PHYSIOLOGICAL RESPONSE OF GRAPEVINE (*VITIS VINIFERA* L. CV. FETEASCĂ ALBĂ) AT THE CLIMATIC CONDITIONS OF 2012 IN IAŞI AND COTNARI WINE REGIONS

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Abstract

As a result of global climate change, strongly felt in recent years, the grapevine is becoming increasingly exposed to abiotic stress factors. Among these, temperature, light intensity and rainfall, with significant variations from normal, play an important role in the occurrence of changes in the physiological activity of the plant. The aim of this study was to investigate the physiological response of Fetească alba grapevine variety at the climatic conditions of the year 2012, in Iaşi and Cotnari wine regions. A source-sink relationship was analyzed based on photosynthetic activity, water use efficiency and storage of metabolites in different plant organs. In the phenophases of flowering, grapes growth and grape maturation were found changes in photosynthetic activity and water use efficiency of the plant, caused by different climate conditions, without significant quantitative differences in the assimilate storage. This means that, at *Vitis vinifera* L cv Fetească albă, better adaptated to environmental conditions in this two regions, reduced photosynthetic activity due to insufficient light or rainfall can be compensated by an efficient transport and storage of assimilates, demonstrated by the grape production and dry matter accumulation on the grapevine leaf or canes level.

Key words: *Vitis vinifera,* photosynthesis, water use efficiency, source-sink relationship

Climate change and its impacts on the vineyards is a major problem for the wine researcher. This led to many problems in wine ecosystems. Vines are forced to change their annual cycle of vegetation, often with negative consequences for the quality of grapes and grape production, finally the quality of the resulting wines. Several researches point out the importance of photosynthesis in the quantitative and qualitative formation of grapevine production (Flexas J., 2009; Lebon G., 2008). During the first half of the growing season the leaves export their assimilates to the flowers or the young grapes and as reserves to the old wood (Koblet W. et al., 1996), or roots. The climate stress factors also influence the deposition of assimilates in the wood and roots. Overloaded vines layered one less reserve materials, and are vulnerable to the cold stress in winter.

Photosynthesis is the most drought sensitive process (Palliotti A., 2009; Zulini L., 2005). The stress caused by the lack of water and related to the water deficit has severe effects, mostly of them they appear suddenly, are highly intense and are accompanied by high temperatures (Cifre J., 2005; Jităreanu Doina, 2011).

The aim of present studies was to analysed a source-sink relationship for *Vitis vinifera* L. cv. Fetească albă, based on photosynthetic activity, water use efficiency and storage of metabolites in different plant organs.

MATERIAL AND METHOD

The research was conducted in the vegetation season of 2012 on the grapevine varietie Fetească albă cultivated in Iasi and Cotnari vineyards. evolution of the climate between January – December was assessed by recording the average temperatures (^oC) as well as the monthly rain all (mm). These data were related to the normal values in Iasi and Cotnari vineyards. As production indicators, we considered the grape production values (kg/plant), average number of grape on a vine, average weight of a grape (g). The dry matter of leaves and canes was determined gravimetrically after drying in an oven to constant weight. The physiological reaction was estimated using a parameter of the photosynthesis process. Net photosynthetic rate (A), transpiration rate (E), stomatal conductance (Gs), intercellular CO_2 concentration (Ci), leaf temperature (Tl), chamber temperature (Tch), atmospheric CO_2

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concentration (Cref) and incident irradiance at leaf surface (Qleaf) were instantaneously measured using the LCpro+, Leaf Chamber Analysis System. All parameters were automatically recorded.
The Water use efficiency (WUE) of photosynthesis was estimated by measuring the instantaneous gas exchange of leaf as expressed by photosynthesis/transpiration (A/E) ratio (Martim S. et al., 2009)
The results were obtained in dynamics, during the following phenophases: flowering, berry growth and grape ripening.

RESULTS AND DISCUSSIONS

The analysis of climatic data pointed out that in Iasi vineyard, the average monthly temperatures were higher than the multiannual average whole year, except March and December to which a precipitation deficit was added for the active vegetation period, extremely intense from June to September (*tab. 1*).
The same tendency was also registered in the wine region Cotnari. A higher monthly temperature and a significant water deficit during the growing season (*tab. 2*). The absence of rainfal and the high diurnal and nocturnal temperatures lead to the appearance of pedological, atmospheric and physiological drought, thus shortening the phenophases (Jitareanu Doina et al., 2011).

Table 1

Climatic factors in 2012, in Iasi vineyard

Specification	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TEMPERATURES (^{o}C)												
Average	-2.5	-9.5	4.0	13.0	18.2	23.3	26.3	23.1	18.9	12.0	6.6	-3.7
Monthly Normal	-3.1	-1.2	3.4	10.4	16.3	19.7	21.2	20.5	15.8	10.1	4.4	-0.8
Deviation	+0.6	+8.3	-0.6	+2.6	+1.9	+3.2	+5.1	+2.6	+3.1	+1.9	+2.2	-2.9
PRECIPITATIONS (mm)												
Monthly amount	12,0	61,0	19.4	56.2	98.2	16.3	22.2	32.1	50.1	34.0	22.5	83.5
Normal	30,5	28,4	32,8	49,1	59,1	88,7	82,8	56,9	52,0	32,8	35,1	31,5
Deviation	-18.5	+32.6	-13.4	+7.1	+39.1	-72.4	-60.6	-24.8	-1.9	+1.2	-10.3	+52.0

Table 2

Climatic factors in 2012, in Cotnari vineyard

Specification	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TEMPERATURES (^{o}C)												
Average	-1.9	-8.4	5.0	12.6	17.5	22.0	25.2	22.7	18.6	11.8	5.6	-3.1
Monthly normal	-2.6	-1.3	3.0	9.6	15.5	18.8	20.4	20.0	15.5	10.1	4.0	-0.7
Deviation	+0.7	-7.1	+2.0	+3.0	+2.0	+3.2	+4.8	+2.7	+3.1	+1.7	+1.6	-2.4
PRECIPITATIONS (mm)												
Monthly amount	16,2	62,1	14,4	71,3	90,4	44,2	27,8	28,2	12,2	27,4	27,8	103,8
Normal	21,3	21,4	27,4	49,7	59,0	78,6	84,6	59,7	44,0	29,2	29,8	24,9
Deviation	-5,1	40,7	-13,0	21,6	31,4	-34,4	-56,8	-31,5	-31,8	-1,8	-2,0	78,9

Photosynthetic capacity and water use efficiency under climatic conditions of the year 2012

The assimilation rate (A) had values between 17,8 µmol CO_2 $m^{-2}s^{-1}$, in Iasi vineyard, in the flowering phenophase, and 0,36 µmol CO_2 $m^{-2}s^{-1}$, in the phenophase of berry growth in Cotnari vineyard.

Generally found Koblet W. et al. (1996) a close relationship between light intensity and assimilation capacity of the leaves.

This also applies to our measurements, except the grape maturation phenophase at grapevine grown in Iasi vineyard. Further depends the assimilation rate on the phenophase (*tab. 3*). Water use efficiency recorded the highest values during the flowering phenophase, registered a decrease, while the berry growth phenophase, and then again increase an erstwhile at grape maturation phenophase (*fig. 1*).

Martim S. et al. (2009) have found that drought stressed grapevine plants have a higher WUE compared with non-stressed plant. It could be that, in our studies, the drought stress in the berry growth phenophase to a better WUE led.

Table 3

Photosynthetic rate (A) of *Vitis vinifera* L cv. Fetească albă in Iasi and Cotnari vineyar function of the incident irradiance at leaf surface (Qleaf)

Vineyard	flowering		berry growth		grape maturation	
	A*	Qleaf**	A*	Qleaf**	A*	Qleaf**
Iaşi	17,84	144,67	1,01	91,55	0,47	118,05
Cotnari	13,05	82,95	0,36	79,07	1,18	82,14

*A (µmol CO_2 $m^{-2}s^{-1}$), **Qleaf (µmol m^{-2} s^{-1})

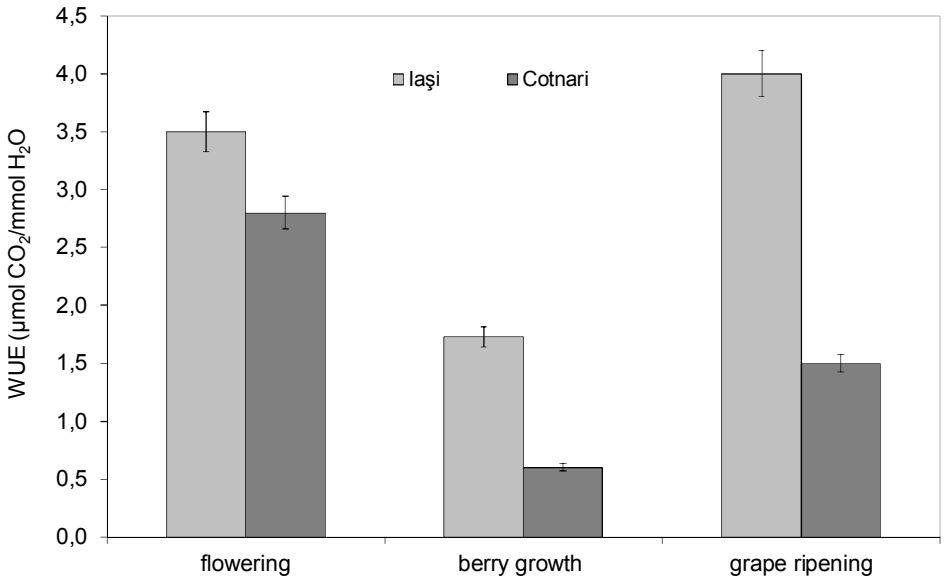

Figure 1 **Water use efficiency under climatic conditions of the year 2012**

Grape yield, dry weight of leaves and canes under climatic conditions of the year 2012

Grape production is the result of two grapevine characteristics, fertility and productivity, as a result of complex transformations in their mechanisms that take place in successive phases and in the presence of certain factors. The vine yield depends on the number and size of grapes, so that varieties with the same percent of fertile shoots or with the same fertility coefficient lead to different grape productions (Marta A. E. et al., 2012). The grape yields has values from 2.5 kg/plant at Cotnari vineyard to 2.8 kg/plant at Iasi vineyard (*tab. 4*) The grape yields and the average weight grapes were more influenced by the number of grapes per plant than the photosyntetic activity. The photosynthetic assimilate transported to a smaller sink were stored in great quantity. The grapevine has a great potential for stress acclimation: under stress condition the stored reserves in old wood and roots can be mobilized and led to the growing organs and ripening grapes (Koblet W. et al. 1996); or as in the case of cv. Cabernet Sauvignon is able to adapt their photosynthetic process to reduction in water availability (Martim S. et al., 2009).

Dry weight of leaves and canes: despite the different environmental conditions dry matter accumulation in the leaves at grape ripening phenophasis and in the cannes, measured in december registered no significant differences between the two wine area (*tab. 4*).

Table 4

Grape yield, dry weight of leaves and canes

Vineyard	Grape yield (kg/plant)	Average number of grape on a vine	Average weight of a grape (g)	Grape yield (t/ha)	Leaves dry matter (%)	Cannes dry matter (%)
Cotnari	2.5	27.9	89.0	9.2	33.2	58.3
Iasi	2.8	22.9	95.0	10.3	34.3	59.2

ACKNOWLEGMENTS

This study was realised and published within the research project POSCCE-A2-O 2.1.2-2009-2 ID.653, code SMIS-CSNR 12596.

CONCLUSIONS

1. The climatic conditions of 2012 were characterized by thermic and hydric stress on the grapevine varieties in both cultivated areas.

2. The changes were found in photosynthetic activity and water use efficiency of the plant during the phenophases of flowering, grapes growth and grape maturation, without significant quantitative differences in the assimilate storage

3. *Vitis vinifera* L cv Fetească albă proved to be better adaptated to environmental conditions in Iaşi and Cotnari wine regions by an efficient transport and storage of assimilates, demonstrated by the grape production and dry matter accumulation on the grapevine leaf or canes level.

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