Scientific Papers, Series B, Horticulture, Vol. LVI, 2012
ISSN Online 2286-1580, ISSN-L 2285-5653

RESEARCHES CONCERNING THE INFLUENCES OF CLIMATE CHANGES ON GRAPEVINE

Georgeta Mihaela BUCUR, L. DEJEU, G. CAZAN, Ana TĂNASE

[1]University of Agricultural Sciences and Veterinary Medicine, Bucharest, 59 Marasti, District 1, 011464, Bucharest, Romania, Phone: +40 21 318 25 64, Fax: + 40 21 318 28 88,
E-mail: mihaela_g_savu@yahoo.com; liviudejeu@gmail.com; ana.tanase@ymail.com.

Corresponding author email: mihaela_g_savu@yahoo.com

Abstract

Starting with the fundamental influence of climatic factors on the territorial repartition, on the quantity and quality of viniviticultural products, there were studied the effects of global warming on grapevine, in the last decade. The research concerned the variety Fetească regală, clone 21 Bl, grafted on Kober 5 BB rootstock, on the experimental plantation of the University of Agronomical Sciences and Veterinary Medicine Bucharest, in 2000-2010. Following the evolution of climatic indicators in this period, as compared to the annual average, we can notice the frequence of the years with high temperature at maturation, which led to increased sugar accumulation in grapes, lowering the acidity of the must, together with the speed-up of the phonological stages and the extension of favorable areas for viticulture.

Key words: *climate change, viticulture, grapes*

INTRODUCTION

The global warming manifested during the last period of time affects the growth and the fructification of grapevine as other plants.
There were studied the consequences of climatic changes on viticulture, on grapes, on must and wines [1, 5, 7, 10], mechanism of genetic and physiological adaptation [2, 6, 9], as well as on new strategies for the adaptation of crop management and varieties to these new conditions [3, 4]. The latest researches in this field regard the grapevine adaptations to stress conditions changing climate effects on grapes productions, grapes composition, wine typicity, and pathogens behavior. Today, of the importance the topic is given also by the recently created OIV group of experts „Viticultural Environment and Climate Change” who have developed the OIV guidelines for studies on the effects of climate change in vitiviniculture and proposed adaptations [8, 11]. This study is aimed to determine the effects of the climate changes from last decade on the vegetative growth of grapevine, grape yield and quality for Fetească regală variety.

MATERIAL AND METHOD

The studied vineyard was established in the year 1994 along the North - South direction in the University of Agricultural Sciences and Veterinary Medicine, Bucharest. The plant material used was the 21Bl Fetească Regală clone on the Kober 5 BB rootstock, with distances of plantation of 2.2/1.2 m.
It has been studied the spur prunet cordon with three bud loads: 10, 15 and 20 buds/m².
The trial was conducted for 10 years (2001-2010) with 3 repeats in such a way that there would be 10 vine per parcel.
From the analysis of climate data, the following agroclimatic indices have been calculated: the average year temperature (°C); the average temperature during the growing period (°C); the average temperature of the hottest month (July or August) (°C); the length of the growing season (days); the active thermic balance (∑°ta); the useful thermic balance (∑°tu) (°C); the sum of the hours of real insolation (∑ir); the sum of the annual precipitations (mm); the sum of the precipitations from the growing period (mm); the real heliotermic index (IHr); the hydrothermic coefficient (CH); the deficit of precipitations (DP-mm); the viticultural bioclimatic index (Ibcv) and the index of the oenoclimatic aptitude (IAOe).

The data collected during the study was: the eliminated pruning wood (kg/vine), the grape yield (kg/vine), the cluster weight (g), the weight of one hundred berries (g), the sugar content (g/l) and the titratable acidity (g/l H_2SO_4).

To calculate the dry matter, the quantity of annual wood eliminated at pruning and the grapes, yield have been increased with the coefficients 0.5 and 0.2 respectively. The dry matter of the leaves was calculated with the help of the formula „m² leaf surface x 65 g/m²".

RESULTS AND DISCUSSIONS

1. The climatic conditions. Following the average annual temperature in the period 1961-2010 (Fig. 1), it can be observed it's upward trend over the past 10 - 15 years.

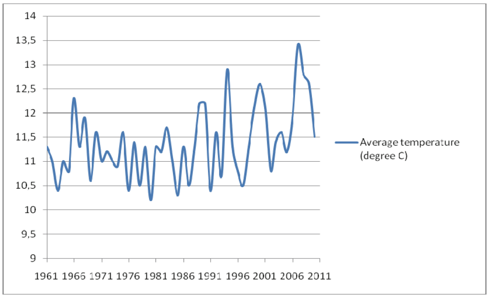

Fig. 1. Evolution of the average annually temperature (° C) for the period 1961-2010

The most pronounced increase is noticed in the hottest month of the year (July or August), when the values of the temperatures of this month during the experimental period, in 7 out 10 years, exceed the values of the average multiannual temperature (Table 1).

Following the evolution of the annual precipitation sum over the 1961-2010 period (Fig. 2), during the last decade, there have been established large variations from one year to another, because of the increasing annual sum, from 615 mm (the 50 years average sum of precipitations) to 659 mm (the average sum of precipitations between 2001 and 2010).

At the same time, the precipitation deficit from May to August, that interest the irrigated vines, has increased during the last decade: during the experimentation the average value was 135 mm, compared with the multiannual average of 99 mm. The enoclimatic aptitude index for producing red wines (IAOe) had a significant increase during the recent years, highlighting their favorability for red wine varieties.

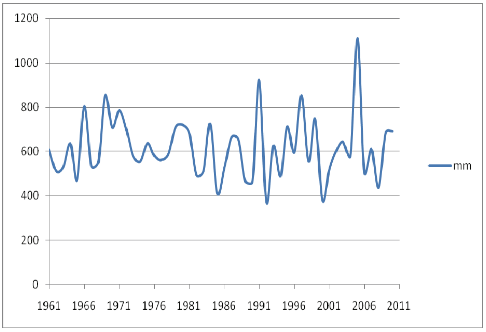

Fig. 2. Evolution of the sum of annually precipitations (mm) for the period 1961-2010

2. The influence of climate change on the vegetative growth parameters. As a consequence of the climatic variations from one year to another, the vegetative growths, the leaf surface and the accumulation of dry matter in the annual organs of the vine, registered high variations according to the hydric and the heliothermic regime (Table 2).

The annual quantity of wood remained at pruning at the end of the year 2002 was of only 0.295 kg/vine, while the values from the other years were 1.1-1.3 kg/vine, as a result of the accentuated deficit of precipitations from the growth period. The values of leaf surface were also reduced in same year only 1.73 m²/vine, compared with 3.5-4 m²/vine during the other years of culture. The dry matter accumulated in the annual organs of the vine (annual pruning wood, grapes, leaves) in the year 2002 totalized, in average 1.70 kg/vine, representing less than half from the values of a very favorable year for viticulture.

3. The influence of climate change on yield quantity and quality. The yield of grapes has varied in large limits (Table 3), according to the year of culture: from 2.596 kg/vine in an unfavorable year (2005) to 7.284 kg/vine in a very favorable year (2006). The accumulation of sugar was stimulated by the climatic warming an the hydric deficit in 2002, 2003, 2007 and 2008, arriving in average to 192.8 g/l (2002), 197.2 (2007), 203.7 (2007) and 196.8 (2008).

Due to the early maturation of the grapes during the high temperature periods, the titratable acidity of the must had lower values because of the combustion of the organic acids being more intense at high values of temperature.

Table 1. Climatic indicators

Climatic index	Average 1961-2010	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2001-2010
Average year temperature (ºC)	11.3	10.80	10.8	9.9	11.6	11.2	11.1	13.4	12.8	12.6	11.5	11.6
Average temperature from the growing period (ºC)	18.6	18.10	18.5	19.4	17.6	17.8	18.2	19.1	17.9	19.1	19	18.5
Average temperature of the hottest month (VII-VIII) (ºC)	22.9	23.30	23.8	25.2	22.8	22.5	22.6	27.3	25.6	24.1	24.9	24.2
Length of the growing season (days)	201	190	180	181	211	200	202	199	207	203	192	196
Active thermic balance (∑ºta)	3738	3444	3328	3511	3721	3564	3675	3816	3709	3885	3649	3.630
Useful thermic balance (∑ºtu)	1728	1544	1528	1701	1611	1564	1655	1826	1649	1855	1729	1.666
Sum of the hours of real insolation (∑ir)	1157	1629	1413	1735	1483	1481	1568	1604	1694	1648	1409	1.566
Sum of the annual precipitatios (mm)	615	492.5	606.6	814.9	582	1109	562.3	610	435	686	692	677
Sum of the precipitatios from the growing period (mm)	361	283	353	429	378	840	340	248	298	391	397	395
Real heliothermic index (IH r)	2.44	2.51	2.15	2.95	2.38	2.31	2.59	2.93	2.79	3.05	2.43	2.6
Hydrothermic coefficient (CH)	1.00	0.82	1.06	1.22	1.01	2.35	0.92	0.65	0.8	1.35	1.08	1.1
Deficit of precipitatios (DP-mm)	99	129	122	301	104	-78.3	97	250	221	109	100	135
Viticultural bioclimatic index (Ibcv)	8.67	10.43	7.4	7.8	6.9	3.14	8.39	12.4	10.16	8.06	6.74	8.1
Index of the oenoclimatic aptitude (IAOe)	4694	4896	4685	5073	4569	4258	4803	5266	5092	5391	4859	4.889

Table 2. The vegetative elements of the vine according to the climatic conditions of the year of culture (Feteasca regală 2001-2010)

Specification	Bud load (bud /m²)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2001-2010
Pruning weight (kg/vine)	10	1.026	0.252	0.89	0.86	1.11	1.152	0.618	0.856	0.527	0.774	0.807
	15	1.11	0.258	1.014	1.33	1.306	1.188	0.632	0.896	0.519	0.956	0.921
	20	1.67	0.375	1.384	1.712	1.465	1.428	0.799	0.984	0.628	0.953	1.140
	Mean	1.269	0.295	1.096	1.301	1.294	1.256	0.683	0.912	0.558	0.894	0.956
Leaf area (m²/vine)	10	3.45	1.64	3.25	2.37	3.45	2.85	3.32	3.29	3.8	3.95	3.14
	15	4.06	1.66	3.35	2.53	3.67	4.17	4.07	4.03	4.07	4.32	3.59
	20	3.85	1.90	4.04	3.14	3.65	4.36	4.90	4.71	4.17	4.30	3.90
	Mean	3.79	1.73	3.55	2.68	3.59	3.79	4.10	4.01	4.01	4.19	3.54
Total dry matter accumulated in the annual organs (kg/vine)	10	1.35	0.83	2.25	1.38	1.26	2.17	1.11	1.66	1.45	1.24	1.47
	15	1.50	1.04	2.25	1.70	1.46	2.17	1.18	1.69	1.54	1.31	1.58
	20	1.73	1.34	2.02	1.89	1.47	2.66	1.53	1.82	1.83	1.26	1.76
	Mean	1.53	1.07	2.18	1.66	1.40	2.33	1.28	1.72	1.61	1.27	1,60

Table 3. Yield of grapes according to the quantitative and qualitative aspect depending on the climatic conditions of the year of culture (Feteasca regală 2001-2010)

Specification	Bud load (bud/m²)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2001-2010
Yield (kg/vine)	10	2.760	3.000	4.070	3.179	2.411	7.057	2.935	4.821	4.148	2.701	3.708
	15	3.280	4.040	5.140	3.236	2.852	6.500	3.018	5.030	4.470	2.528	4.009
	20	4.440	5.190	5.270	3.977	2.525	8.295	4.067	5.438	5.513	2.330	4.705
	Mean	3.493	4.077	4.827	3.464	2.596	7.284	3.340	5.096	4.710	2.520	4.141
Average weight of a grape (g)	10	47.8	64.8	89.1	63.1	71.5	144.2	88.6	109.5	104.3	118.2	90.1
	15	58.3	57.9	96.1	51.3	65.1	146.8	98.1	112.2	98.6	96.4	88.1
	20	52.4	56.3	82.9	49.5	56.5	151.7	83.6	110.5	104.5	108.5	85.6

	Mean	52.8	59.7	89.4	54.6	64.4	147.6	90.1	110.7	102.5	107.7	87.9
Weight of one hundred beries (g)	10	143.5	110.6	156.0	186.3	170.7	183.2	135.8	162.5	134.7	168.4	155.2
	15	147.0	128.6	173.1	173.5	161.8	177.1	131.6	162.9	132.2	171.1	155.9
	20	153.6	130.0	149.5	158.2	167.5	180.8	152.6	168.8	136.8	166.0	156.4
	Mean	148.0	123.1	159.5	172.7	166.7	180.4	140.0	164.7	134.6	168.5	155.8
Sugar (g/l)	10	171.1	192.2	193.7	164.2	176.3	188.8	203.7	196.3	174.8	211.8	187.3
	15	185.0	196.6	200.6	171.0	174.3	194.3	201.8	196.7	180.1	215.6	191.6
	20	178.8	189.5	197.3	162.8	169.8	196.3	206.0	197.3	185.8	218.1	190.2
	Mean	178.3	192.8	197.2	166.0	173.5	193.1	203.8	196.8	180.2	215.2	189.7
Acidity (g/l H_2SO_4)	10	4.01	3.48	3.52	6.14	6.29	4.86	3.99	4.14	5.09	4.39	4.59
	15	3.75	3.53	3.21	5.88	5.97	4.96	4.11	4.21	5.38	4.30	4.53
	20	3.92	3.43	3.28	5.83	5.88	4.91	3.95	4.18	5.13	4.37	4.49
	Mean	3.89	3.48	3.34	5.95	6.05	4.91	4.02	4.18	5.20	4.35	4.54

In Fig. 3, there is presented the correlation between the average temperature of the hottest month (July or August) and sugar accumulation, and in Fig. 4 there is shown the correlation between the useful thermic balance and sugar accumulation.

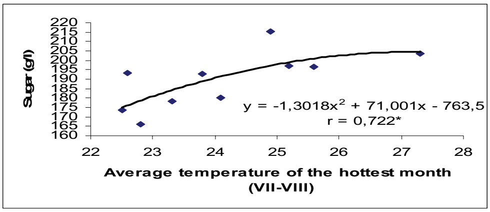

Fig. 3. Correlation between the average temperature (ºC) of the hottest month (VII-VIII) and sugar accumulation (g/l)

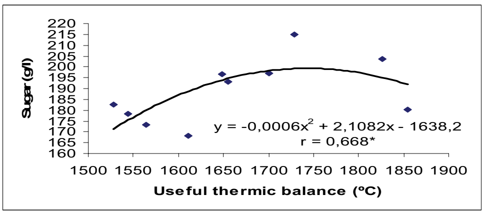

Fig. 4. Correlation between the useful thermic balance (ºC) and sugar accumulation (g/l)

CONCLUSIONS

The impact of high temperatures on grapevine and quality of grapes is to cause early ripening, increased sugar content and reduced acidity.

In order to diminish the impact of climate change it is necessary to adapt the cultural practices (the size of the bud load attributed of pruning, the application of some green operations, the water conservation from the soil, the irrigation etc) to the evolution of climate over time. Also the expansion of varieties adapted to the climate varming and the cultivation area of the red wine grape varieties are important.

REFERENCES

[1] Bonnefoy C**.**, Quenol H**,** Planchon O**.,** Barbeau G., 2010. *Températures et indices bioclimatiques dans le vignoble du Val de Loire dans un contexte de changement climatique*. EchoGéo, 14. http://echogeo.revues.org/12146 (8.06.2012).

[2] Burzo I., Dejeu L., Şerdinescu A., Bădulescu Liliana, 2005. *Fiziologia plantelor de cultură. Vol. III – Fiziologia viţei-de-vie*. Editura Elisavaros, Bucureşti, p. 300.

[3] Carbonneau A., Ojeda H., Escudier J.L., 2010. *Systèmes de production innovants en viticulture durable, face aux changements du climat et de la consommation.* Progrès Agricole et Viticole, 127 (13-14), 284-292.

[4] Carbonneau A., 2011. *Quelques idees de strategies viticoles face au changements climatique.* Progrès Agricole et Viticole, 128 (15/16), 301-305

[5] Duchêne E., Huard F., Dumas V., Schneider C., Merdinoglu D., 2010. *The challenge of adapting grapevine varieties to climate change*. Climate Research, 41, 193-204.

[6] Duchêne E., Butterlin G., Dumas V.,2012. *Toward the adaptation of grapevine varieties to climate change: QTL and candidate genes for developmental stages*. Theoretical and Applied Genetics, 124, 623-635.

[7] Holland T., Smit B., 2010. *Climate change and the wine industry: Current research themes and new directions*. Journal of Wine Research, 21 (2-3), 125-136.

[8] Quénol H. et al., 2012. *Variabilité Spatiale du Climat a l'echelle des terroirs viticoles dans un contexte de changement climatique: Programmes TERVICLIM et TERADCLIM*. Organisation Internationale de la Vigne et du Vin, Paris, le 13 mars 2012.

[9] Schultz H.R.,2010. *Climate change and viticulture: Research needs for facing the future.* Journal of Wine Research, 21 (2-3), 113-116.
[10] Tomasi D., Jones G.V., Giust M., Lovat L., Gaiotti F., 2011. *Grapevine Phenology and Climate Change: Relationship and Trends in the Veneto Region of Italy for 1964 to 2009*. American Journal of Enology and Viticulture, 62 (3), 329-339.
[11] *** - *OIV guidelines for studies on the effects of climate change in vitiviniculture and proposed adaptations.* Organisation Internationale de la Vigne et du Vin, Paris, le 13 mars 2012.

EX·TERRA·AVRVM