Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 23, Issue 1, 2023
PRINT ISSN 2284-7995, E-ISSN 2285-3952

A WAY OF MITIGATION AND ADAPTATION TO CLIMATE CHANGE

Eugeniu ALEXANDROV

Institute of Genetics, Physiology and Plant Protection, 20 Padurii Street, 2002, Chisinau, Republic of Moldova, Phone: +373 22 770447, Fax: +373 22 556180, Mobile: +373 79450998, E-mail: alexandrov.eugeniu@gmail.com

Corresponding author: alexandrov.eugeniu@gmail.com

Abstract

Climate change is not only manifested by high temperatures, but means perverse, cascading effects that must be viewed in interaction. Climate change solutions can not only be cost-effective, but also improve the level and quality of life of the population while protecting the environment. In order to improve the situation, at the moment, the following actions are necessary: reducing emissions, adapting to the effects of climate change and financing the necessary adaptation measures. Photosynthesis, respiration, transpiration, stomatal conductance, assimilation, etc. can be used in the plant breeding process, with the aim of identifying plant genotypes with an increased potential for capturing CO_2 *from the atmosphere, thus contributing to maintaining the global average temperature within the limits, which would not lead to the intensification of the greenhouse effect and the change of factors climatic. In order to carry out the study, grapevine genotypes of intraspecific origin from the V. vinifera L. and genotypes of interspecific origin (V. vinifera L. x M. rotundifolia Michx.) were used. The measurements were made in the period up to flowering, the formation (growth) of berries and in the period of mature berries (formed). Phytomonitoring was carried out with the help of the PTM-48A monitor, which is an automatic CO2 exchange monitoring system. Studies have shown that the interspecific grapevine genotypes are characterized by much better adaptive features than intraspecific genotypes in relation to climate change. The respective methodology can also be applied in the improvement process of different plant crops.*

Key words: *climate change, genotypes, grapevine, photosynthesis, respiration, transpiration, stomatal conductance, assimilation*

INTRODUCTION

Climate change is an unprecedented challenge that human society has been facing, and the extent of its impact will largely depend on the level of awareness of the compromises that have to be reached and accepted globally. The real and alternative costs will increase with future climate change, affecting the health and economic well-being of the population. Therefore, the biggest challenge of society is to integrate sustainable strategies in the economic development. The development of society according to the principles of "green economy" provides for the restoration and maintenance of a sustainable, long-term balance between economic development and integrity of the natural environment, in forms understanded and accepted by society. The ability of living organisms to adapt to environmental conditions is a key factor in the evolutionary process. The adaptation of plants to climatic factors means nothing more than the modification of the physiological-biochemical and morphological-anatomical characteristics of the organism in the process of ontogenesis and the creation of other new criteria in the phylogenetic process. The adaptive potential of plants is their ability to survive, propagate and self-develop under the conditions of the ever-changing climate. Each organism has a certain ability to react to environmental factors, which is driven by the genetic code. Living organisms, during evolution, have developed certain capacities to react in response to climatic conditions. The coexistence of living organisms in a certain habitat is supported by heritability and genotypic changes. Due to genotypic changes, organisms adapt to environmental factors that are characteristic of a particular habitat. But due the development of new features, a normal existence of a newly formed genotype is possible under conditions where the initial variety could not develop normally. The process of photosynthesis of grapevine differs from that of other plants in the level, rate and degree of response to environmental and technological factors. All the green organs of a grapevine plant perform photosynthesis, but the main role in this process is performed by the leaf mesophyll. The dependence of photosynthesis on sunlight allows evaluating the efficiency of the use of light energy by the plant organism, this principle being established in the genetic code and represented by the mechanism of light energy use and the transformation of inorganic biogenic compounds into organic substances [8, 9]. Climate change doesn't just mean higher temperatures, it means perverse, cascading effects that must be viewed in interaction. Climate change solutions can not only be cost-effective, but also improve the level and quality of life of the population while protecting the environment. There are three general categories of actions: reducing emissions, adapting to the effects of climate change and financing the necessary adaptation measures [8].

MATERIALS AND METHODS

In order to carry out the respective study, grapevine genotypes of intraspecific origin from the *Vitis vinifera* L. group were used, such as: Muscat de Alexandria, Coarna Neagră, Sauvignon, Cabernet-Sauvignon etc.
Genotypes of interspecific origin (*Vitis vinifera* L. x *Muscadinia rotundifolia* Michx.), such as: Ametist, Alexandrina, Augustina, Nistreana, Malena, Sarmis, etc. [2]. The measurements were made in the pre-flowering stage of grapevine, In the fruit development stage, In the fruit maturation stage. Phytomonitoring was carried out with the help of the PTM-48A monitor, which is an automatic CO_2 exchange monitoring system. The system is equipped with four chambers for fixing on the leaf, which work sequentially, when one of the chambers is closed the others are open. The working mechanism of this system consists in the analysis of the gas exchange based on the concentration of CO_2 at the exit of the measuring chamber of the leaf in relation to the concentration of CO_2 in the environment at the time of measurement.
The statistical processing of the data was carried out by applying the Statistica 10 computer software (Stat sof INC, USA) and Microsoft Excel 2010 [5, 10, 1].

RESULTS AND DISCUSSIONS

The photosynthesis irradiance curve makes it possible to understand the eco-physiological characteristics of a species, and in turn, these indices give us the opportunity to compare different plant genotypes in more or less similar conditions, thus determining the productive capacity and resistance to environmental factors [3, 4, 6,11,7].
Analysing light intensity and photosynthetic activity *in the pre-flowering stage of grapevine* in intraspecific genotypes (Sauvignon, Muscat de Alexandria etc.) it was found that at a light intensity of 1,000-1,500 **µmol**/m^2*s, the photosynthetic activity was on average 7-9 µmol (CO_2)/m^2*s, and starting from the sunlight intensity of 1,500 µmol/m^2*s, the intensity of photosynthetic activity was declining. In the interspecific grapevine genotypes (Ametist, Augustina, Alexandrina, Regent, Viorica etc.), at a light intensity of 1,000-1,500 µmol/m^2*s, the photosynthetic intensity was on average 10-12 µmol (CO_2)/m^2*s, these indices of photosynthesis were maintained at an intensity of sunlight of 2,000-2,500 µmol/m^2*s.
In the fruit development stage, intraspecific genotypes (Sauvignon, Muscat de Alexandria etc.), at a light intensity of 1,000-1,500 µmol/m^2*s, demonstrated a photosynthetic activity of 8-10 µmol (CO_2)/m^2*s, these indices were also maintained at the light intensity of 2,000 µmol/m^2*s, then the intensity of photosynthesis decreased. Interspecific genotypes (Ametist, Augustina, Alexandrina, Regent, Viorica etc.) at a light intensity of 1,000-1,500 µmol/m^2*s, demonstrated a photosynthetic activity of 8-11 µmol (CO_2)/m^2*s, these indices were maintained at a light intensity of 2,000 µmol/m^2*s, and at a light intensity of 2,500

μmol/m²*s there was a decrease in the photosynthetic activity.

In the fruit maturation stage, intraspecific genotypes (Sauvignon, Muscat de Alexandria etc.), at a light intensity of 1,000-1,500 μmol/m²*s, demonstrated an average photosynthetic activity of 3-6 μmol (CO_2)/m²*s, these indices were maintained up to a light intensity of 1,700 μmol/m²*s, then they were decreasing. Interspecific genotypes (Ametist, Augustina, Alexandrina, Regent, Viorica etc.), at a light intensity of 1,000-1,500 μmol/m²*s, demonstrated an average photosynthetic activity of 8-9 μmol (CO_2)/m²*s, these indices of photosynthesis were maintained up to a light intensity of 2000 μmol (CO_2)/m²*s, and at a higher light intensity the photosynthetic activity was characterized by a slight decrease.

The analysis of the transpiration rates depending on temperature fluctuations, *in the pre-flowering stage*, in the intraspecific genotypes of grapevine (Sauvignon, Muscat de Alexandria etc.) demonstrated that at a temperature of 15 °C, the transpiration rate was 4.5-6.0 mg/m²*s, and at a temperature of 30 °C the transpiration rate was 25-30 mg/m²*s. In interspecific genotypes (Ametist, Augustina, Alexandrina, Regent etc.), at the temperature of 15 °C, the transpiration rate was 3.75-5.25 mg/m²*s, and at 30 °C, it was 23-26.5 mg/m²*s.

In the fruit development stage, the intraspecific genotypes of grapevine (Sauvignon, Muscat de Alexandria etc.), at the temperature of 20 °C, had a transpiration rate of 4-5 mg/m²*s, and at 35 °C, it was 50-55 mg/m²*s. The intraspecific genotypes (Ametist, Augustina, Alexandrina, Regent etc.) at the temperature of 20 °C had a transpiration rate of 5.75-7.75 mg/m²*s, and at 35 °C, it was 42.5-45 mg/m²*s.

In the fruit maturation stage, the intraspecific genotypes (Sauvignon, Muscat de Alexandria etc.) at the temperature of 20 °C had a transpiration rate of 8-10 mg/m²*s, and at 30 °C – 38-45 mg/m²*s. The interspecific genotypes (Ametist, Augustina, Alexandrina, Regent etc.) at the air temperature of 20 °C had a transpiration rate of 7.75-9.75 mg/m²*s, and at 35 °C – 35-40 mg/m²*s.

The analysis of the relationship between stomatal conductance and light intensity has shown that *in the pre-flowering stage*, in the intraspecific genotypes of grapevine: Muscat de Alexandria, Coarnă Neagră etc. at a sunlight intensity of 1000 μmol/m²*s, stomatal conductance was on average 0.2-0.4 mm/s, as the sunlight intensity increases to 2,000 μmol/m²*s, stomatal conductance decreased to 0.1-0.2 mm/s. In the interspecific genotypes: Ametist, Alexandrina, Augustina etc., at a sunlight intensity of 1,000-1,500 μmol/m²*s, stomatal conductance was 1.5-2.0 mm/s, and at an intensity of 2,000 μmol/m²*s, stomatal conductance was 0.7-1.2 mm/s.

In the fruit development stage, in the intraspecific genotypes of grapevine: Muscat de Alexandria, Coarnă Neagră etc., at a light intensity of 1,000 μmol/m²*s, stomatal conductance was 0.5-0.8 mm/s, and at the light intensity of 2,000 μmol/m²*s, it was 0.4-0.6 mm/s. In the interspecific grapevine genotypes Ametist, Alexandrina, Augustina etc., at a light intensity of 1,000 μmol/m²*s, stomatal conductance was 1.5-2.2 mm/s, and at the light intensity of 2,000 μmol/m²*s, it was 2.5-3.5 mm/s.

In the fruit maturation stage, in the intraspecific genotypes: Muscat de Alexandria, Coarnă Neagră etc. at a sunlight intensity of 1,000 μmol/m²*s, stomatal conductance was on average 0.8-1.2 mm/s, and at the light intensity of 2,000 μmol/m²*s – 0.2-0.5 mm/s. In the interspecific grapevine genotypes: Augustina, Alexandrina, Ametist etc., at a light intensity of 1000 μmol/m²*s, stomatal conductance was 2.5-3.5 mm/s, and at 2000 μmol/m²*s, stomatal conductance was 1.5-2.5 mm/s. While studying photosynthesis and assimilation in relation to respiration in intraspecific grapevine genotypes, such as: Muscat de Alexandria, Sauvignon, Coarna Neagră etc., it was found that at the intensity of photosynthetic activity of 8-10 μmol (CO_2)/m²*s, real assimilation was 8-9 μmol (CO_2)/m²*s, and the activity of the respiration process was in the range of 1.0-1.4 μmol (CO_2)/m²*s. In interspecific genotypes, such as: Algumax, Ametist, Nistreana, Augustina etc., at an intensity of the photosynthesis of 12-15 μmol (CO_2)/m²*s, the real assimilation was 12-14 µmol (CO_2)/m^2*s, and the intensity of the respiration process was 0.8-2.0 µmol (CO_2)/m^2*s. Studies have shown that the interspecific grapevine genotypes are characterized by much better adaptive features than intraspecific genotypes in relation to climate change. The adaptability of organisms is a key issue in the process of evolution. The adaptation of plants to climatic factors is nothing more than the modification of the physiological-biochemical and morphological-anatomical characters of the organism in the process of ontogenesis and the creation of new capacities in the phylogenetic process. The adaptation potential of plants represents their ability to survive, multiply and self-develop in the continuous change of climatic factors [2, 11, 7].

CONCLUSIONS

Taking into account the effectiveness of physiological processes, such as: photosynthesis, respiration, transpiration, stomatal conductance, assimilation etc., in the process of plant breeding, it is possible to identify plant genotypes with an increased potential for capturing carbon dioxide from the atmosphere, thus helping to maintain the global average temperature within limits that would not lead to an intensification of the greenhouse effect and climate change.
This method can also be applied in the process of breeding different plant crops. In this case, it is necessary to apply techniques and methods of plant breeding to create plant genotypes that will be used to expand the forest areas, to stop desertification processes, to create protective forest belts, for the sustainable use of agricultural and other types of land etc., and which will be characterized by a high efficiency of the photosynthesis process under the new climatic conditions.

ACKNOWLEDGEMENTS

Research was carried out within the project of the state Program 20.80009.5107.03 „*Efficient use of plant genetic resources and advanced biotechnologies to increase the adaptability of crop plants to climate change*”, financed by the National Agency for Research and Development.

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