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EFFECT OF PRUNING TIME AND METHOD ON HYBRID GRAPEVINE (*Vitis* sp.) 'HASANSKI SLADKI' BERRY MATURITY IN A COOL CLIMATE CONDITIONS

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Abstract. Climate and weather conditions are important factors influencing grapevine growth and fruit quality. Cooler regions are expected to be unsuitable for grape growing due to insufficient maturation and variability of quality parameters. Therefore, a field trial was conducted, aimed to determine the effect of pruning time on low cordon cane (CP) and spur pruned (SP) grapevines of the hybrid cultivar Hasanski Sladki in a cool climate conditions. A vineyard, with the low double trunk (25 cm in height) training system, was established at the experimental station of the Estonian University of Life Sciences (58°23'17'' N, 26°41'50'' E) in June 2007. The treatments were carried out in autumn after leaf fall and in spring at the two leaf phase in 2010/2011 and 2011/2012. Pruning time affected grape maturity parameters depending on pruning method. Autumn SP increased the soluble solids content from 18.5 to 19.8 °Brix in 2011 and from 17.1 to 18.0 in 2012. Titratable acids content was high in both experimental years ranging from 1.3 to 2.1 g 100 g^{-1}, and only autumn CP decreased it. Pruning in spring significantly decreased the soluble solids/ titratable acids for both pruning methods. The timing of SP affected the maturity index (MI = °Brix × pH^2) variably; in 2011, spring pruning decreased the index whereas; the index was increased in 2012. Spring pruning decreased the total phenolics up to 22% in both treatments in the two years mean. In CP, spring pruning increased anthocyanins content from 31 to 77 mg 100 g^{-1} in 2012.

Key words: soluble solids, titratable acids, total phenolics, anthocyanins, maturity index

INTRODUCTION

Viticulture in cool climates (10 to 20°C annual isotherm, latitudes 30–50° N and 30–40° S) is of increasing interest as cool weather conditions favour flavours not achieved under more temperate conditions [Gustafsson and Mårtensson 2005]. Climate

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has a significant influence on grape quality [Falcão et al. 2008, Ferrer-Gallego et al. 2012] but the suitability of cooler regions, especially for high quality grape production, has not been fully investigated and berry maturation can be problematic [Gustafsson and Mårtensson 2005, Iyer et al. 2012]. Acclimatization is cultivar-dependent determining the vitality of buds as environmental and climatic conditions play a major role in bud-burst, fruit-set, veraison and maturation [Martin and Dunn 2000]. According to Gustafsson and Mårtensson [2005], hybrids of *Vitis labrusca*, *V. riparia* and *V. amurensis*, are winter hardy down to temperatures of -30°C when dormant, and are therefore suitable for growing in cool climate areas. For instance in Poland, the best tolerance to extremely low temperatures (no damage to shoots or buds) was shown by an American hybrid 'Alwood' and 'Zilga' of the *V. labruscana* group [Lisek 2007]. The hybrid cultivar Hasanski Sladki has shown a good winter hardiness and therefore, is recommended for commercial growing in Estonia [Kivistik et al. 2010] but it is also suitable and widely grown in different climatic conditions in Scandinavia and the United States of America [Gustafsson and Mårtensson 2005, Hart 2008, Plocher and Parke 2008]. In addition to cultivar selection, the training system is also important. Various vine training systems are used in Scandinavian countries (long cane, low cordon, low head training and mini J-style) [Gustafsson and Mårtensson 2005]. Low cordon spur and long cane pruning are used widely in Estonia so that canes can be bent to the ground and covered by the snow layer in winter.

Although some cultivars are extremely cold hardy, susceptibility to spring frosts can still be a problem. Manipulation of bud break can reduce spring frost damage to shoots [Dami et al., 2000] and enhance yield stability [Intrieri and Poni, 1998]; delayed pruning can also influence other phenological events related to vine growth and grape quality [Martin and Dunn 2000, Friend and Trought 2007], but can also result in later ripening which may result in vines being unable to attain sufficient maturity for harvesting [Friend and Trought 2007]. The influence of pruning time on grape quality parameters has been little investigated in Nordic areas, where it is important to take many factors into account, such as the duration of xylem sap flow because of the long-lasting spring [Keller and Mills 2007].

The measurement of total soluble solids is a well-established parameter for basic grape maturity assessment [Ferrer-Gallego et al. 2012], although alone is not enough to ensure the maturity of grapes [Ferrer-Gallego et al. 2012, Iyer et al. 2012]. Combinations of soluble solids, titratable acids and pH values are generally used to determine the optimum ripeness of grapes for making red wine [Coombe et al. 1980, Hunter et al. 1991, Iyer et al. 2012]. According to these measurements, the recommended range of values for wine are at maturity index (MI = °Brix × pH^2) from 200 to 270 [Schalkwyk and Archer 2000]. Phenolics content varies depending on several factors such as temperature [Haselgrove et al. 2000, Ferrer-Gallego et al. 2012]; cultural practices [Peña-Neira et al. 2004, Palliotti et al. 2012] and grape developmental stage [Haselgrove et al. 2000]. For red grapes, the content of anthocyanins varies greatly with cultivar and grape maturity [Ryan and Revilla 2003, Fournand et al. 2006], production area, seasonal conditions [Ferrer-Gallego et al. 2012] and yield [Haselgrove et al. 2000, Hülya Orak 2007, Falcão et al. 2008]. The complexity of factors affecting grapevine yields and their com-

position vary significantly from one place to another and one year to the next [Martin and Dunn 2000].

Thus grape maturity parameters can be affected by pruning time. Delayed pruning is suitable for bud burst manipulation, but it may have a negative effect on grape maturation due to the shorter period for ripening. The aim of the present experiment was to evaluate the effect of pruning time on maturity parameters in the hybrid grapevine 'Hasanski Sladki' that were either low cordon cane or spur pruned and growing in cool climate conditions.

MATERIAL AND METHODS

Site and plant material. The vineyard was established at the experimental station of the Estonian University of Life Sciences (58°23'17'' N, 26°41'50'' E) in June 2007. Plantation soil was sandy loam with pH_{KCl} 5.8, with 4.4% humus content and a 50 cm thick humus layer. The content of P, K, Ca and Mg was sufficient in the soil and hence, no fertilizers were used. The grapevines were propagated *in vitro* and grown as own-rooted. They were spaced 2 × 2 m apart and planted in single rows with 0.04 mm thick and 1 m wide black polyethylene mulch with turf between the mulched beds. The experiment was conducted using a randomized block design with 4 replications and 8 vines in each. Rows were oriented from north to south. Vines were not irrigated or covered for winter.

The interspecific *V. amurensis* hybrid cv. Hasanski Sladki (synonyms 'Baltica', 'Hasansky Sladky', 'Hasan (Xasan) Sweet', 'Varajane Sinine') originates from Hasan (Xasan), Primorsky Krai, Russia [Gustafsson and Mårtensson 2005, Hart 2008, Plocher and Parke 2008, Smiley et al. 2008]. It was developed by the breeder, A. K. Bous and released in the late 1950's or early 1960's [Hart 2008, Plocher and Parke 2008]. This early season cultivar is rather disease resistant, having strong but not excessive vigour and a procumbent growth habit. Clusters are of medium size, long and slightly loose, with an average weight of 90 g. The berries are blue-coloured, small to medium-sized (average weight 2 g). When dormant, the cultivar is winter hardy down to -20°C.

Pruning technology. The training system was low double trunk (25 cm in height). The vine treatments were spur pruning (SP) and cane pruning (CP) in autumn (2010 and 2011) after leaf fall and at two-leaf phase in spring (2011 and 2012). With SP, four overwintered fruit-bearing canes were pruned to short two-bud spurs and new shoots were directed vertically. With CP, an over-wintered fruit-bearing cane was pruned to 8 buds and bent horizontally. In summer, any shoots growing from summer buds were cut and removed from all vines. All fruiting shoots were cut off to 10 leaves after clusters. The height of the canopy was approximately 1.6 m. Suckers were cut and removed throughout the summer. Leaf removal adjacent to berry clusters was implemented at the beginning of veraison when removing the leaves from the east side of the canopy to allow morning sun exposure due to the occurrence of dew.

Weather conditions. By the end of November 2010, temperatures were already down to -25°C. On 15 April 2011, temperatures were above 5°C and attained 20°C by the end of the month. The period of active plant growth temperatures in 2011 was from

7 May to 8 October. Summer of 2011 was warm; the mean temperature in July was 3.3°C higher than the long term mean (tab. 1). First night frosts occurred on 20 October. In 2011, the sum of active temperatures (> 10°C) was 2498°C, and the length of active plant growth period was 155 days.

Table. 1. Weather conditions in 2011–2012: monthly mean air temperature and total monthly precipitation compared to the long term mean (1971–2000)

Month	Air temperature (°C)			Precipitation (mm)		
	2011[a]	2012[a]	1971–2000[b]	2011[a]	2012[a]	1971–2000[b]
April	5.7	4.6	4.7	1	45	33
May	11.0	11.4	11.1	58	78	53
June	17.2	13.3	15.1	35	98	69
July	20.0	17.7	16.9	48	80	76
August	15.9	14.8	15.6	55	80	80
September	12.3	11.9	10.4	80	61	67

[a] Data was collected from automatic weather station of the experimental station
[b] Data according to the Estonian Hydrological and Meteorological Institute (www.emhi.ee) database

In 2012, temperatures were above 10°C from the beginning of May until 6 October. The active plant growth period was 150 days. Late spring frosts stopped in mid-May and temperature remained > 0°C until 20 October. Mean temperatures in June and July were cooler than in 2011; respectively 3.9°C and 2.3°C lower (tab. 1). The sum of active temperatures from 1 April until 31 October 2012 was 1967°C.

In 2011, there was almost no rain in April but 27 mm more rain than the long term mean in September (tab. 1). In 2012, the precipitation level was significantly higher than the long term mean in April, May and June but similar to it in August and September.

Sample preparation and determination. All the analyses and measurements were carried out in 2011 and 2012. Fully expanded leaves were selected in July from the middle of shoots to determine chlorophyll content of the vine leaves using a portable SPAD-502 (Soil Plant Analysis Development), chlorophyll meter (Minolta). This permits a rapid and non-destructive determination of leaf chlorophyll content by measuring leaf transmittance. One replication comprised measurement of 30 leaves.

The weight of ten randomly selected bunches of a vine was determined in each replication. The number of berries per bunch was recorded. Grape weight was calculated as the mean of 100 berries. The soluble solids content (SSC) was measured from fresh berries by refractometer (Atago Pocket Refractometer Pal-1). For °Brix measurement, 30 grapes in 3 replications from the different parts of a cluster were picked and analyzed.

All the other biochemical parameters were determined from frozen (-20°C) grapes. Titratable acids content (TAC) was determined manually by the titration method with 0.1 M NaOH solution, using Bromothymol blue as an end point indicator [Chone et al. 2001]. The TAC was expressed as grams of tartaric acid per 100 g of fresh weight

(FW). Soluble solids and titratable acids ratio (SSC/TAC) was calculated based on the content of SSC and TAC. pH was evaluated from grape juice with a pH/conductivity meter (HD 2156.1, Delta OHM). Maturity index (MI) was calculated according to the formula determined by Coombe et al. [1980]: MI = °Brix × pH^2. The content of total anthocyanins (ACC) was estimated by a pH differential method from grape skin [Cheng and Breen 1991]. Absorbance was measured with a UVmini-1240 Shimadzu spectrophotometer at 510 and at 700 nm in buffers at pH 1.0 (HCl 0.1N) and pH 4.5 (citrate buffer). The results were expressed as mg of cyanidin-3-glucoside equivalent per 100 g of FW. Total phenolics content (TPC) was determined from grape skin with the Folin-Ciocalteau phenol reagent method [Slinkard and Singleton 1977], using a spectrophotometer (UVmini-1240 Shimadzu) at 765 nm. The TPC was expressed as mg of gallic acid equivalents per 100 g of FW.

Statistical analysis. The results of grape chemical composition were tested by one-way analysis of variance and the two years mean were tested by two-way analysis of variance (factors were pruning treatment and pruning time). To evaluate the effect of treatments, the least significant difference ($LSD_{0.05}$) was calculated. Different letters on figures and tables mark significant differences at $P \leq 0.05$. Linear correlation coefficients were calculated between variables with the significance of coefficients being $P \leq 0.01$*. The strength of the relationships was estimated as $r \leq 0.3$ (weak), $0.3 \leq r \leq 0.7$ (moderate) and $r \leq 0.7$ (strong).

RESULTS

Soluble solids, titratable acids and maturity index. SSC ranged from 17.1 to 19.8 °Brix and pruning time caused significant differences in SP (fig. 1). Autumn pruning increased the SSC compared to spring treatment in both experimental years and in two years mean (tab. 2). The mean effect of pruning time and treatment was significant at $P \leq 0.01$. TAC ranged from 1.3 to 2.1 g 100 g^{-1} (fig. 2). Pruning time had no effect in

Table. 2. The effect of pruning time and treatment on 'Hasanski Sladki' grape biochemical composition (2011–2012)

Treatment	Time	Soluble solids, °Brix	Titratable acids, g 100 g^{-1} FW	Soluble solids/ titratable acids	Maturity index	Total phenolics, mg 100 g^{-1} FW	Anthocyanins, mg 100 g^{-1} FW
SP	autumn	18.9a	1.7b	11.3c	172b	311a	92a
	spring	18.9a	1.4d	13.3a	188a	261b	94a
CP	autumn	17.8b	1.8a	10.1d	169b	309a	42c
	spring	18.9a	1.6c	12.4b	172b	240b	70b
Mean effect of time		**	*	**	**	NS	***
Mean effect of pruning		**	***	***	**	**	***

NS, *, **, *** – non-significant or significant at $P \leq 0.05$, 0.01 or 0.001, respectively
Different letters mark significant differences at $P \leq 0.05$.

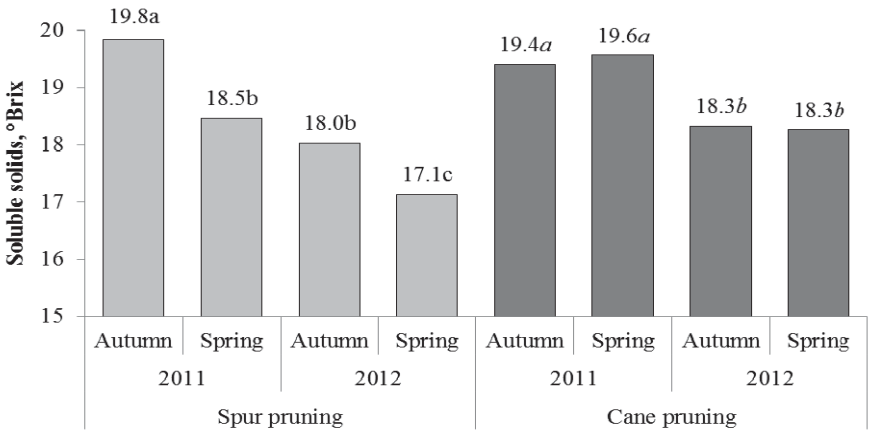

Fig. 1. Effect of spur and cane pruning times (autumn, spring) on 'Hasanski Sladki' soluble solids content in 2011 and 2012. Values followed by the same letter are not significantly different at P≤ 0.05

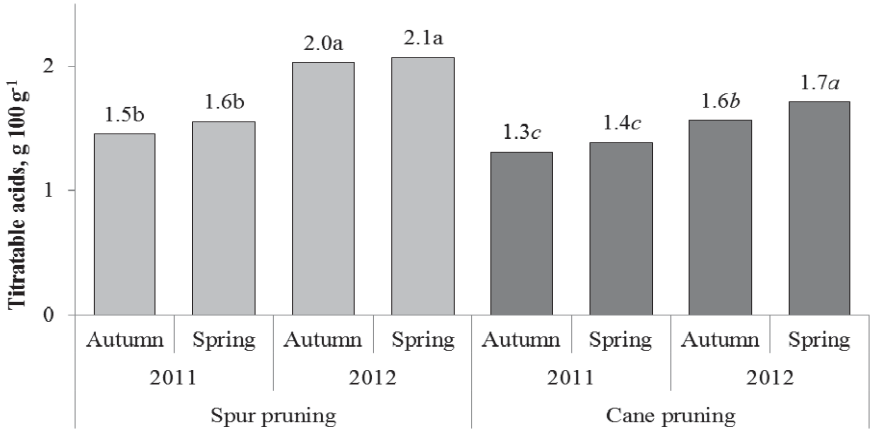

Fig. 2. Effect of spur and cane pruning times (autumn, spring) on 'Hasanski Sladki' titratable acids content in 2011 and 2012. Values followed by the same letter are not significantly different at P≤ 0.05

SP vines. Autumn CP had a negative effect in year 2012 and in the two years means (tab. 2). The mean effect of time ($P \leq 0.05$) and treatment ($P \leq 0.001$) was significant. SSC/TAC varied from 8.3 to 14.8 (fig. 3). Spring SP decreased the ratio in year 2011, with 12.5% lower results. Spring CP decreased the ratio significantly in 2012. In the two years mean, SSC/TAC was significantly affected by pruning time; spring pruning caused an increase for both pruning methods (tab. 2). The experimental mean effect of pruning time ($P \leq 0.01$) and treatment ($P \leq 0.001$) was also significant.

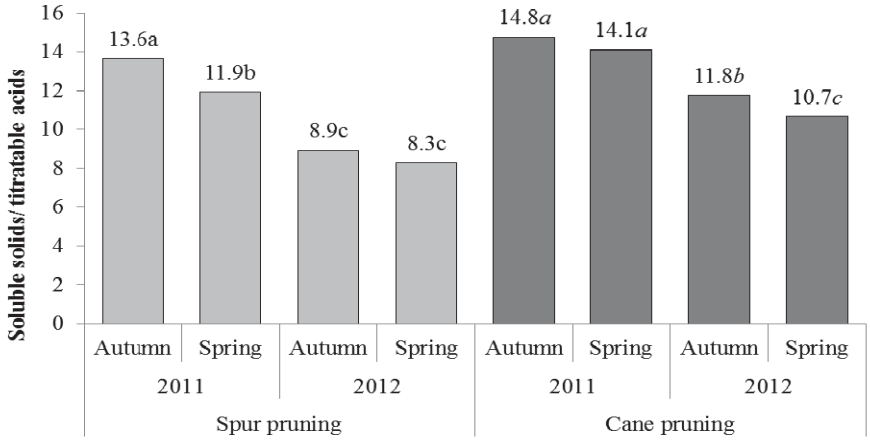

Fig. 3. Effect of spur and cane pruning times (autumn, spring) on 'Hasanski Sladki' soluble solids and titratable acids ratio in 2011 and 2012. Values followed by the same letter are not significantly different at $P \leq 0.05$

Grape MI varied from 132 to 213, and the variations were caused by pruning time (fig. 4). For SP, the effect of pruning time differed in the two years; in 2011, spring pruning decreased the MI, but in 2012 increased it. In CP, the autumn treatment increased the MI compared to spring in 2011. Spring SP increased the MI in the two years mean, and the mean effect of the pruning time and treatment was ($P \leq 0.01$) also significant (tab. 2).

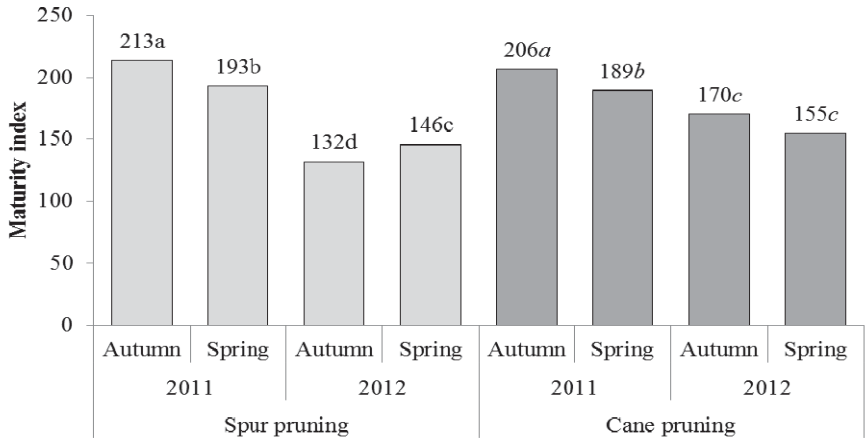

Fig. 4. Effect of spur and cane pruning times (autumn, spring) on 'Hasanski Sladki' maturity index in 2011 and 2012. Values followed by the same letter are not significantly different at $P \leq 0.05$

Total phenolics and anthocyanins content. TPC ranged from 224 to 393 mg 100 g^{-1} in SP and from 192 to 298 mg 100 g^{-1} in CP (fig. 5). In both pruning treatments, pruning time did not cause significant differences. In two years mean, spring pruning decreased the TPC in both treatments (tab. 2). The pruning methods mean effect was significant ($P \leq 0.01$).

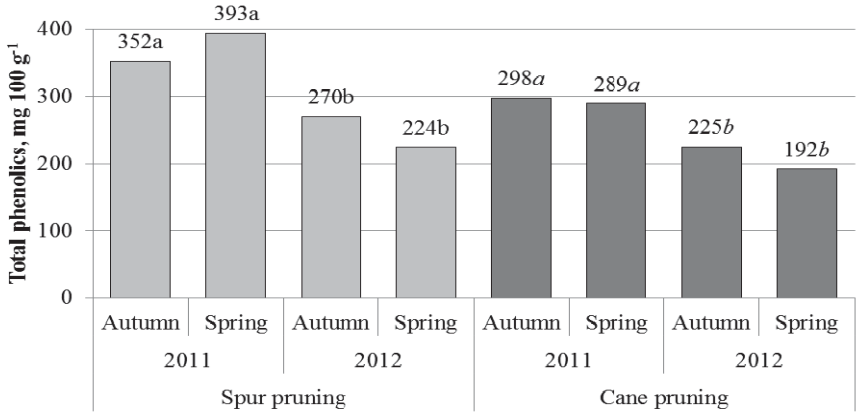

Fig. 5. Effect of spur and cane pruning times (autumn, spring) on 'Hasanski Sladki' total phenolics content in 2011 and 2012. Values followed by the same letter are not significantly different at $P \leq 0.05$

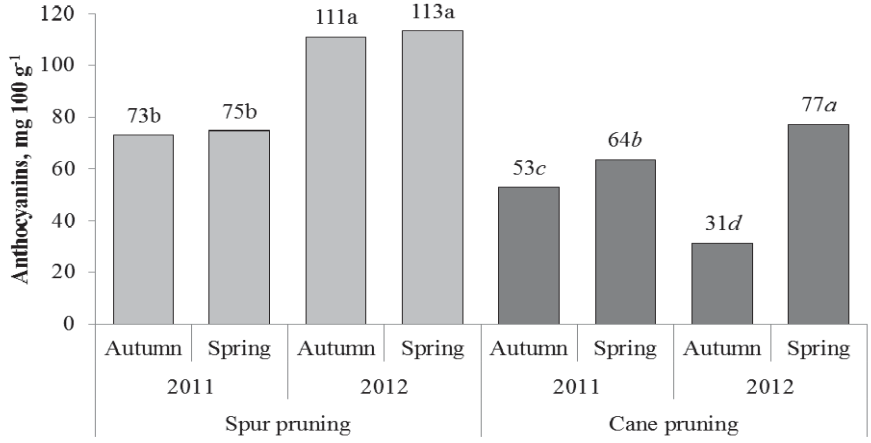

Fig. 6. Effect of spur and cane pruning times (autumn, spring) on 'Hasanski Sladki' anthocyanins content in 2011 and 2012. Values followed by the same letter are not significantly different at $P \leq 0.05$

High variability among treatments was found for ACC, ranging from 73 to 113 mg 100 g^{-1} in SP and 31 to 77 mg 100 g^{-1} in CP (fig. 6). The time of SP had no significant effect. The influence of pruning time was evident in CP; spring pruning caused an increase of up to 60% in 2012. In two years mean, spring pruning time increased the ACC, and the effect of pruning time and method was significant ($P \leq 0.001$, tab. 2).

Correlations. No significant correlations were found between SPAD readings and grape maturity parameters for either pruning method. In SP, berry weight was strongly positively correlated with SSC (r = 0.729), SSC/TAC (r = 0.878), TPC (r = 0.939), MI (r = 0.885) and pH (r = 0.923) (tab. 3). Strong negative correlations were found between berry weight and TAC (r = -0.922) and ACC (r = -0.900). Bunch weight correlated moderately positively with SSC (r = 0.610) and strongly with TPC (r = 0.963), and the correlations were negative and strong with MI (r = -0.942) and pH (r = -0.914). There was strong positive correlation between the number of berries per bunch and TAC (r = 0.883), while strong negative correlations were evident with SSC/TAC (r = -0.820) and ACC (r = -0.866).

Table. 3. The correlation coefficients (r) between leaf SPAD readings, yield components and fruit maturity parameters of 'Hasanski Sladki'

	Parameters	Soluble solids, °Brix	Titratable acids, g 100 g^{-1} FW	Soluble solids × titratable acids	Total phenolics, mg 100 g^{-1} FW	Anthocyanins, mg 100 g^{-1} FW	Maturity index	pH
Spur pruning	SPAD	-0.054	-0.003	-0.035	-0.344	0.234	-0.114	-0.142
	Berry weight, g	0.729*	-0.922*	0.878*	0.939*	-0.900*	0.885*	0.923*
	Bunch weight,g	0.610*	0.050	0.295	0.963*	-0.489	-0.942*	-0.914*
	Berries × bunch	-0.554	0.883*	-0.820*	-0.034	-0.866*	-0.259	0.045
Cane pruning	SPAD	-0.375	0.281	-0.330	-0.541	-0.512	-0.270	-0.382
	Berry weight, g	0.756*	-0.620*	0.691*	0.684*	0.256	0.590*	0.806*
	Bunch weight,g	-0.537*	0.004	-0.198	0.161	-0.127	-0.113	0.066
	Berries × bunch	-0.163	0.627*	-0.623*	-0.546	0.397	-0.182	-0.154

* Indicates significance at $P \leq 0.01$

In CP, a strong positive correlation was found between berry weight and SSC (r = 0.756) and pH (r = 0.806), moderate positive correlation appeared between berry weight and SSC/TAC (r = 0.691), TPC (r = 0.684) and MI (r = 0.590). Negative moderate correlation was with TAC (r = -0.620). Bunch weight correlated moderately negatively with SSC (r = -0.537). Number of berries per bunch was positively moderately correlated with TAC (r = 0.627) and negatively with SSC/TAC (r = -0.623).

DISCUSSION

Pruning time effects on grape maturity parameters differed for cane and spur pruning. The differences may be related to variations in compound bud position, and whether the shoots develop from the large central primary bud, from smaller secondary bud or from both at the same time. Martin and Dunn [2000] investigated the effect of pruning time on budburst and found that different types of buds burst at different times according to a hierarchy of bursting which depends on different types of shoots and their bud positions. In our experiment, in the case of SP, the fruit bearing shoots developed from the two proximal buds that were left after pruning. This treatment stimulated the vines to produce shoots with bursting primary and secondary buds. The impact of CP was less stressful to the vines – fewer shoots were formed, because the secondary buds did not burst at all. According to Andersen and Sims [1991], the lower the pruning severity, the greater the proportion of highly productive shoots derived from primary buds. In CP, the reproductive buds were in the middle of the cane and hence, the basal buds did not burst at all because of apical dominance.

In cold climate conditions, a common problem of insufficient grape maturation is because of TAC being too high and SSC too low [Gustafsson and Mårtensson 2005]. The recommended °Brix for red wine grapes according to Schalkwyk and Archer [2000] is from 20 to 23. In the present experiment, the SSC achieved almost the recommended minimum (being 19.8°Brix) in 2011, but did not reach optimum in 2012. The decrease of SSC in 2012 may be related to the lower temperatures and higher precipitation rate of this season. The TAC achieved in the present experiment was significantly higher (from 1.3 to 2.1 g 100 g^{-1}) compared to the recommended values for red wine grapes. According to Schalkwyk and Archer [2000], the recommended acid concentration should be from 0.6 to 0.7 g 100 g^{-1}. Iyer et al. [2012] determined TAC values in *V. vinifera* grapes from 0.6 to 2 g 100 g^{-1} in a single year in a cooler vine growing area in U.S.A. In our case, the higher contents were also obtained in the cooler year. Therefore, the influence of CP is considered to be positive when decreasing TAC towards the recommended values for wine production, though, contents still remained high. Autumn pruning also increased the MI values of grapes in both treatments in the warmer year 2011, reaching (from 206 to 213) almost to the recommended level, which is, according to Schalkwyk and Archer [2000] from 200 to 270.

In the present study, significantly increased TPC in case of autumn pruning in two years mean up to 311 mg 100 g^{-1} show quite high concentrations. The reason for differences in TPC and ACC between the years could be related to the weather being warmer in 2011 than in 2012 and hence more favorable for grape ripening. Higher values of ACC were determined in the cooler summer conditions in 2012. The temperatures during berry maturation in August 2012 were somewhat lower than in 2011 and the long-term mean (tab. 1). Differences in ACC were caused by lower night temperatures which caused major day-night temperature fluctuations. The temperature fluctuations during ACC accumulation caused stress and therefore the increase of ACC occurred. The effect was especially evident in the case of SP, because of the particular treatment being more extensive compared to CP, as discussed previously. In addition to temperatures, light conditions are also important. Nicolosi et al. [2012] indicate that direct sunlight inter-

ception by fruit has been associated with improved fruit quality and is generally desirable to some degree in most vineyards. In the present experiment, the height of the trellis system and row spacing were taken into account to provide maximum light exposure that is available in cooler climatic conditions. The angle of sunshine in northern areas differs from the southern parts of the world; in Nordic conditions the sun shines obliquely rather than directly overhead and therefore the shading effect of the leaves is minor.

Correlation results indicate that the leaf function parameter SPAD (chlorophyll content estimated non-destructively) had no influence on grape maturity. Pruning treatment and time had no effect on leaf functioning during yield formation and therefore, no influence on berry maturation. Most of the maturity parameters determined in the present experiment were affected by berry weight due to the higher soluble solids and lower acids concentration in heavier berries. In SP, TPC was increased in heavier berries and bunches. At the same time, an increase of ACC was determined in lighter berries and bunches with fewer grapes. These results suggest that thinner bunches provide better light conditions for berries which influenced the ACC. Light is a limiting factor in the accumulation of anthocyanins during the early stages of ripening [Haselgrove et al. 2000]. In CP, yield parameters had no effect on the anthocyanins accumulation. Meanwhile in SP, the positive correlation between the number of berries per bunch and TAC show that significantly increased number of grapes in a bunch resulted in higher concentration of acids.

CONCLUSION

The results indicate that pruning time had a significant influence on 'Hasanski Sladki' grape maturation and this varied with pruning method. Autumn SP increased the SSC, but the time had no effect on CP. Though, autumn CP decreased the TAC, the concentrations remained high compared to the recommended level. In neither pruning treatment, did pruning time cause significant differences in TPC. Pruning time increased the anthocyanin accumulation in spring CP in the cooler year, but had no significant influence in SP.

In conclusion, pruning in spring is suitable for CP grapevines, because it did not decrease the SSC, TPC and ACC, but in SP vines, soluble solids may stay below the recommended level with spring pruning. Future studies are needed to find ways of achieving the optimum concentration of acids.

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WPŁYW CZASU I METODY CIĘCIA NA DOJRZAŁOŚĆ OWOCÓW MIESZAŃCÓW ZŁOŻONYCH WINOROŚLI (*Vitis* sp.) 'HASANSKI SLADKI' W WARUNKACH CHŁODNEGO KLIMATU

Streszczenie. Warunki klimatyczne i pogodowe są ważnymi czynnikami wpływającymi na wzrost winorośli i jakość owoców. Uważa się, że chłodniejsze regiony są nieodpowiednie dla wzrostu winorośli ze względu na niedostateczne dojrzewanie oraz różnorodność parametrów jakościowych. Przeprowadzono więc próbę polową, mającą na celu określenie wpływu czasu przycinania na niskie cięcie (CP) i krótkie cięcie (SP) winorośli hybrydowej odmiany Hasanski Sladki w warunkach chłodnego klimatu. Winnica z systemem uprawy dwuramiennego pnia (25 cm wysokości) została założona w stacji eksperymentalnej Estońskiego Uniwersytetu Przyrodniczego (58°23'17''N, 26°41'50''E) w czerwcu 2007. Zabiegi przeprowadzono jesienią, po opadnięciu liści, oraz wiosną, w fazie dwóch liści, w latach 2010/2011 oraz 2011/2012. Czas przycinania wpływał na parametry dojrzałości winogron w zależności od metody przycinania. Jesienne samooczyszczanie zwiększało zawartość związków rozpuszczalnych z 18,5 do 19,8 °Brix w 2011 r. oraz z 17,1 do 18,0 w 2012 r. Kwasowość była wysoka w obydwu latach i wynosiła od 1,3 do 2,1 g 100 g^{-1} i zmniejszało ją tylko CP. Cięcie wiosenne istotnie zmniejszało stosunek: rozpuszczalne substancje/kwasowość w przypadku obydwu metod. Czas SP miał wpływ na zmienność wskaźnika dojrzałości (MI = °Brix × pH^2). W roku 2011

wiosenne cięcie zmniejszało ten wskaźnik, natomiast w roku 2012 wskaźnik zwiększył się. Wiosenne cięcie zmniejszało całkowitą zawartość fenoli do 22% w obu zabiegach w średniej dwuletniej. W przypadku CP, wiosenne cięcie zwiększało zawartość antocyjanów z 31 do 77 mg 100 g^{-1} w roku 2012.

Słowa kluczowe: rozpuszczalne substancje, kwasowość, całkowita zawartość fenoli, antocyjany, wskaźnik dojrzałości

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