

Climate change a necessity on the process of improvement and cultivation of the grapevine

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Abstract

The grapevine genotypes created so far meet certain requirements and are highly appreciated. Intraspecific genotypes of *Vitis vinifera* L. ssp. *sativa* D.C. have a high capacity for use, but at the same time do not ensure overcoming the genetic barrier in terms of changing climatic conditions. Performance and productivity depend on climatic conditions; genotype; cultivation technology. Analyzing the average annual temperature for the period 2002-2024, it was found that it is 10.8 °C, and in relation to the average annual temperature, the norm calculated on the territory of the Republic of Moldova, it demonstrated an increase of 1.33 °C. Taking into account the functionality of the taxonomic entities used in grapevine crossing techniques in relation to the climatic factors of the species: *Vitis vinifera* L. ssp. *sativa* D.C. (2n=38) and *Muscadinia rotundifolia* Michx. (2n=40) with reduced combinatorial capacity, interspecific genotypes of rhizogenic grapevine BC₃ with valuable characters were obtained. Overcoming climate change can be achieved by creating grapevine genotypes with increased adaptability, as well as by rectifying the technological elements of cultivation. Changing climatic conditions requires revising the technological elements of grapevine cultivation, for example, the use of mulch from plant residues, which contributes to preserving moisture in the soil, prevents and stops soil erosion, improves soil biota, etc., as well as considerably reduces logistical costs in the cultivation process. The present study aims to highlight the interspecific adaptability created to climate change in grapevines.

Keywords: conditions, genotypes, mulch, humidity, temperature, technological elements

Introduction

Climate change is an unprecedented challenge that human society has faced, and the degree of its impact depends on the level of awareness and actions that must be achieved and accepted both at the local, regional and global levels. Thus, the greatest challenge for human society consists in integrating the principles of sustainable economic development into strategies. The development of society according to the principles of a "green economy", which provides for the restoration and maintenance of a sustainable, long-term balance between economic development and the integrity of the natural environment, in forms understood and accepted by society [12 – 15].

The intensity of climate change is so pronounced that many genotypes of living organisms will not be able to adapt and will disappear. The ability of living organisms to adapt to environmental conditions is a key factor in the evolutionary process. Under natural conditions, the adaptation process requires a long period of time. Adaptation of plants to climatic factors means nothing more than changing the physiological-biochemical and morphological-anatomical characteristics of the organism in the process of ontogenesis and creating other new criteria in the phylogenetic process. The adaptive potential of plants is their ability to survive, propagate and self-develop in the conditions of a constantly changing climate [2, 7, 11].

The grapevine genotypes created and approved to date meet certain criteria and are highly valued. However, the cultivation, production and use of primary and finished derivative products must constantly demonstrate something. Unfortunately, to date, no grapevine genotype has been created that does not have to demonstrate something. Thus, the genotype represents perfection itself, copes with climate change, is

cultivated in an organic system, has a quantitative and qualitative capacity for productivity and primary and finished derivative products, which are ultimately highly valued by consumers [1, 2, 5, 10].

Intraspecific genotypes in the *Vitis vinifera* L. ssp. *sativa* D.C. group have a wide range of uses, but at the same time do not ensure overcoming the genetic barrier to changing climatic conditions. Although intraspecific genotypes offer wide possibilities for use, they are not able to cope with the impact of climate change. Often these genotypes do not meet the requirements of productivity, due to loss of yield, as a result of the low level of resistance to various biotic and abiotic factors [6, 9].

Based on the findings, it is necessary to create grapevine varieties that ensure annual and stable productivity, superior quality of the derived products obtained, as well as grapes for table and fresh consumption under changing climatic factors. Taking into account the functionality of genotypes and the use of algorithms and methodologies of the interspecific hybridization technique, interspecific genotypes with increased plasticity in terms of their adaptation to climate change are to be created, with beneficial repercussions on sustainable development [1, 2, 3, 7]. The present study aimed to highlight the created interspecific grapevine genotypes and some technological elements of cultivation, which contribute to reducing logistical costs and negative impact on the environment.

Material and Method

The object of study was the interspecific genotypes of grapevine (*Vitis vinifera* L. ssp. *sativa* D.C. and *Muscadinia rotundifolia* Michx.) of the fourth generation. From a technological point of view, the plants were planted at an interval of 1.5 meters between plants in a row and 3 meters between rows. Sawdust from plant residues of *Miscanthus* sp was used as mulch. The mulch layer was a strip with a thickness of 10-15 cm and a width of 50 cm [1].

Sensors were installed in the soil, which allowed determining, in the 10-15 cm layer: soil temperature, soil surface temperature, soil moisture, soil electrical conductivity, as well as the amount of sunlight falling on the soil surface. With the help of the weather station, the amount of precipitation, relative air humidity, and air temperature were determined: average, minimum, and maximum [4, 8, 11, 16, 17].

Results and Discussion

Agriculture is a decisive factor in the process of food security and at the same time is extremely vulnerable to the variability of extreme climatic factors and phenomena, which are intensifying from year to year. Changing climatic factors negatively influence the process of productivity and quality of agricultural crops. However, the recovery of the situation can be achieved by the efficient use of resources and the motivation to use plant genotypes that demonstrate performance under the conditions of continuous change in environmental factors. The ability to adapt and ensure sustainable productivity of living organisms is an essential factor in the evolutionary process [12, 15].

Based on the principles of the functionality of taxonomic entities involved in grapevine hybridization techniques in relation to the climatic factors of the species: *Vitis vinifera* L. ssp. *sativa* D.C. and *Muscadinia rotundifolia* Michx. which have a diminished combinative capacity, which can be overcome by involving two determining genetic factors: parental as a hybridization component - *Vitis vinifera* maternal parent, and *Muscadinia rotundifolia* - paternal and additive - through backcrossing, it allows obtaining recombinant genotypes that offer opportunities for streamlining interspecific hybridization in the process of improving valuable characters. Finally, rhizogenic interspecific genotypes are obtained, which allow overcoming the barrier of changing climatic factors, while contributing to the efficient and stable functioning of the wine sector.

As a result of the cross between *V. vinifera* L. (2n=38) x *M. rotundifolia* Michx. (2n=40), interspecific rhizogenic grapevine genotypes with valuable traits were created in BC3 (2n=38) [7]. Interspecific rhizogenic grapevine varieties are intended for cultivation on their own roots, including in organic systems and for expanding the northern limit of the grapevine cultivation area.

Interspecific genotypes make very good use of climatic conditions with high temperatures and low precipitation in summer, poor quality lands, etc. These genotypes have been recommended for cultivation in accordance with uvological and technological principles as table grape varieties: "Malena", "Nistreana" and "Algumax" and grape varieties for fresh consumption and processing: "Alexandrina", "Aarmetrina", "S". "Thetys" (tab.1.).

Table 1. Some properties of the interspecific genotypes of grapevine *V.vinifera* L. (2n=38) x *M.rotundifolia* Michx. (2n=40).

Genotype	The coefficient of fertility		The productivity index		The sum of the sugars, %	The weight of the grape, g
	relative	absolute	relative	absolute		
Ametist	1.4	1.62	0.42-0.49	0.48-0.56	24-26	300-350
Alexandrina	1.2	1.36	0.48-0.6	0.54-0.68	22-24	500-600
Augustina	2.06	2.06	1,23-144	1.23-1,44	17-20	600-700
Nistreana	1.45	1.65	0.58-0.65	0.66-0,74	20-24	400-500
Malena	1.72	1.76	0.68-0,95	0.7-0.96	20-24	400-500
Algumax	1.1	1,42	0.33-0.38	0.42-0.49	18-20	300-350
Tethys	1.15	1.46	0.28-0.4	0.36-0.51	20-22	250-300
Sarmis	1.8	1.72	0.68-0.86	0.72-0.9	22-24	400-500

Taking into account the properties of the created interspecific genotypes, they can contribute to the expansion of the grapevine cultivation area to the northern limit of the area.

Conducting a time analysis of the climatic conditions of the territory of the Republic of Moldova, we find that the amount of annual precipitation is uneven. In the future, this unevenness will be even more pronounced.

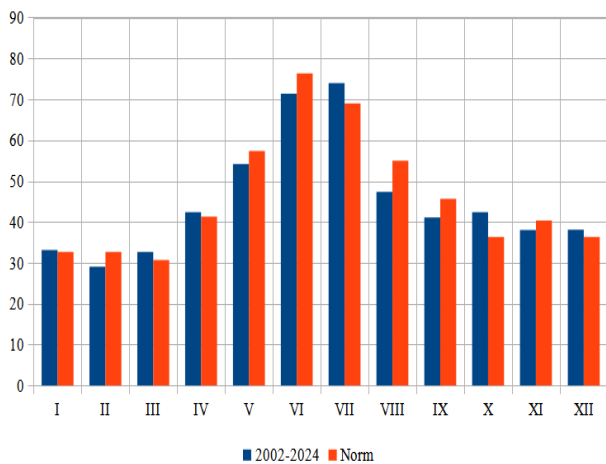


Figure 1. Monthly amount of atmospheric precipitation (mm) on the territory of the Republic of Moldova in relation to the norm calculated for the period 2002-2024.

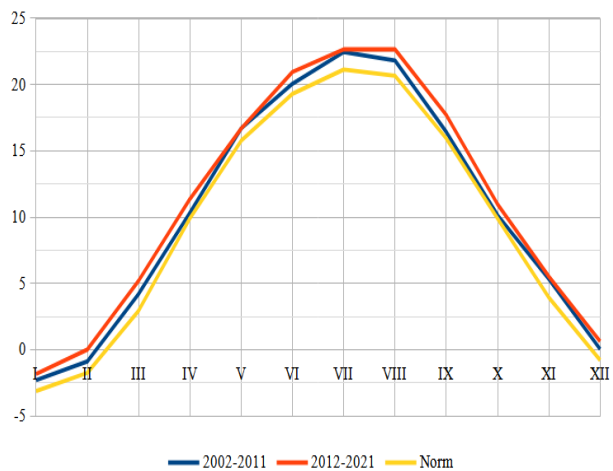


Figure 2. Average monthly temperature (°C) by decade (2002-2011 and 2012-2021) on the territory of the Republic of Moldova in relation to the calculated average temperature.

The total annual amount of precipitation allows us to determine that we have the necessary annual amount of atmospheric precipitation. However, if we distribute this amount of precipitation over certain periods of time, for example: weeks, months, we come to the conclusion that for a long period of time (3-6 months) there is no atmospheric precipitation. However, in a very short time, an amount of precipitation can fall that far exceeds the norm for that period (Fig. 1.).

The average annual temperature, the norm calculated for the territory of the Republic of Moldova, is 9.47 °C. Based on the calculations of the average annual temperature estimate for the last two decades, we

conclude that for the decade 2002-2011 the average annual temperature was 10.35 °C, and for the decade 2012-2021 the average annual temperature was 11.039 °C (Fig. 2.).

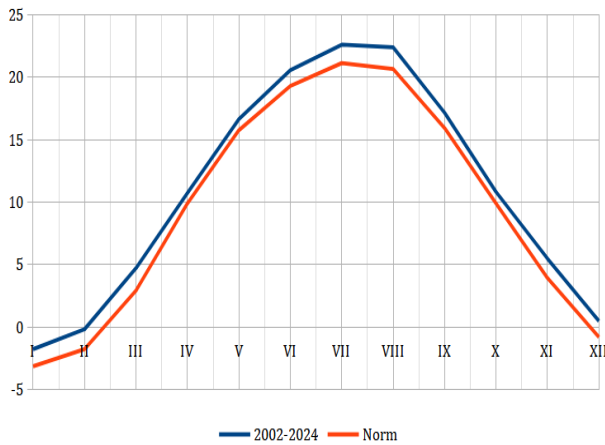


Figure 3. The average annual temperature for the period 2002-2024 in relation to the average temperature, the calculated norm, on the territory of the Republic of Moldova.

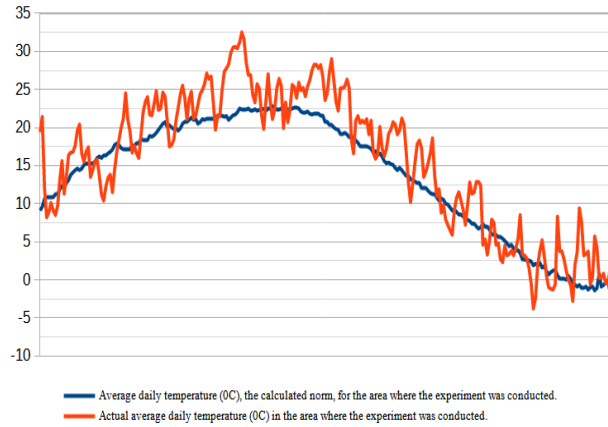


Figure 4. The actual average daily temperature (°C) in the area where the experiment was conducted and the average temperature, the calculated norm (2024).

During the period 2002-2011, the calculated average annual temperature increased in relation to the average temperature, the calculated norm, by 0.88 °C., and for the period 2012-2021, the average annual temperature in relation to the average temperature, the calculated norm, increased by 1.57 °C, and in relation to the average annual temperature for the period 2002-2011 it increased by 0.69 °C (fig. 2.).

In conclusion, the average annual temperature value for the period 2002-2024 was 10.8 °C and comparing it with the average annual temperature, the norm calculated for the territory of the Republic of Moldova, it increased by 1.33 °C (Fig. 3.).

Taking into account the average annual temperature values for the area where the experimental tests were carried out, an average annual temperature value of 13.73 °C is found, and as a result of the evaluation of the temperature values during 2024, we conclude that the average annual temperature value was 15.83 °C. Based on the estimates made, an increase in the average annual temperature value by 2.1 °C is found, compared to the average temperature calculated for this area (fig. 4.).

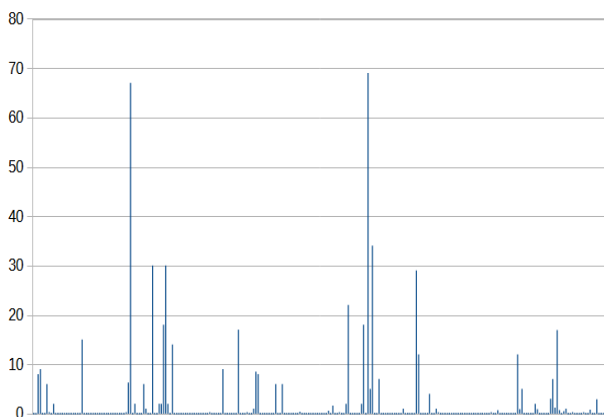


Figure 5. Atmospheric precipitation (daily), throughout the period of the experience. (2024).

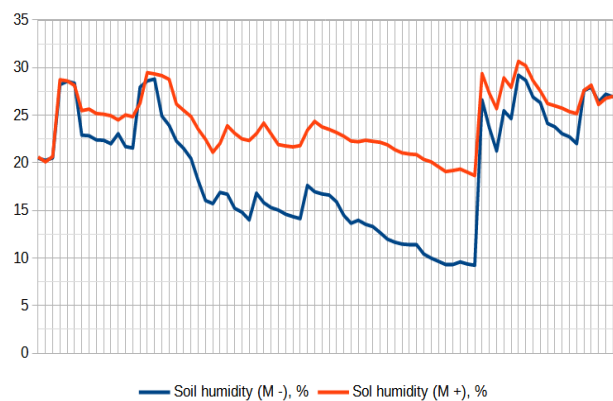


Figure 6. Soil moisture (%), 10-15 cm layer from the surface. (M - without mulch; M + with mulch).

The amount of atmospheric precipitation for the respective area, the calculated norm, falls within the limit of 530 mm annually, and according to estimates it was found that the real annual amount of precipitation is 542.6 mm. Based on the respective calculations, the annual amount of precipitation falls within the admissible norm, a little more, but taking into account their frequency, it is very uneven (Fig. 5.).

There are periods of time when there is no precipitation, and in other periods there is precipitation well above the permissible norm, which in some cases causes material damage.

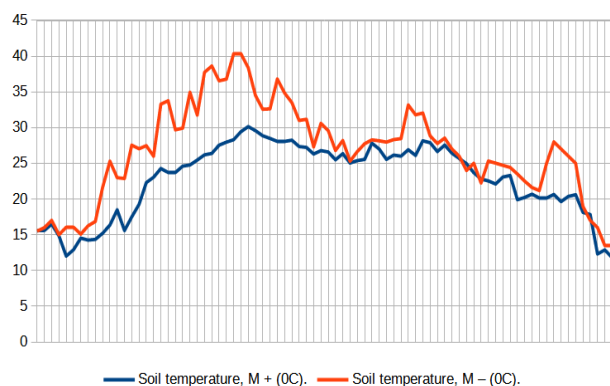


Figure 7. Soil temperature, °C, (M - no mulch; M + with mulch).

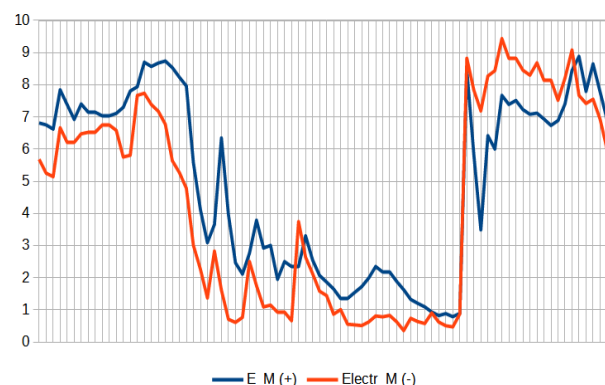


Figure 8. The electroconductivity. (M - without mulch; M + with mulch).

As a result of installing the mulch layer in the vineyard, collecting data from sensors mounted in the soil, during the vegetation period, it was found that the soil moisture in the 10-15 cm layer from the surface, in the case of mulch from *Miscanthus* sp. plant residues, the soil moisture is on average 24.24%, and in the case without mulch, the soil moisture is 19.26% (fig. 6.).

Also, analyzing the soil temperature value in the 10-15 cm layer from the surface, it is found that in the case of mulch, the average temperature value is within the limit of 22.74 °C, and in the case without mulch, the average temperature value is 26.76 °C (fig. 7.).

The electrical conductivity of the soil, in the case of the vegetable mulch layer, represents an average value of 5.01 u.c., and in the case without the mulch layer, this value represents an average of 4.3 u.c. (fig. 8.).

Using the vegetable mulch layer in the technological process of grapevine cultivation also results in a significant reduction in logistics costs.

Conclusions

The average annual temperature value for the period 2002-2024 was 10.8 °C, and comparing it with the average annual temperature value, the norm calculated on the territory of the Republic of Moldova, it is found that it is increasing by 1.33 °C.

By crossing *V. vinifera* L. (2n=38) x *M. rotundifolia* Michx. (2n=40), interspecific rhizogenic grapevine genotypes in BC₃ (2n=38) were obtained, table grape varieties: "Malena", "Nistreana" and "Algumax" and grape varieties for fresh consumption and processing: "Augustina", "Alexandrina", "Ametist", "Sarmis" and "Thetys".

The use of a mulch layer of plant residues in the grapevine cultivation process significantly contributes to reducing logistics costs, as well as reducing the negative impact on the environment.

The use of a mulch layer of plant residues contributes to: - maintaining soil moisture; - stopping the growth of herbaceous plants; - restoring the fertile layer; - reducing soil temperature; - preventing and stopping soil erosion; - reducing financial and human resources for plantation maintenance; - increasing plant productivity.

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