10.7251/AGSY1303771R

OBSERVED CHANGES IN GRAPEVINE PHENOLOGY IN THE REGION OF SREMSKI KARLOVCI, SERBIA

Mirjana RUML[1*], Nada KORAC[2], Dragoslav IVANISEVIC[2], Mirjam VUJADINOVIC[1], Ana VUKOVIC[1]

[1] Faculty of Agriculture, University of Belgrade, Serbia
[2] Faculty of Agriculture, University of Novi Sad, Serbia
*(Corresponding author: mruml@agrif.bg.ac.rs)

Abstract

An analysis of recent-past changes in grapevine phenology in the region of Sremski Karlovci was performed. The study was based on 26 years of observations (1986–2011) on beginning of budburst, beginning of flowering, beginning of veraison and harvest for 21 different vine cultivars. The study revealed a trend toward earlier occurrence of phenological events for all cultivars. However not all the phenological events responded to changes in the environment to the same extent and with the same level of significance. Trends of –0.4, –0.7 and –0.6 days/year were detected for the phenological dates averaged over all examined cultivars for the beginning of flowering, beginning of veraison, and harvest dates, respectively. Beginning of budburst exhibited no significant trend during studied period. The trend comparison between cultivars revealed that harvest dates of early and middle ripening cultivars were advancing somewhat more than dates of late ripening cultivars.

Key words: grapevine, phenology, Sremski Karlovci, Serbia

Intorduction

Recently there has been increased interest in phenology, mainly in the contest of climate change. Changes in the timing of phenological events may be one of the earliest observed plants responses to global warming. Grapevine (*Vitis vinifera* L.*)* is a phenologically distinct crop with the most important phenological stages being bud break, flowering, fruit set, veraison, harvest and leaf fall (Jones and Davis, 2000). The rate of development depends on grapevine cultivar, climatic conditions and geographical location. Besides climate change studies, phenology data can contribute to viticulture in different ways. They are important in determining suitable vine cultivars for a given climate regime, timely application of fertilization, pesticides, irrigation and other viticultural practices, as well as in estimating crop yields and planning harvest operations.

The earlier phenological events of grapevine have been recorded in different parts of the world (Chuine et al., 2004; Jones and Davis, 2000; Petrie and Sadras, 2008; Webb et al., 2011). Viticultural regions of Serbia have not been much studied in this regard. One of the reasons is a lack of suitably long and reliable phenological datasets, necessary for detection of meaningful trends.

This study has aimed to determine trends in grapevine phenology based on 26–year dataset for Sremski Karlovci, the wine capital of the Srem viticultural region, one of the oldest vine growing areas in Europe. The research also examined cultivar similarities/differences in phenological timing and their response to climate variability and climate change.

Materials and methods

Phenological data were collected at the experimental station of the Novi Sad Faculty of Agriculture (45°10’ N, 20°10’ E, 110 m a.s.l.). The station is situated in Sremski Karlovci, 12 km away from Novi Sad on Mt. Fruška Gora’s slopes. The climate is mid-latitude moderate continental (Koeppen’s Cfw) with mean annual air temperature of 12.3°C and mean annual precipitation of 650 mm. Soil type is pararedzina on loess. For conducting this study, a group of 21 cultivars (Table 1), both Serbian and internationally recognized ones, was selected from ampelographic collection. The collection was established in 1979 and all cultivars were represented by 20 vines, planted with a spacing of 3 x 1 m and grown with Simple Guyot system**.**
Four phenological stages of grapevine were examined for the period 1986–2011:

- beginning of budburst (the date when green shoot tips became just visible);
- beginning of flowering (the date when first flower hoods were detached from the receptacle);
- beginning of veraison (the date when berries begin to develop variety-specific colour);
- harvest.

Harvest date was not precisely defined in phenological sense and mainly depended upon winery requests and some other constraints such as current weather conditions, disease outbreaks, etc.
The trends in investigated phenological events of vine were determined by the slope from a linear regression fit.

Results and discussion

Mean dates, given as day of the year (DOY), the slope of linear regressions and corresponding correlation coefficients (R) of the investigated vine phenological stages are shown in Table 1. In the last table row, parameters’ values correspond to "average cultivar". The mean date for each phenological event of "average cultivar" was obtained by averaging mean values of all examined cultivars. Time series, slopes and correlation coefficients were then determined for that "average cultivar" (Fig.1).

Table 1. Mean day of the year, slope of linear regression fit and Pearson coefficient of correlation (R) for main phenological stages of 21 vine cultivars for Sremski Karlovci, Serbia

Phenological stage	**Beginning of budburst**			**Beginning of flowering**			**Beginning of veraison**			**Harvest**		
Cultivar	**Mean (DOY)**	**Slope**	**R**	**Mean (DOY)**	**Slope**	**R**	**Mean (DOY)**	**Slope**	**R**	**Mean (DOY)**	**Slope**	**R**
Portugizer	100	-0.18	0.14	148	-0.38	0.35*	200	-0.86	0.66***	256	-0.51	0.36*
Pinot noir	99	-0.40	0.29	148	-0.45	0.44*	202	-0.76	0.60***	261	-1.09	0.53**
Cabernet Sauvignon	108	-0.25	0.22	151	-0.29	0.30	212	-0.63	0.57***	271	-0.44	0.28
Gamay	98	-0.27	0.20	147	-0.48	0.47**	204	-0.57	0.51***	264	-0.59	0.35*
Merlot	104	-0.37	0.34	149	-0.44	0.42*	212	-0.69	0.50***	270	-0.58	0.33*
Probus	106	-0.19	0.17	153	-0.41	0.40*	215	-0.68	0.61***	271	-0.44	0.25
Frankovka	98	-0.16	0.12	148	-0.44	0.43*	205	-0.82	0.62***	267	-0.42	0.22
Prokupac	100	-0.26	0.18	151	-0.32	0.35*	211	-0.69	0.62***	271	-0.61	0.38*
Chardonnay	97	-0.38	0.27	146	-0.49	0.45**	205	-0.70	0.60***	254	-0.69	0.41**
Buvije	97	-0.26	0.20	148	-0.43	0.42*	194	-0.64	0.58***	249	-0.64	0.47**
Ezerjo	98	-0.12	0.10	148	-0.40	0.40*	203	-0.62	0.54**	254	-0.65	0.40*
Petra	97	-0.18	0.14	148	-0.40	0.40*	211	-0.89	0.63***	260	-0.56	0.32
Pinot Blanc	99	-0.27	0.21	147	-0.49	0.43*	208	-0.76	0.64***	257	-0.83	0.50**
Neoplanta	101	-0.26	0.19	151	-0.45	0.43*	211	-0.93	0.77***	254	-0.58	0.40*
Kreaca	101	-0.28	0.23	151	-0.43	0.42*	210	-0.81	0.60***	261	-0.67	0.44*
Muscat Ottonerl	101	-0.20	0.19	150	-0.40	0.39*	203	-0.56	0.53**	249	-0.60	0.39*
Riesling 239 20 Gm	102	-0.35	0.29	149	-0.44	0.45**	211	-0.89	0.66***	260	-0.56	0.35*

Pinot Gris	102	-0.31	0.26	147	-0.34	0.35*	204	-0.53	0.49**	255	-0.72	0.44*
Beli medenac	103	-0.18	0.15	151	-0.41	0.39*	207	-0.78	0.71***	253	-0.93	0.59**
Bagrina	103	-0.24	0.23	153	-0.52	0.45**	211	-0.77	0.61***	263	-0.73	0.39**
Riesling Italian	103	-0.23	0.23	150	-0.31	0.37*	213	-0.59	0.56**	269	-0.71	0.45**
Average	101	-0.25	0.22	149	-0.42	0.42*	207	-0.72	0.64***	260	-0.65	0.45**

*, **, *** statistical significance at the 0.05, 0.01, 0.001 levels, respectively

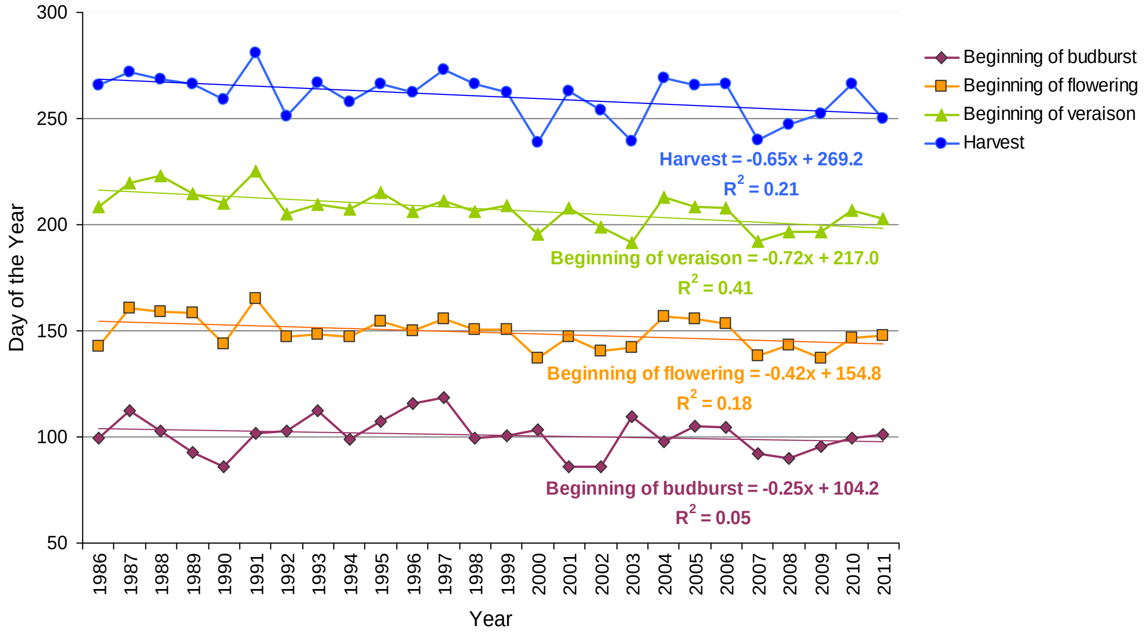

Figure 1. Time series and linear trends for the averaged phenological dates of 21 cultivars for budburst, bloom, veraison, and harvest for Sremski Karlovci, Serbia (1986–2011)

The period from the beginning of budburst to harvest averaged over all cultivars was 159 days and lasted from 10 April (101 DOY) to 17 September (260 DOY). The average time of beginning of flowering in the Sremski Karlovci region was the 29 May (149 DOY). The mean date of veraison was 26 July (207 DOY). All examined phenological stages showed a negative trend over the period of observation (Tab.1).

The steepest slope was obtained for the beginning of veraison (–0.7 days/year –averaged value over all cultivars) with highest level of significance (p<0.001). Considering trend differences among cultivars, the highest rate of veraison date change was –0.9 days/year for cultivars Neoplanta, Petra and Riesling 239 20 Gm, while smallest rate was –0.5 days/year for Point Gris. The beginning of budburst exhibited no significant trend. The mean date of beginning of flowering averaged over all cultivars showed a trend of –0.4 days/year (p<0.01). The highest observed rate of change was –0.5 days/year for Bagrina, Gamay and Chardonnay and smallest –0.3 days/year for Cabernet Sauvignon. The date of harvest averaged over all cultivars showed a trend of –0.6 days/year (p<0.05). The rate of change of that phenological event varied the most between cultivars. The largest trend (–1.0 days/year) was found for Pinot Noir and smallest and not significant trend (–0.4 days/year) was found for Frankovka, Probus and Chardonnay).

Similar results have been found for Europe, where different phenological events occur 6–25 days earlier than 30–50 years ago (Jones, 2006). More specifically, in Germany in Lower Franconia, the phenology of grapevines has tended towards earlier occurrence during the period from 1949 to 2010 (Bock et al., 2011). Similarly as in our study, the advance in budburst was small

(1 to 2 days/decade) and not significant. The average dates for full flowering advanced 3 to 4 days/decade. Veraison showed the strongest trend in time, advancing 4 to 6 days/decade. Harvest started 2 to 5 days earlier per decade. In Italy in the productive area of Montepulciano wine, the onset of bud-break and flowering showed a negative trend whereas harvest date showed no significant variations during the period from 1970 to 2006 (Dalla Marta et al., 2010). On the other hand, observations from different viticultural regions have provided evidence of advanced harvest dates, particularly in the last 10 to 30 years. Data from Johannisberg (Rheingau, Germany) shows that the first day of harvest occurs on average of 2–3 weeks earlier than it was between the late 18th and the early 20th century (Stock et al., 2005). In Baden (southwest Germany), the average dates for the beginning of maturation of Pinot Noir had advanced by 3 weeks from 1976 to 2006 (Sigler, 2008), while in the Palatinate (Germany), harvest advanced 2 weeks (Petgen, 2007). For Chateauneuf du Pape and Tavel (southern France), harvest dates are observed 18 and 21 days earlier in comparison with the period from 1945 to 2000, respectively (Ganichot, 2002). In Alsace (eastern France), harvest takes place 2 weeks earlier (Duchêne and Schneider, 2005). In Beaune (Burgundy), harvest dates were two weeks earlier at the end of the 20th century than in the years 1960–1970 (Madelin et al., 2008).

In our study, no clear pattern of phenological timing change was detected among cultivars, except for harvest. The value of correlation coefficient between the mean harvest dates and trend values for studied cultivars was 0.33 (p=0.07), meaning that the harvest date of late cultivars was advancing somewhat slower than harvest date of cultivars ripening earlier. To date, this trend is not significant, but if it continues in the future, it will lead to expansion of harvest period, what may have positive implications for grape processing. This finding should be taken with caution, since, as it was already stated, harvest dates are based on subjective evaluations of optimum fruit composition and depend on many constrains.

Conclusion

Analysis of the 26 years of phenological data the region of Sremski Karlovci revealed that the ongoing shifts in vine phenology are toward the beginning of the year, although the observed rate of change was not the same for all phenological stages. Given that further changes to climate are likely, these observed trends in phenological timing are expecting to continue and to become even stronger. Possible consequences of advanced phenology may include shifts in regional cultrivar viabilty and wine styles, since optimum cultivar ripening will be occuring in a warmer conditions affecting balance between sugar content and acidity, and changes in compounds development that give the aroma, colour and flavour in grapes.

Acknowledgement

This paper was realized as a part of the project "Studying climate change and its influence on the environment: impacts, adaptation and mitigation" (43007) financed by the Ministry of Education and Science of the Republic of Serbia within the framework of integrated and interdisciplinary research for the period 2011–2014.

References

Bock A., Sparks T., Estrella N., Menzel A. (2011). Changes in the phenology and composition of wine from Franconia, Germany. Clim. Res. 50(1), 69–81.

Chuine I, Yiou P, Viovy N, Seguin B, Daux V, Ladurie E.L.R. (2004). Historical phenology: grape ripening as a past climate indicator. Nature 432 (7015), 289–290.

Dalla Marta, A., D. Grifoni, M. Mancini, P. Storchi, G. Zipoli, Orlandini S. (2010). Analysis of the relationships between climate variability and grapevine phenology in the Nobile di Montepulciano wine production area. J. Agric. Sci. 148, 657–666.

Duchêne, E., Schneider, C. (2005). Grapevine and climatic changes: A glance at the situation in Alsace. Agronomy for Sustainable Development, 25, 93–99.

Ganichot, B. (2002). Evolution de la date des vendanges dans les Côtes du Rhône méridionales. Proceedings of the 6th Rencontres rhodaniennes, Orange, France, Institut Rhodanien Editeur, 38-41.

Jones G.V., Davis R.E. (2000). Climate influences on grapevine phenology, grape composition, and wine production and quality for Bordeaux, France. Am. J. Enol. Vitic. 51, 249–261.

Jones G.V. (2006). Climate change and wine: observations, impacts and future implications. Wine Industry Journal 21(4), 21–26.

Madelin M, Chabin J-P, Bonnefoy C. 2008. Global warming and its consequences on the Beaune vineyards. Enometrica 1(2): 9–19.

Petgen, M. (2007). Möglichkeiten und Grenzen der Reifesteuerung: Wie flexibel reagiert die Rebe? Das Deutsche Weinmagazin, 7/8, 42–47.

Petrie P.R., Sadras 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 R. 14(1), 33–45.

Sigler, J. (2008). In den Zeiten des Klimawandels: Von der Süßreserve zur Sauerreserve? Der Badische Winzer, 33, 21–25.

Stock, M., Gerstengarbe, F., Kartschall, T., & Werner, P. (2005). Reliability of climate change impact assessments for viticulture. In L. E. Williams (Ed.). Proceedings of the VII international symposium on grapevine physiology and biotechnology (Vol. 689, pp. 29–39). Davis, USA: Acta Horticulturae.

Webb L.B., Whetton P.H., Barlow E.W.R. (2011). Observed trends in winegrape maturity in Australia. Glob. Change Biol. 17, 2707–2719.