

CZU 634.848.1:634.849:57.047(478)(043.2)

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THE CAPACITY OF GRAPEVINE GENOTYPES TO CAPTURE CO₂ FROM THE ATMOSPHERE

*According to calculations of the inventory of greenhouse gases emitted into the atmosphere, it was found that CO₂ accounts for about 80%. Cultivation of agricultural plant genotypes with an increased potential for capturing CO₂ from the atmosphere represents an additional benefit for economic agents, expressed through the sale of "green allowances" (the equivalent of CO₂ produced), to economic agents, which do not fit into the technological process of absorbing greenhouse gases emitted into the atmosphere. In the study, the intraspecific grapevine genotypes from the *Vitis vinifera* L. subspecies *sylvestris* Gmel. group and the genotypes from the *D.C. sativa* subspecies group were used: *Feteasca alba*; *Feteasca neagra* etc., as well as interspecific genotypes *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx.: *Ametist*, *Augustina*, *Alexandrina*, *BC3-580* etc. The coefficient of capture of CO₂ from the atmosphere was determined with the help of the light saturation curve method for photosynthesis, using the PTM-48A phytomonitor. The results of the study demonstrated that the interspecific grapevine genotypes *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. have a CO₂ capture coefficient from the atmosphere that is twice as high compared to the intraspecific genotypes from the *Vitis vinifera* L. ssp. *sativa* D.C. group.*

Keywords: CO₂, climate change, genotypes, grapevine, photosynthesis.

INTRODUCTION

The increase in CO₂ levels in the atmosphere leads to a disruption of the balance of climatic factors both locally and globally. Thus, climate change is a phenomenon that occurs very rapidly in time and space, and many genotypes of living organisms will not be able, in a short period of time, to adapt to new environmental conditions. Based on calculations of the volume of greenhouse gases emitted into the atmosphere, it was found that CO₂ is eliminated in the largest quantity, approximately 80%. The increase in the volume of greenhouse gases in the environment is currently on the rise and is also generating irreversible climate processes. Ultimately, the results of the impact of these gases will contribute to radically altering life on Earth [1,2].

Currently, there are various methods for capturing carbon dioxide from the atmosphere, but a fairly effective method is the cultivation on agricultural land of agricultural plant genotypes that also have an increased potential for capturing CO₂.

The use of agricultural plant genotypes with an increased potential for capturing CO₂ from the atmosphere represents an additional benefit for economic agents. By cultivating such genotypes, it is possible to obtain derivative products specific to the respective genotype and, at the same time, to sell "green quotas" (the equivalent of CO₂ produced) to economic agents who are not able to cope with the technological process of absorbing greenhouse gases emitted into the atmosphere [3, 2].

A significant amount of research today is devoted to the study of grapes in the areas of analysis of photosynthetic activity, transpiration and stomatal conductance depending on the ambient temperature and the genotype [4, 5, 6, 7, 8, 9, 10, 11, 12].

The purpose of the present study is to analyze the photosynthetic activity in conjunction with transpiration and stomatal conductivity of grapevine genotypes in relation to the ambient

temperature in order to determine the photosynthesis coefficient.

MATERIALS AND METHODS

As the object of study served: intraspecific grapevine genotypes from the group *Vitis vinifera* L. of the subspecies *sylvestris* Gmel.; the genotypes from the group of the subspecies *sativa* D.C.: Feteasca Alba; Feteasca neagra etc.; interspecific genotypes *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx.: Ametist, Augustina, Alexandrina, BC3-580 etc.

The activity of physiological parameters was analyzed, such as: transpiration, stomatal conductivity, photosynthesis, etc. in relation to temperature and sunlight. [3].

The determination of the CO₂ absorption capacity from the atmosphere was carried out using the PTM-48A phytomonitor, which is an automatic system with four cameras, which operate automatically, being fixed on the leaves of plants. The time period for evaluating the activity of physiological criteria was 72 consecutive hours. Statistical processing of the obtained data was carried out using the Statistics 10 computer program (Statsoft INC, USA) and Microsoft Excel 2010 [13, 14].

RESULTS AND DISCUSSIONS

The census fulfills the role of a unique photosynthetic system, the efficiency of whose functionality depends on the ability of the plant genotype to capture CO₂ from the atmosphere and use an increased coefficient of solar radiation energy. Based on the photosynthesis coefficient indices, it is possible to optimize the essential vital factors for plant development in agrophytocenoses [2].

Analyzing the indices regarding photosynthetic activity, transpiration and stomatal conductivity, we find that the genotype *Vitis vinifera* L. ssp. *sylvestris* Gmel. at a temperature of 28 °C has a photosynthetic activity of 6.17 micromol (CO₂)/m²/s and transpiration of 0.76 millimol (H₂O)/m²/s, while at a temperature of 33.42 °C, the photosynthetic activity is 6.06 micromol (CO₂)/m²/s and transpiration of 2.62 millimol (H₂O)/m²/s, (tab. 1).

At the same time, the intraspecific grapevine genotypes from the *Vitis vinifera* L. ssp. *sativa* D.C. group, at a temperature of 27.5-28.5 °C have a photosynthetic activity of 8.2 micromol (CO₂)/m²/s, (Feteasca Albă) and 8.5 micromol (CO₂)/m²/s, (Feteasca Neagră), at the same time the transpiration is 1.85 millimol (H₂O)/m²/s (Feteasca Albă) and 1.78 millimol (H₂O)/m²/s (Feteasca Neagră), (tab. no. 1).

But, at a temperature of 34.56-35.21 °C, photosynthetic activity is 7.25 micromol (CO₂)/m²/s (Feteasca Albă) and 7.5 micromol (CO₂)/m²/s (Feteasca Neagră), while transpiration is 4.43 millimol (H₂O)/m²/s (Feteasca Albă) and 5.04 millimol (H₂O)/m²/s (Feteasca Neagră), (tab. no. 1).

The interspecific grapevine genotypes *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. at a temperature of 27-28.5 °C have a photosynthetic activity of 10.68 micromol (CO₂)/m²/s (Alexandrina), 10.96 micromol (CO₂)/m²/s (Ametist) and 12.02 micromol (CO₂)/m²/s (Augustina), at the same time the transpiration is 2.52 millimol (H₂O)/m²/s (Alexandrina), 1.75 millimol (H₂O)/m²/s (Ametist) and 2.94 millimol (H₂O)/m²/s (Augustina) (tab. no. 1).

However, at a temperature of 35.57-35.84 °C, photosynthetic activity is 9.26 micromol (CO₂)/m²/s (Alexandrina), 10.3 micromol (CO₂)/m²/s (Ametist) and 11.1 micromol (CO₂)/m²/s (Augustina), while transpiration is 4.56 millimol (H₂O)/m²/s (Alexandrina), 3.95 millimol (H₂O)/m²/s (Ametist) and 4.1 millimol (H₂O)/m²/s (Augustina) (table no. 1).

Using the light saturation curve method for photosynthesis, with the help of the PTM-48A phytomonitor, the intraspecific grapevine genotypes *Vitis vinifera* L. ssp. *sativa* D.C. and the interspecific rhizogenic grapevine genotypes *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. were evaluated in terms of the capacity to absorb CO₂ from the atmosphere and the determination of the capture coefficient. The duration of the test start for each genotype studied was at least 72 consecutive hours.

Analyzing the intensity of photosynthesis of grapevine genotypes of intraspecific origin *Vitis vinifera* L. ssp. *sativa* D.C., it was concluded that the genotype: Sauvignon has a capture coefficient of 2.2 micromol(CO₂)/m²/s; Muscat de Alexandria – 1.7 micromol (CO₂)/m²/s etc. (fig. 1a).

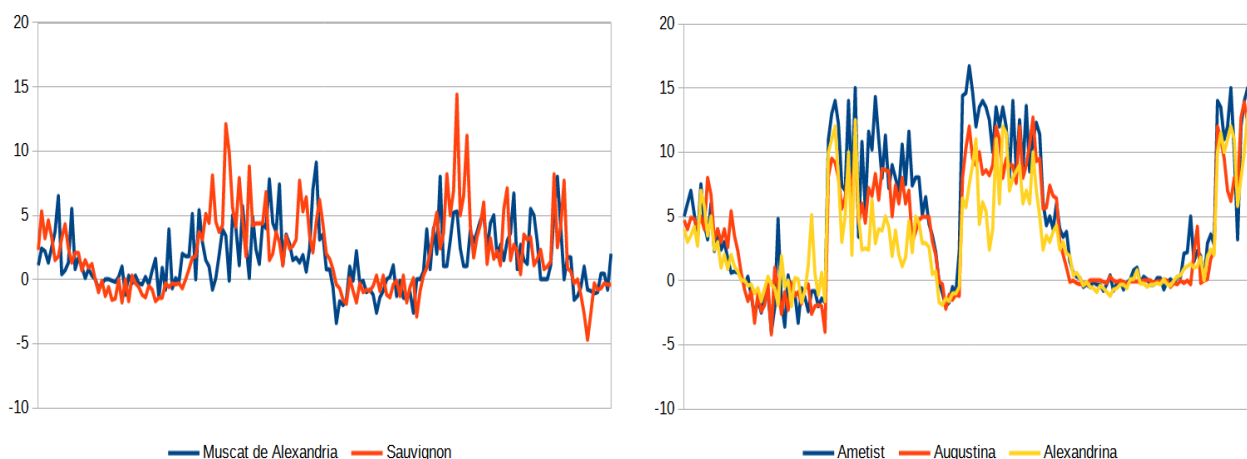
The interspecific rhizogenic grapevine genotypes *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. have a capture coefficient as follows: Ametist – 4.8 micromol

(CO₂)/m²s; BC₃-580 – 4.3 micromol (CO₂)/m²s; Augustina – 3.8 micromol (CO₂)/m²s; Alexandrina – 3.1 micromol (CO₂)/m²s (fig. 1b).

Table 1

Physiological peculiarities of grapevine genotypes

Genotype	Leaf temperature (°C)	Transpiration (milimol (H ₂ O)/m ² /s)	Stomatal conductivity (mol/m ² /s)	Photosynthesis (micromol (CO ₂)/m ² /s)
<i>Vitis vinifera</i> L. ssp. <i>sylvestris</i> Gmel.				
	28	0,76	0,05	6,17
	33,42	2,62	0,12	6,06
<i>Vitis vinifera</i> L. ssp. <i>sativa</i> D.C.				
Feteasca Albă	28,44	1,85	0,14	8,2
	35,21	4,43	0,21	7,5
Feteasca Neagră	27,5	1,78	0,14	8,5
	34,56	5,04	0,3	7,25
<i>Vitis vinifera</i> L. ssp. <i>sativa</i> D.C. x <i>Muscadinia rotundifolia</i> Michx.				
Alexandrina	27,41	2,52	0,27	10,68
	35,84	4,56	0,3	9,26
Ametist	27	1,75	0,16	10,96
	35,57	3,95	0,24	10,3
Augustina	28,51	2,94	0,28	12,02
	35,62	4,1	0,31	11,1
<i>Vitis labrusca</i> L.				
Ontario	28,9	2,65	0,18	8,5
	33,5	3,35	0,24	7,28



a) intraspecific genotypes

b) interspecific genotypes

Fig. 1. The photosynthetic activity of grapevine genotypes

Based on the results of the study, it was found that the interspecific genotypes *Vitis*

vinifera L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. have a carbon capture coefficient from the atmosphere that is twice as high compared to the intraspecific genotypes *Vitis vinifera* L. ssp. *sativa* D.C. (fig. 2).

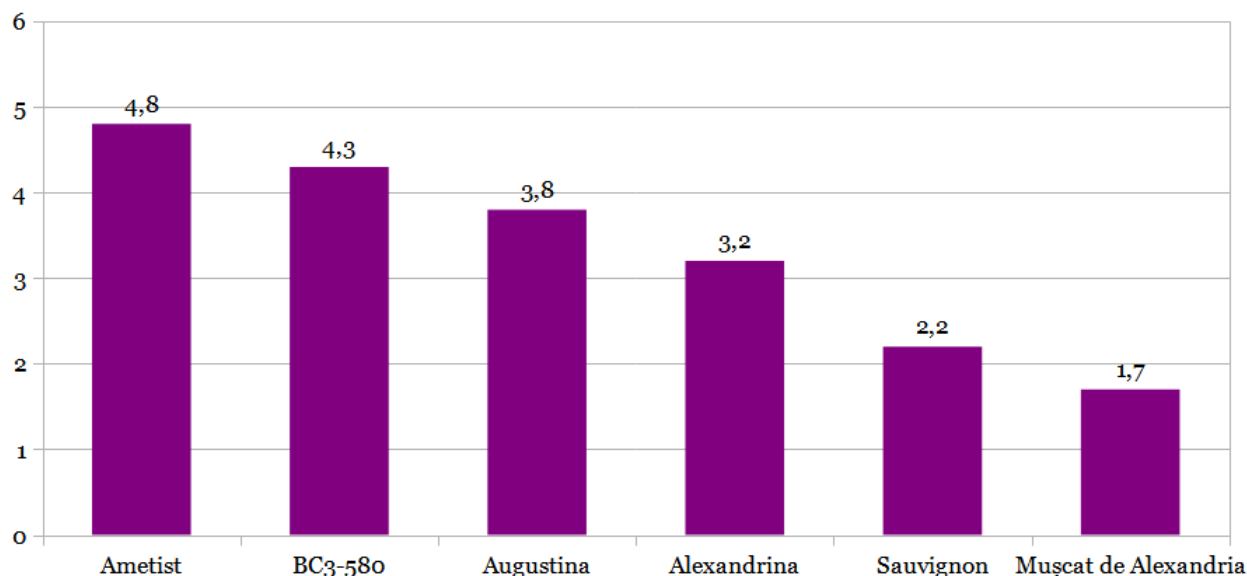


Fig. 2. The coefficient of CO₂ capture

The technique can also be applied to other crops, both agricultural and forestry. The genotype that has an increased coefficient of capturing CO₂ from the atmosphere can be multiplied vegetatively and cultivated in the respective areas.

CONCLUSIONS

The interspecific genotypes of the grapevine *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. have a carbon capture coefficient from the atmosphere twice as high compared to the genotypes of intraspecific origin *Vitis vinifera* L. ssp. *sativa* D.C.

The method can be applied to determine the CO₂ capture coefficient from the atmosphere and to other crops, both agricultural and forestry.

The genotype that possesses an increased CO₂ capture coefficient from the atmosphere can be multiplied vegetatively and cultivated in the respective areas.

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ЗДАТНІСТЬ ГЕНОТИПІВ ВІНОГРАДУ ПОГЛИНАТИ СО₂ З АТМОСФЕРИ

Згідно з розрахунками інвентаризації парникових газів, що викидаються в атмосферу, було встановлено, що на частку СО₂ припадає близько 80%. Вирощування генотипів сільськогосподарських рослин з підвищеним потенціалом поглинання СО₂ з атмосфери є додатковою вигодою для економічних суб'єктів, що виражається в продажу «зелених квот» (еквівалента виробленого СО₂) економічним суб'єктам, які не вписуються в технологічний процес поглинання парникових газів, що викидаються в атмосферу. У дослідженні використовувалися внутрішньовидові генотипи винограду з групи *Vitis vinifera* L. підвид *sylvestris* Gmel. і генотипи з групи підвиду *D.C. sativa*: *Feteasca alba*; *Feteasca neagra* та ін., а також міжвидові генотипи *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx.: *Ametist*, *Augustina*, *Alexandrina*, *BC3-580* та ін. Коефіцієнт поглинання СО₂ з атмосфери визначався за допомогою методу кривої світлової сатурації фотосинтезу з використанням фітотимонітора РТМ-48А. Результати дослідження показали, що міжвидові генотипи винограду *Vitis vinifera* L. ssp. *sativa* D.C. x *Muscadinia rotundifolia* Michx. мають коефіцієнт поглинання СО₂ з атмосфери, який удвічі вищий порівняно з внутрішньовидовими генотипами з групи *Vitis vinifera* L. ssp. *sativa* D.C.

Ключові слова: СО₂, зміна клімату, генотипи, виноградна лоза, фотосинтез.