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Characterization and adaptation of some 'Pinot Noir' clones to the environmental conditions of Serbian grape growing regions

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Summary

The adequate choice of suitable cultivar/clone together with the ecological characteristics of the region and combination of agro technical measures represents the most important factors in the viticulture production. Aim of this study was to determine the characteristics of two Pinot Noir clones (R4 and 667) in two Serbian grape growing regions with different meteorological conditions. The following properties were investigated: beginning, end and length of the growing season, grape yield, mechanical composition of bunch and berry, grape and wine quality. Differences between studied 'Pinot Noir' clones and environmental conditions in grape growing regions resulted in the production of grapes and wine with different characteristics.

Key words: terroir; meteorological conditions; grape quality; wine.

Introduction

'Pinot Noir' originates from Burgundy region in France which means that its adaptation is very specific to this environment. Now, 'Pinot Noir' has become an international variety and it is grown in a large number of viticultural regions all around the world. Its enological potential is reflected in the interaction with different "terroir" conditions resulting in specific elements of the sensory and quality characteristics of wines (Carbonneau and Boidron 2012). A large intra varietal variability in 'Pinot Noir' has been described. It produced a large number of clones that are more or less adapted to different environmental conditions (Stefani *et al*. 1995). The interaction between cultivar/clone and growing environment is the base of wine quality and typicality. In recent time the behavior of different clones within the same cultivar became another fundamental factor influencing the enological result (Santini *et al*. 2009-2010). The environment plays a key-role on the quality of grapes, producing a unique wine style (Deloire *et al*. 2002). Tonietto and Carbonneau (2004) consider that climate is the most dominant factor in determining grape quality and it is responsible for the "terroir effect". Climatic conditions (solar radiation, heat accumulation, rainfall, frost, temperature, humidity, etc.) have a strong impact on viticulture, affecting grapevine growth, chemical and sensory characteristics of the wine. Out of all the climatic factors, temperature appears to be one of the most important (Ruml *et al*. 2012). The aim of this study was to determine the characteristics of two 'Pinot Noir' clones (R4 and 667) in two Serbian grape growing regions in relation to the most important meteorological factors.

Material and Methods

The study focused on the 'Pinot Noir' clones R4 and 667 which were grown in two Serbian grape growing regions: Sumadia-Great Morava (Experimental field 'Radmilovac' - Faculty of Agriculture, University of Belgrade) and Banat region ('Vrsac Vineyards - Gudurica'). Ten vines from each clone have been tested in 2009, 2010 and 2011. The investigated clones were planted on *V. berlandieri* x *V. riparia* Kober 5BB rootstock at the distance of 3.0 x 1.0 m in single Guyot training system. The analysis of meteorological conditions (air temperature and precipitation) was based on the data recorded by the weather stations located next to the experimental vineyards. The following properties were investigated for the clones: beginning, end and length of the growing season, grape yield, mechanical composition of bunch and berry, grape and wine quality. Start and end of the period of vegetation was determined on the basis of average daily temperatures in five consecutive days which was higher than 10 °C (not calculated if the start was before March and the end before September). Grape yield (kg per vine), bunch length and width (cm), bunch and berry mass (cm) were investigated by these measures. The quality of grapes was determined on the basis of sugar content (refractometer - Pocket Atago Pal 1) and total acids content (titration with n/4 NaOH) in the must. Total phenol content was determined by the A.O.A.C. spectrophotometric method (1984) in berry skin and by Mazza and Velioglu (1992) in wines. Antioxidant activities in the grape and wine were determined based on the DPPH radicals assay. The measured data were statistically analyzed using the software package Statistica (StatSoft, Inc., Tulsa, OK, USA).

Results and Discussion

Meteorological parameters (air temperature and precipitation) varied with respect to the year of investigation (Figs 1 and 2). Higher mean annual air temperature was found during the tested years at Radmilovac locality (from 13 to 13.4 °C) compared to Vrsac locality (12 to 12.8 °C). Spayd *et al*. (2002) found that the grape harvest dates may

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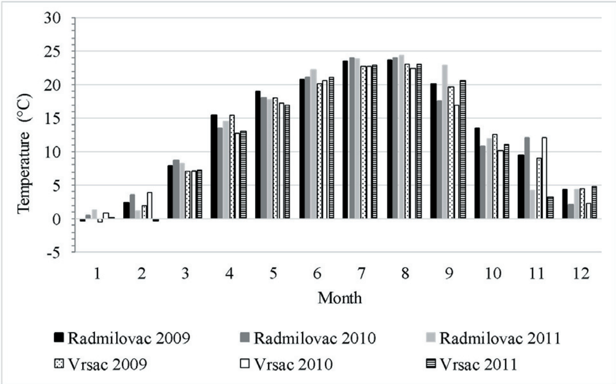

Fig. 1: Mean monthly air temperatures in 2009, 2010 and 2011 recorded in the two wine growing regions in Serbia: Radmilovac and Vrsac.

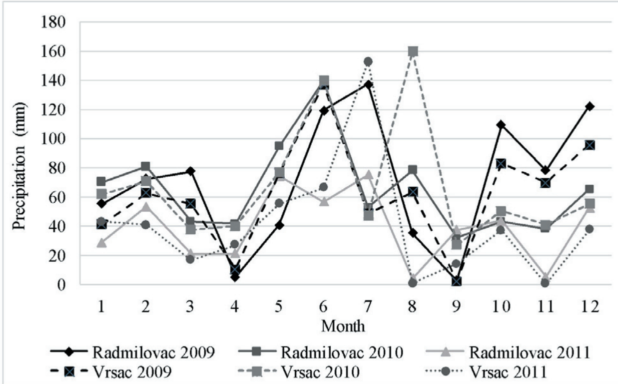

Fig. 2: Mean monthly sums of precipitation in 2009, 2010 and 2011 recorded in the two wine growing regions in Serbia: Radmilovac and Vrsac.

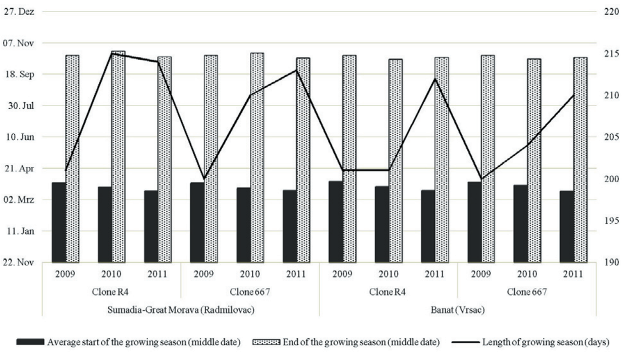

Fig. 3: Phenology recorded at the Radmilovac and Vrsac wine growing region.

change in warmer years. Precipitations varied between the examined years (Fig. 2). A significant decrease in the total annual sum of precipitation was recorded in 2011 in Radmilovac (472.6 mm). The amount and the distribution of precipitation could affect the quality of grapes and wines (Jones and Davis 2000).

Clones (R4 and 667) phenology in the two growing regions are presented in Fig. 3. In Radmilovac region, vegetation began earlier than in the Vrsac area. Thus, it appears that cultivar and environmental factors affected the phenological phases. In particular, the onset and duration of certain phenophases seemed to be conditioned by the temperature. This finding is in agreement with Petrie and Sandars (2008): an increase in the air temperature could produce an advance in the start of phenophases and an effect on the ripening length in grapes.

The Table shows grape yield, bunch and berry properties and quality parameters of grape and wine. Grape yield of the clones depended on the interaction of growing region and year of investigation (F = 4.16, $p < 0.05$). Bunch and berry characteristics, except berry mass, showed significant differences compared to the clones, localities, weather conditions of the year, and interaction between them. The tested parameters of grape quality showed different levels of variation. Sugar content in the must mainly depended on the clone (F = 4.85, $p < 0.05$), weather conditions of the year (F = 26.07, $p < 0.01$), interactions between cultivation area and year (F = 4.27, $p < 0.05$). Berthaut and Morvan (2012) determined the composition of 'Pinot Noir' berries and found that the sugar content depends on various elements of *terroir* (clones, characteristics of the cultivation sites, soil, harvest time, etc.). The clones were significantly different based on the acid content in the musts (F = 10.83, $p < 0.01$). This trait has been influenced by: year (F = 22.64, $p < 0.01$), interaction of clone and year (F = 8.10, $p < 0.01$), cultivation site and year (F = 15.00, $p < 0.01$) and clone, cultivation site and year (F = 6.86, $p < 0.01$). Mullins *et al.* (1992) showed that the acid content in the must, beside the cultivar effect, varies depending on meteorological factors, time of grape harvesting and yield. Phenolic content of berry skin was influenced by the cultivation area (F = 6.54, $p < 0.05$), the year (F = 7.52, $p < 0.01$), the interaction between cultivation site and year (F = 10.51, $p < 0.01$) and the clone x cultivation site x year interaction (F = 4.59, $p < 0.05$). Antioxidant activity by grape clones varied in relation to the year (F = 16.00, $p < 0.01$), the clone x year (F = 6.52, $p < 0.01$), the cultivation site x year (F = 15.17, $p < 0.01$) and clone x cultivation site x year (F = 7.92, $p < 0.01$) interactions. Revilla *et al.* (1997) have demonstrated different content of phenolic compounds in different grapevine varieties depending on the year and the climatic conditions of the cultivation site. Phenolic composition and antioxidant activity of the wines varied in relation to the cultivation site (F = 142.69, p < 0.01, F = 13.91, $p < 0.01$) and cultivation site x year interactions (F = 4.52, $p < 0.05$; F = 8.76, $p < 0.01$). Clone x cultivation site x year interaction (F = 19.05, $p < 0.01$) had an important effect on the phenolic composition. The antioxidant activity of wine depended mainly by the year (F = 23.84, $p < 0.01$) and the interaction of clones and the cultivation site (F = 9.69, $p < 0.01$).

Conclusions

The tested clones of 'Pinot Noir' (R4 and 667) were significantly different in the length and weight of the bunch, sugar content and total acids in the must. The characteristics of the cultivation sites, the meteorological factors and the interaction between clone, cultivation site and year had a very significant effect on the tested characteristics. Some

Table

Mean values of yield; bunch and berry characteristics; and grape and wine quality of investigated clones in two wine growing regions in Serbia: Radmilovac (R) and Vrsac (V)

Clone	Locality	Year	GY	Mean values of investigated characteristics									
				Bunch and berry characteristics				Grape quality				Wine	
				BM	BL	BW	BEM	SU	AC	FB	AB	PW	AW
R4	R	2009	2.04	79.00	8.82	5.62	1.01	23.12	5.84	157.69	72.87	873.25	78.39
		2010	1.46	88.00	10.10	7.00	0.97	22.46	6.70	161.33	70.95	913.31	80.88
		2011	1.56	93.60	9.62	4.80	0.94	24.76	4.88	278.19	72.98	961.33	85.68
	V	2009	1.58	96.00	8.30	6.00	1.10	22.68	6.62	170.96	46.55	1047.68	84.07
		2010	1.98	100.00	8.98	3.92	0.99	23.40	6.04	304.79	93.82	984.41	84.55
		2011	1.66	104.00	10.04	5.34	1.05	25.18	4.66	215.25	78.98	985.93	88.09
667	R	2009	1.56	107.00	11.72	4.90	1.08	23.32	5.96	165.88	71.43	924.72	81.66
		2010	1.40	102.00	10.50	6.44	1.19	22.10	6.40	188.08	75.16	908.42	82.34
		2011	1.50	96.60	13.20	5.68	0.95	24.46	6.94	207.67	65.66	908.53	89.15
	V	2009	1.50	115.00	9.20	5.30	1.30	22.78	6.64	211.64	67.34	965.49	85.06
		2010	1.86	95.00	10.98	4.46	0.90	22.88	6.44	230.56	78.19	1015.62	84.70
		2011	1.78	112.20	10.36	4.54	1.04	23.30	5.02	200.54	70.61	996.46	84.46
Source of variation				Values of F test									
Clone (C)			1.12	5.69*	23.08**	0.83	1.04	4.85*	10.83**	1.50	0.36	1.21	2.73
Locality (L)			1.72	4.11*	8.42**	10.75**	0.37	0.00	2.59	6.54*	0.25	142.69**	13.91**
Year (Y)			0.09	0.47	4.55*	0.96	1.63	26.07**	22.64**	7.52**	16.00**	0.76	23.84**
C x L			0.66	0.70	3.03	0.14	0.32	2.16	1.85	0.03	0.01	0.65	9.69**
C x Y			0.71	1.78	0.48	0.95	0.38	2.94	8.10**	3.07	6.52**	2.25	1.26
L x Y			4.16*	0.56	1.05	12.62**	2.02	4.27*	15.00**	10.51**	15.17**	4.52*	8.76**
C x L x Y			0.39	0.54	4.32*	2.66	0.99	1.34	6.86**	4.59*	7.92**	19.05**	2.43

** $p < 0.01$; * $p < 0.05$. GY-grape yield (kg per vine); BM-bunch mass (g); BL-bunch length (cm); BW-bunch width (cm); BEM-berry mass (g); SU-sugar content in the must (%); AC-acid content in the must ($g \cdot L^{-1}$ of tartaric acid equivalent); PB-total phenol content in berry skin ($mg \cdot kg^{-1}$ grapes); AB-antioxidant activity in berry skin (inhibition %); PW-total phenol content in wine ($mg \cdot L^{-1}$); AW-antioxidant activity in wine (inhibition %).

specific features of the experimental vineyards among the examined years showed the suitability of these growing regions for the studied 'Pinot Noir' clones.

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References

A.O.A.C.; 1984: Officials Methods of Analysis. Association of Official Analytical Chemicts. Washington, D.C., USA.

Berthaut, A.; Morvan, G.; 2012: Influence of pedoclimatic factors during berry ripening in Burgundy. Proc. IX Int. Terroirs Congr. **2**, 5-8.

Carbonneau, A.; Boidron, R.; 2012: 'Pinot Noir': an endemic or a flexible variety? Proc. IX Int. Terroirs Congr. **2**, 21-24.

Deloire, A.; Lopez, F.; Carbonneau, A.; 2002: Réponses de la vigne et terroir. Eléments pour une méthode d'étude. Progr. Agric. Vitic. **119**, 78-86.

Jones, G.; Davis, R.; 2000: Climate influences on grapevine phenology, grape composition, and wine production and quality for Bordeaux, France. Am. J. Enol. Vitic. **51**, 249-261.

Mazza, G.; Velioglu, Y.S.; 1992: Anthocyanins and other phenolic compounds in fruits of red-flesh apples. Food Chem. **43**, 113-117.

Mullins, M. G.; Bouquet, A.; Williams, L. E.; 1992: The cultivated grapevine. In: Biology of the grapevine, 147-202. Cambridge Univ. Press.

Petrie, P. R.; Sandars, V. O.; 2008: Advancement of grapevine maturity in Australia between 1993 and 2006: putative causes, magnitude of trends and viticultural consequences. Aust. J. Grape Wine Res. **14**, 33-45.

Revilla, E.; Alonso, E.; Kovač, V.; 1997: The content of catechins and procyanidins in grapes and wines as affected by agroecological factors and technological practices. Am. Chem. Soc. **7**, 69-80.

Ruml, M.; Vuković, A.; Vujadinović, M.; Đurđević, V.; Ranković-Vasić, Z.; Atanacković, Z.; Sivčev, B.; Marković, N.; Matijašević, S.; Petrović, N.; 2012: On the use of regional climate models: Implications of climate change for viticulture in Serbia. Agric. Forest Meteorol. **158-159**, 53-62.

Santini, D.; Cascio, P.; Mazza, G.; Mannini, F.; 2009-2010: Influence of different environments on grape phenolic and aromatic composition of three clones of 'Nebiolo' (*Vitis Vinifera* L.). Quad. Vitic. Enol. Univ. Torino **31**, 103-106.

Spayd, S. E.; Tarara, J. M.; Mee, D. L.; Ferguson, J. C.; 2002: Separation of sunlight and temperature effects on the composition of *Vitis vinifera* cv. 'Merlot' berries. Am. J. Enol. Vitic. **53**, 171-182.

Stefanini, M.; Iacono, F.; De Micheli, L.; Porro, D.; 1995: Adaptability of 'Pinot Noir' clones to different altitudes. Acta Hortic. **388**, 71-76.

Tonietto, J.; Carbonneau, A.; 2004: A multicriteria climatic classification system for grape-growing regions worldwide. Agric. Forest Meteorol. **124**, 81-97.