is measured on a degree-Brix scale (Nelson, 1985). Growers mainly use it as an indicator of ripness (Muñoz-Robredo et al., 2011). For winegrowers it is the most practical parameter to look at because the sugar concentration determines the potential alchol content in the wine (Liu et al., 2006; Nogales-Bueno et al., 2014). Also table grape growers need to measure the sugar content because it is connected with grape technological maturity.

Soluble solids content depends on the cultivar and production area (Nelson, 1985). In the world there are marketing standards for table grapes cultivars grown from *V. vinifera* L. Overall rule is that table grape production cultivars are harvested with a lower level of soluble solids than wine grapes (Liu et al., 2006). In the EU minimum soluble solids content levels are given as 12 °Brix for the cultivars Alphonse Lavalleé, Cardinal and Victoria, 13 °Brix for all other seeded cultivars, and 14 °Brix for all seedless cultivars (OJ L-157 15/06/2011). These standarts are same in Afghanistan, but the minimum °Brix for the Indian markets is 16 (ETN 300, 2004). In the United States, in California and early production areas the minimum soluble solids content is 16.5 °Brix (Rees et al., 2012). According to the International Organisation Vine and Wine (OIV, 2008) tabel grapes with a Brix degree equal to or above 16 is considered as ripe. Recommended soluble solids content in red wine grapes are from 20 to 23°Brix (Schalkwyk & Archer, 2000).

Proceeding from the previous, we can set up a hypothesis: in cool climate conditions table grapes ripen and achieve desired level of soluble solids on protected area faster. The aim of the study was to determine the accumulation dynamics and content of soluble solids from the beginning of veraison to harvest in table grapes with protected cultivation condition.

MATERIALS AND METHODS

The research was conducted with 3 black (‘Osella’, ‘Kosmonavt’, ‘Mars’), 3 red (‘Swenson Red’, ‘Somerset Seedless’, ‘Canadice’) and 2 white (‘Arkadia’, ‘Supaga’) vine hybrid cultivars in 2013 and 2014. The berry samples were collected from the protected cultivation area in West-Estonia at Lüüste village (58° 37′ 42″ N, 25° 8′ 17″ E). The grapevines were propagated *in vitro* and grown as own-rooted. The protected cultivation vineyard plastic tunnels 45 m in length, 8 m in width and 4 m in height were used. The protected area was covered with 0.18 thick UV stable low density polyethylene, at the end of April. Vines were planted in 2010, in 1.65 × 3.5 m spaces and trained in high double trunk trellis. White polypropylene fabric and spruce *(Picea*) branches were used as vine winter cover no additional heating system was used in plastic tunnels. The vine rows were oriented from north to south and ground covered with 0.04 mm thick black polyethylene plastic. The experimental area soil was sandy loam, pH_{KCl} 5.6 and 4.5% humus content. The soil P, K, Ca and Mg content was sufficient based on vine nutrients need and no additional fertilizers were used in experimental area. The experimental design was a randomized block with 3 replicates.

On the protected cultivation, in 2013 and 2014, the air temperatures were higher than open field and many years’ means (Fig. 1). In 2013, average air temperatures on the protected cultivation and open field were respectively 21.6 °C and 17.8 °C in June, 21.1 °C and 17.5 °C in July, 18.9 °C and 16.6 °C in August, and 12.8 °C and 10.8 °C in September. In 2014, average air temperatures on the protected cultivation and open field were respectively 17.2 °C and 13.4 °C in June, 22.9 °C and 19.3 °C in July, 18.7 °C and 16.4 °C in August, and 13.1 °C and 11.1 °C in September. In June 2013 on the protected cultivation the air temperature were 4.4 °C higher and in July 1.7 °C lower than 2014. The average temperatures in Estonia in the period from 1971–2000 were respectively 15.1 °C in June, 16.9 °C in July, 15.6 °C in August and 10.4 °C in September. It appears that, in June 2014, in the open field the temperature was 1.7 °C lower than usual. Both

years in August and September air temperature were similar among protected cultivation and among open field.

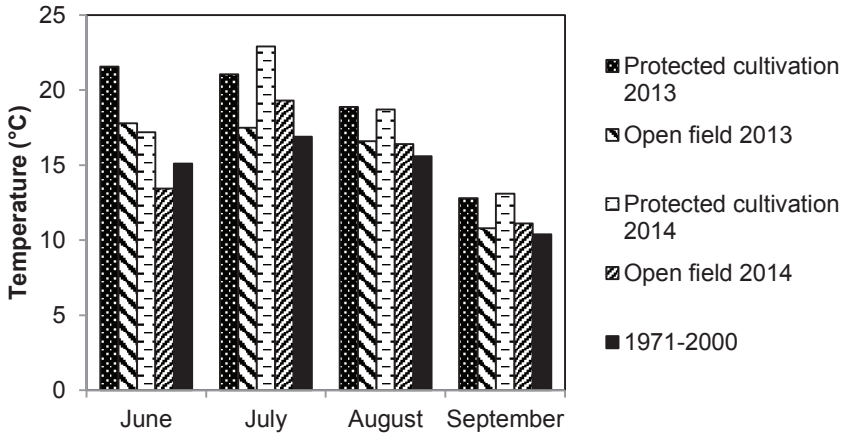

Figure 1. The mean air temperature in protected and open field in 2013, 2014 and the many years' means (1971–2000).

The soluble solids (SS, °Brix) measurements were carried out in 2013 from 08.08 to 20.09 and in 2014 from 7.08 to 12.09. The soluble solids content was measured from fresh berries by refractometer (Atago Pocket Refractometer Pal-1). For °Brix measurements, 30 grapes in 3 replications from the different parts of a cluster were picked and analysed.

The results of SS dynamics were tested by one-way analysis of variance. To evaluate significant influence, the least significant difference ($LSD_{0.05}$) was calculated. Different letters on figures mark significant differences at $P \leq 0.05$.

RESULTS AND DISCUSSION

In 2013 grapes SS content varied from the beginning of veraison to harvest from 8.7 to 22.6 °Brix and received at the minimum required level of maturity (EU standards) in different times (Fig. 2). At the beginning of August SS content varied from 8.7 to 16.3 °Brix. SS content changed in August among the cultivars 0.1 to 6.2 °Brix. SS content increased the most in cultivar Kosmonavt (10.5 to 16.7 °Brix) and least in cultivar Osella (14.1 to 14.2 °Brix). At the beginning of September SS content varied 13.0 to 20.5 °Brix and the last day of harvest 15.0 to 22.6 °Brix. SS content changed in September among cultivars 1.6 to 5.6 °Brix. SS content increased the most in cultivar Canadice (3.0 to 18.6 °Brix) and least in cultivar Mars (13.4 to 15.0 °Brix).

In 2014 grapes SS content varied from the beginning of veraison to harvest from 9.0 to 19.6 °Brix and received at the minimum required level of maturity (EU standards) in different times (Fig. 3). At the beginning of August SS content varied from 9.6 to 16.1 °Brix. SS content changed in August among the cultivars 1.5 to 6.1 °Brix. SS content increased the most in cultivar Supaga (10.6 to 16.7 °Brix) and least in cultivar Kosmonavt (16.1 to 17.6 °Brix). At the beginning of September SS content varied 12.7

to 18.1 °Brix and the last day of harvest 13.9 to 18.3 °Brix. SS content changed in September among cultivars 0.2 to 0.7 °Brix.

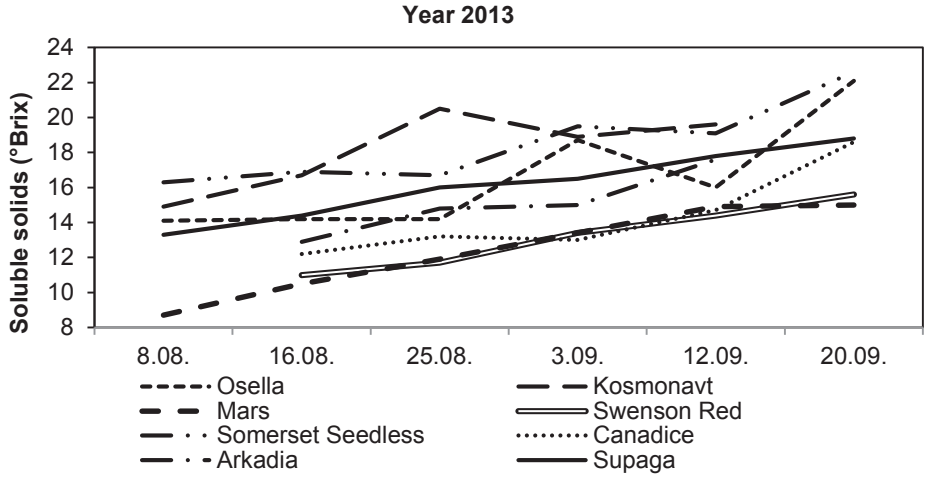

Figure 2. Table grape 'Osella', 'Kosmonavt', 'Mars', 'Swenson Red', 'Somerset Seedless', 'Candice', 'Arkadia' and 'Supaga' soluble solids content (°Brix) changes during the periods 08.08–20.09.2013.

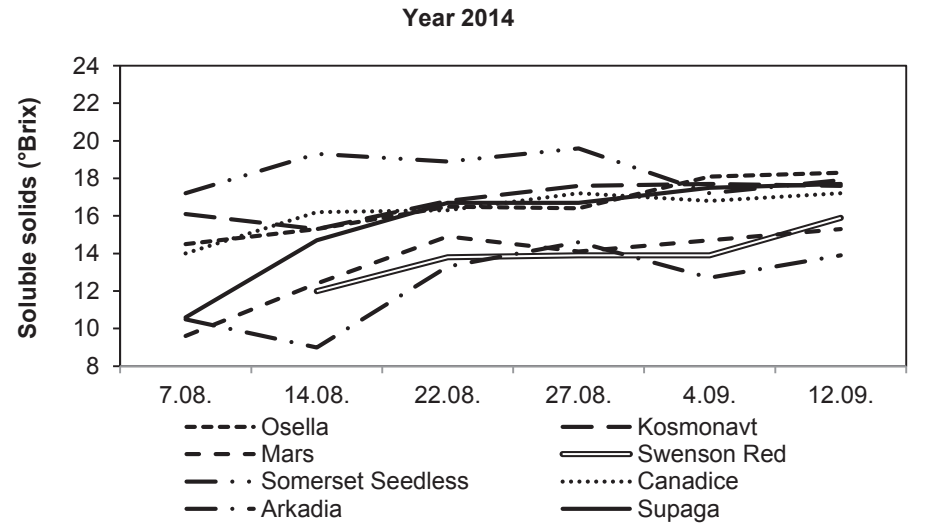

Figure 3. Table grape 'Osella', 'Kosmonavt', 'Mars', 'Swenson Red', 'Somerset Seedless', 'Candice', 'Arkadia' and 'Supaga' soluble solids content (°Brix) changes during the periods 7.08.–12.09.2014.

The rapid accumulation of sugars starts in grapes at the beginning of veraison and slows as maturity approaches (Bisson, 2001; Pedneault et al., 2013). It was also confirmed in our experiment. The beginning of veraison depends on the cultivar and

growth conditions. The length of the veraison is 6 to 8 weeks (Plocher & Parke, 2008). For example in this experiment shorter ripening period has 'Osella' and 'Kosmonavt'. In 2013 SS content in the cultivars Kosmonavt and Osella drops with some evaluation terms. It could be caused by the fact that SS content is not valuable with bare eye and collecting samples we focus on berry color. Different phenolic compounds are responsible for the grape color. It is known maximum accumulation level of sugars and phenols do not coincide (Maujean et al., 1983). Because of that into the berry samples could get some berries with lower SS content. In this experiment cultivars Mars, Swenson Red and Arkadia started to ripen later than other cultivars in both year. Earliest cultivars were Somerset Seedless, Kosmonavt and Osella. Also their SS content were highest at the end of veraison, because of longer ripening period. In 2014 grapes started to ripen earlier, this is due to higher temperatures in July. Also because of higher temperatures SS content could be reached an optimum level faster in 2014 than 2013, as demonstrated by the SS content stability in the measuring period (variation was less than in 2013).

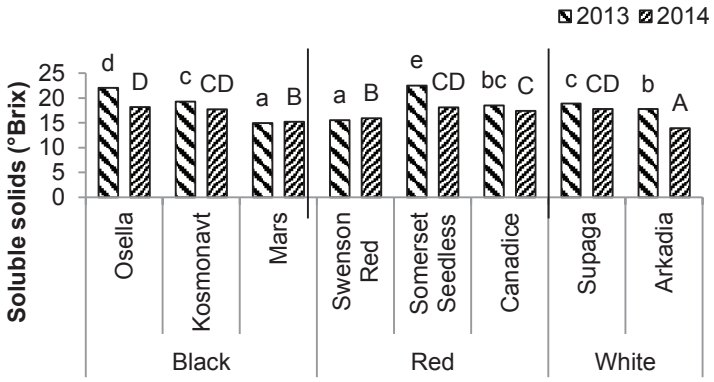

Figure 4. The grapes soluble solids (°Brix) content in the protected cultivation on cultivars Osella, Kosmonavt, Mars, Swenson Red, Somerset Seedless, Canadice, Supaga and Arkadia in 2013 and 2014. 2013 growing season cultivars effect PD%=0.9, 2014 growing season cultivars effect PD% = 0.8.

The content of SS ranged on the harvest from 15.0 to 22.6 °Brix in 2013 and 13.9 to 18.2 °Brix in 2014 (Fig. 4). In 2013 among black cultivars Osella had the highest value of SS (22.6 °Brix), but in both experimental year it was significantly lower in Mars (respectively 15.0 and 15.2 °Brix). Among red cultivars Somerset Seedless had the highest value of SS (22.1 °Brix) in 2013, but both experimental year it was lower in Swenson Red (respectively 15.6 and 15.9 °Brix). Among white cultivars Supaga had significantly higher values of SS in both years (respectively 18.9 and 17.8 °Brix). Year had a significant effect on table grapes SS content. In 2013 in several cultivars SS content was higher than 2014. In 2013 the harvest time was longer and because of that soluble solids accumulation period was also longer and °Brix values higher. Growing grapes on protected area we can extend the grape growing season, due to heat accumulation (Plocher & Parke, 2008). In Helsinki greenhouses accumulates 75 to 100% more heat than outdoor and because of that they can extend the growing season one month in the

spring and in the autumn (Plocher & Parke, 2008). Fruits sugar concentration is higher in higher temperature conditions (Mira de de Orduńa, 2010) and it is also influenced by the genotype (Shiraishi et al., 2010). It was also confirmed in our study.

The EU Regulation provides maturity requirements for *V. vinifera* L. cultivars. The lowest allowed SS content is 13 °Brix for seeded cultivars and 14 °Brix for seedless cultivars. Compared to this requirement all our hybrid cultivars achieved these levels. But in the Nordic countries an important factor in the formation of taste are acids. Jayasena and Cameron (2008), on the Crimson Seedless cultivar, reported that the consumer acceptance increases with increasing SS content from 10 to 20 °Brix. In our experiment SS content was lowest in cultivars Mars, Swenson Red and Arkadia and highest in cultivars Osella, Kosmonavt and Somerset Seedless. Investigators of this experiment assessed better tasting cultivars Arkadia, Kosmonavt, Swenson Red and Somerset Seedless. This indicates that the taste is not determine only by SS content.

SS content differs among cultivars. For example optimum level for 'Arkadia' is find by Tairov National Research Centre for Viticulture and Winemaking 15 to 16 °Brix (Vinograd 'Arkadia', 2015), for 'Kosmonavt' is find by I.M. Filippenko 18.4 °Brix (Vinograd 'Kosmonavt', 2015), for 'Mars' find by J.N. Moore is 16 to 20 °Brix (Vinograd 'Mars', 2015) and for 'Swenson Red' find by E. Swenson is 17 to 18 °Brix (Myvinogradnik 'Swenson Red', 2015). In our experiment 'Arkadia' and 'Kosmonavt' reached that optimum level. 'Mars' and 'Swenson Red' SS content did not reach to optimum level, because they started to ripen later.

CONCLUSIONS

The study results indicates that soluble solids content in table grapes on protected area depends on the beginning of ripening on the cultivar and temperature. SS content was highest in cultivars Osella, Kosmonavt and Somerset Seedless. For growers it means that planning table grapes harvesting time they need to take into account temperature and cultivar ripening time.

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