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

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ABSTRACT

Climate change manifests itself not only in high temperatures, but also a distribution of rainfall during a vegetative year, extreme weather events (waves of heat, heavy rains, hail, frost, and strong winds) and prolonged drought, which must be taken into account in the complex, in the process of plant growth and development. Climate change solutions can be not only profitable, but can affect the level and quality of life of the population while protecting the environment. To improve the current situation, it is necessary to take actions that contribute to reducing emissions, a adapting to the consequences of climate change, and financing the necessary adaptation measures. Evaluating the climatic conditions of the Republic of Moldova, we find that in the past the climate was of a temperate-continental type, as a result of the evaluation of these conditions over the years, a trend of change was found, towards the creation of arid conditions. Climate change requires the creation of genotypes with increased adaptability and the revision of agricultural plant cultivation technologies. Climate change requires the creation of genotypes with increased adaptability and the revision of agricultural plant cultivation technologies

Keywords*:* climatic changes, creation, genotype, grapevine, technology, valorisation

INTRODUCTION

Climate change requires revising the strategy for creating plant genotypes, as well as the methods and techniques for cultivating crops, including grapes. The costs of producing planting material and planting, purchasing and using chemicals needed to combat diseases and pests, agricultural work, etc. ultimately affect the productivity and quality of the resulting derivatives, as well as the selling prices of these products. That is, it is necessary to create and select a genotype and technology for cultivating grapes with minimal use and/or exclusion of protective chemicals that contribute to the preservation of biodiversity and the conduct of biological viticulture. The adaptive potential of plants to the environment is a response to climatic factors, simultaneously demonstrating a certain quantitative and qualitative capacity for productivity and derivatives (Gaina B., *et a*l. 2023; Nan, R., *et al*. 2021). The purpose of this work is to identify the productive characteristics of grape genotypes in the context of changing climatic factors. Creation and implementation of grape genotypes in relation to changes in climatic factors, thereby contributing to the development of biological viticulture.

MATERIALS AND METHODS

The experiment was organized within the Institute of Genetics, Physiology and Plant Protection of the USM, Republic of Moldova of the USM. The main climatic parameters were evaluated during the period 2002-2023.

The parameters of climatic factors of the last 22 years (2002-2023), such as temperature (average, minimum and maximum), relative air humidity, amount of precipitation (Alexandrov E., 2023a; Nan, R., *et all*. 2021)., sunlight, air temperature at the soil surface, average wind speed and soil parameters, annual average in the context of geographical areas using the weather station, were analyzed. PTM-4A. Located at the place of the experiment.

Five varieties (Ametist, Alexandrina, Augustina, Malena, Nistreana) of grapevines served as the study object. Planting scheme 3 meters between rows and 1.5 meters between plants in a row. Sawdust from the vegetable mass of *Miscanthus* sp served as mulch. Electro conductivity, as a method for determining soil fertility, was measured in our experiment both in the version in which mulch was placed and in the one without mulch. The thickness of the mulch layer was about 10 cm, the width of the strip about 50 cm and the length in a row 15-20 meters. In order to measure the parameters, sensors were fixed in the soil, which determine, in the 10-15 cm layer: the temperature in the soil, the temperature at the surface of the soil, the humidity of the soil, the electro conductivity of the soil, as well as the amount of sunlight that falls on the surface of the soil.
The use of soil sensors allowed the determination of air temperature at the soil surface, electrical conductivity, soil temperature and humidity in the 10-15 cm layer. The respective sensors were installed both in the vineyard experiment in which mulch was placed and in the one without mulch.

RESULTS AND DISCUSSIONS

Taking climate changes into account, the promotion of the green economy policy is required by motivating, stimulating through various aspects (economic-financial, technologies, products, etc.) At the same time, plant cultivation technologies have a minimal carbon footprint in the atmosphere. The grapevine varieties created to date meet certain criteria and are valued. However, as a result of cultivation, it is necessary to constantly demonstrate that they meet a number of criteria. Unfortunately, an "*ideal*" grapevine cultivar adapted to climate change has not yet been created, which cultivated in biological conditions has high quantitative and qualitative productivity, as well as primary and secondary derivative products, which are ultimately very appreciated by consumers.
The increase in consumer demand for products of biological origin creates the preconditions for the further development and expansion of the market for the corresponding products and ultimately contributes to the reducing of the negative impact on the environment, the conservation and use of natural resources, and the increase in the income of the economic agents involved in the production process, etc. The yield of agricultural crops depends on climatic conditions, genotype, technology of growing, storage and processing of culture. As a result of climatic from one year to the next, the cultivation of many perennial species becomes difficult, with negative effects on the growth and development processes, and over time, some of these will disappear.
The Republic of Moldova is located in the temperate-continental climate zone. In the past, the climate was characterized by mild and snowy winters, and the warm summer with more

or less uniform atmospheric precipitation over time (Figure 1. - 4.). The average annual air temperature in the north 8.0 °C and 10.0 °C, and the soil between 10 °C and 12 °C (2002 - 2023). Approximately 10% of the total annual precipitation falls in the form of snow (Mihailescu C. 2004; Atlas. 2019; Ediţie enciclopedică, 2009). Based on the temperature indices, there is an increase in the average annual temperature on the territory of the republic by 1.5 ^{0}C (Figure 3 and 4.) and an uneven annual amount of precipitation (Figure 1 and 2.). Regarding the amount of atmospheric precipitation during a vegetative year, we note that for a long period of time there is no precipitation, but in a very short time an amount can fall, which far exceeds the norm for that period (Figure 1. and Figure 2.).

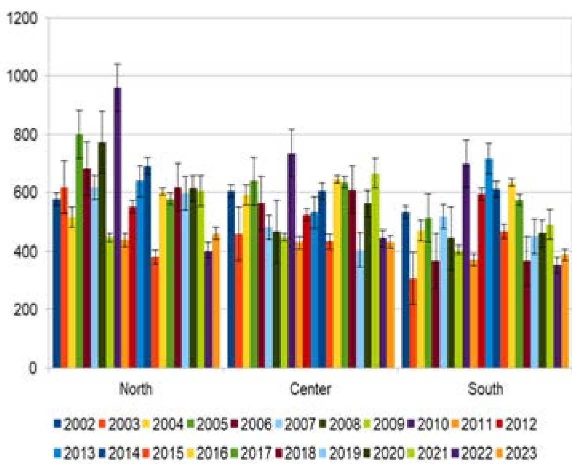

Figure 1. The annual amount of precipitation (mm) in the Northern, Central and Southern regions of the Republic of Moldova (2002 – 2023)

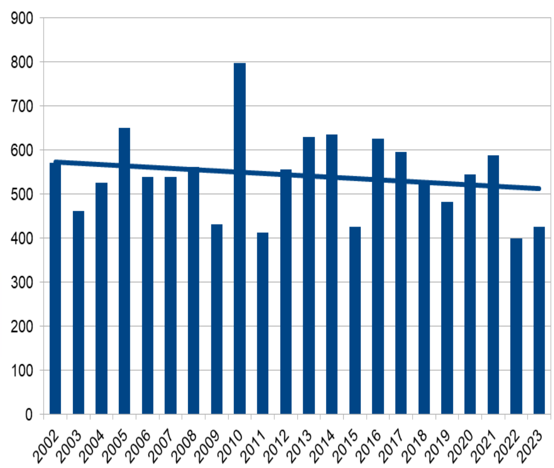

Figure 2. The trend of the annual amount of precipitation (mm). Republic of Moldova (2002 - 2023)

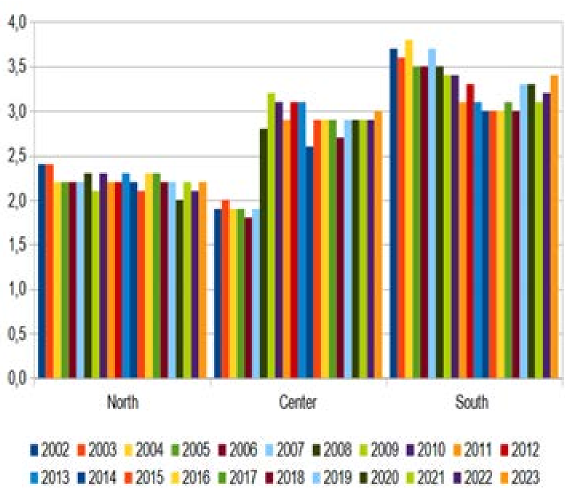

Figure 3. Average annual temperature (°C) in the Northern, Central and Southern areas of the Republic of Moldova (2002 - 2023)

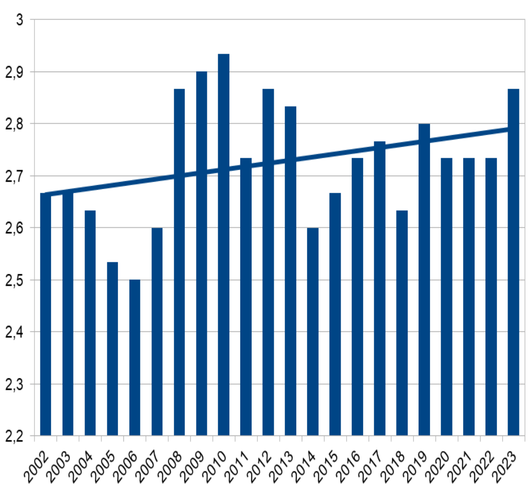

Figure 4. Trend of annual mean temperature (°C). Republic of Moldova (2002-2023)

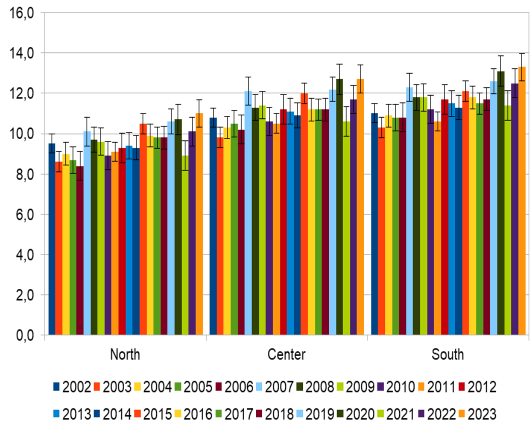

Figure 5. Average annual wind speed (m/s) in the Northern, Central and Southern areas of the Republic of Moldova (2002-2023)

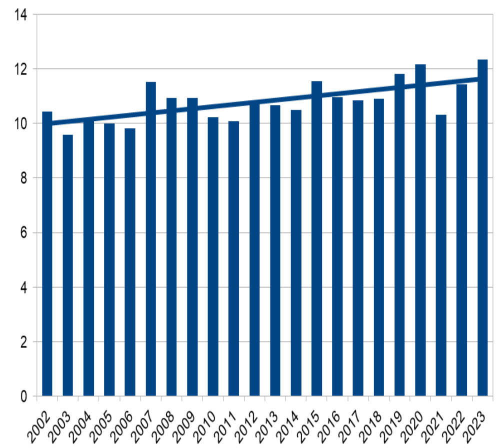

Figure 6. The trend of the average wind speed (m/s). Republic of Moldova (2002-2023)

As a result of the fact that atmospheric precipitation is uneven, it is necessary to take measures to reduce the process of water evaporation from the soil in the technological process of plant growth. Wind significantly influences the process of climate formation and causes a number of geological processes. Finally, the winds can trigger the desertification process. The wind regime is characterized by the predominance of the north-west wind direction on most of the country's territory, and in the southern area – the north direction. The direction and speed of the wind largely depends on the relief, the degree of coverage of the area with forest vegetation. The average annual wind speed varies on the territory of Moldova from 2 to 4 m/s (Figure 5 and 6.) during the analyzed period (2002-2023).

The trend of the factors influencing climate change is highly depend–on the land area covered with forest vegetation. The Republic of Moldova has approximately 450.6 thousand ha of land with forest vegetation (13.6% of the country's territory), including in agroclimatic zones: - 57.7% in the Central area; - 26.6% in the North area and 15.7% in the South area (Hazardurile naturale. 2008; HGRM nr. 864 / 09.12.2020).

During the period May - August 2022 atmospheric precipitation was insignificant. In January there were 14.6 mm of precipitation, February and March 5.0 mm and 6.0 mm respectively, April – 40.8 mm, May and June each 4.4 mm and 3.0 mm, July – 26.2 mm and in August 87.0 mm (Figure 11.).

The soil structure of lands with insufficient water, as a rule, differs essentially compared to the soil structure of lands with abundant water.

The water holding capacity is easily determined due to the electrical conductivity of the soil. The average level of electrical conductivity indicates that the soil has an average structure and, consequently, has an average drainage capacity. Such soils are the most fertile. Because water holding capacity has a major impact on cereal crop productivity.

Electro conductivity is a method of determining soil fertility (granulometric and mineralogical, pH, humidity, absorption capacity, etc.), which allows to determine the need and the necessary quantity of introducing fertilizers into the soil.

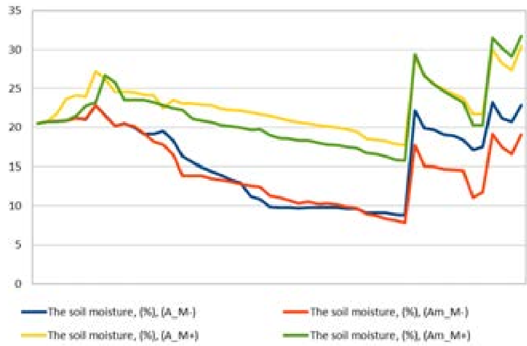

Figure 7. Soil moisture (%), layer 0-15 cm

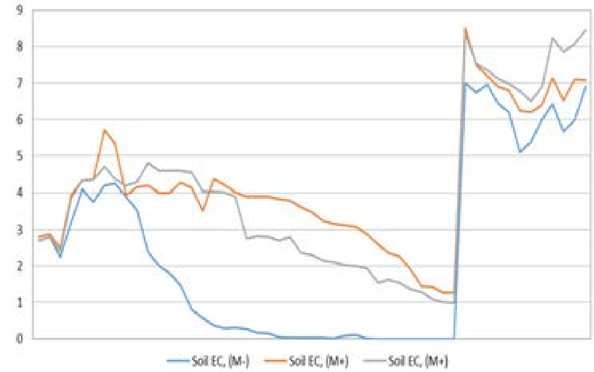

Figure 8. Electroconductivity of the soil, the 0-15 cm layer

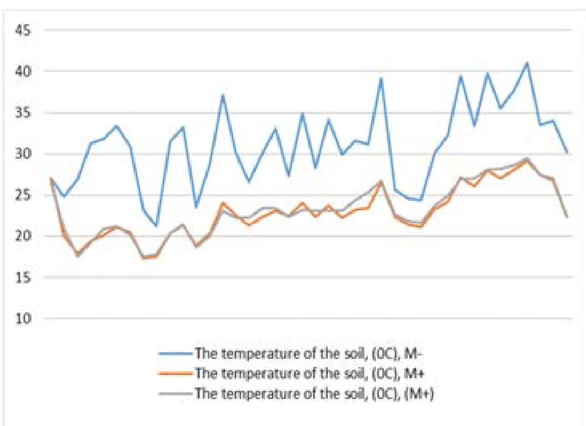

Figure 9. The temperature (^{0}C) of the soil in the 0-15 cm layer.

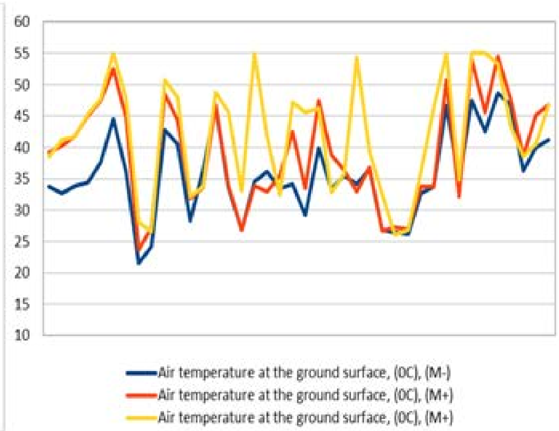

Figure 10. Air temperature (^{0}C) at the surface of the ground

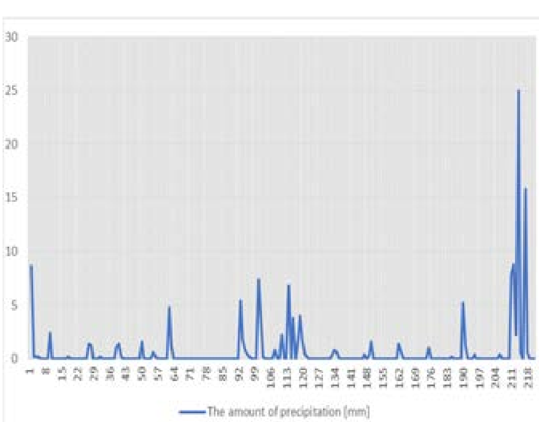

Figure 11. The amount of atmospheric precipitation (mm)

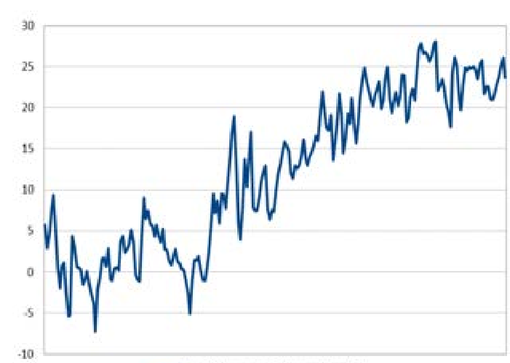

Figure 12. The average air temperature (^{0}C)

Using electro conductivity techniques allows not only determining the potential of soil fertility, but also ensuring the development of sustainable agriculture, determining the ability to provide plants with mineral substances necessary for the development and maintenance of vital processes, determining the level of soil pollution with toxic substances, assessing the cultivation capacity of certain crops on different types of soil, etc.
As a result of the mounted experiences, it was found that the electro conductivity of the soil in the case with mulch demonstrates much higher indices than in the case without mulch (Fig. 8).
Analyzing the soil temperature in the layer 0-15 cm from the surface, it was found that in the case where mulch is placed, it is on average 15-18^0 Celsius lower than in the case without mulch (Figure 9. and 10.)
Thus, by improving soil conditions, mulch has a positive effect on plant development and productivity. So, if the soil was covered with mulch, the annual shoot growth was 12-20% higher and the plant productivity was 25.5-29.5% compared to the control (Figure 7 and 8.). Also, the content of sugars, in the case with mulch, is 2-3% higher compared to the case without mulch.
The financial resources needed to carry out agrotechnical works, related to soil processing, are reduced by approx. 25-35%.
During the experience, it was found that in the case of covering a respective layer with mulch, the growth of grasses is stopped one by one and the process of soil erosion is prevented. According to estimates, it was found that about 40% of agricultural lands are degraded and yield crops lower than their productive capacity.
The continuous degradation of agricultural land drastically reduces the possibilities of obtaining adequate harvests (Atlas, 2021; HGRM nr. 864 / 09.12.2020].
The grapevine cultivars used in the study are rhizogenic interspecific genotypes, which have increased resistance to climatic factors. The climatic conditions of 2023 influenced plant productivity, but still demonstrated successful productivity (Table 1).
From the research results, both the production of grapes and their weight are influenced by the climatic conditions in the year of study. Productions decreased in 2021 by up to 2 t/ha compared to those recorded in 2019, respectively 1.5 t/ha in 2023 for the Amtist cultivar. The same differences were evident in all other cultivars, the climatic year being decisive for the recorded productions. It can be highlighted (table 1) that the lack of precipitation in the vegetative year 2023 and the high temperatures in the summer periods led to a decrease in production, by 1.5 to 2 t/ha, compared to the years favorable to the growth and development of the vine, as well as the analyzed year 2019.
From table 1, it can be seen that, although the number of fruits was not influenced by climate conditions, being more a biological characteristic of the cultivar, the weight of the grapes was higher in 2019 and 2020, years that also recorded the highest production, for all five analyzed cultivars.

Table 1. The influence of climatic factors on the productivity indicators of the analyzed cultivars

Year/cultivar	Production t/ha	grape weight (g)	number of grapes/plant
Amtist			
2019	14	350	27
2020	13	350	25
2021	12	320	26
2022	13.5	330	26
2023	13.5	330	26

Year/cultivar	Production t/ha	grape weight (g)	number of grapes/plant
Alexandrina			
2019	13	450	24
2020	13.5	450	24
2021	11	400	22
2022	12.5	420	23
2023	12	400	23
Augustina			
2019	14	550	24
2020	13.5	560	23
2021	12.5	530	22
2022	13	540	23
2023	12	520	22
Malena			
2019	12	400	22
2020	11	350	23
2021	11.5	350	21
2022	10	320	20
2023	10	320	21
Nistreana			
2019	13	450	21
2020	12.5	350	22
2021	12.5	360	22
2022	12	320	21
2023	11	300	20

CONCLUSIONS

Use of the mulch layer: maintains soil moisture; stops the growth of grassy plants; contributes to the restoration of the fertile layer; - reduces soil temperature; - prevents soil erosion; reduces the financial and human resources for maintaining the plantations by about 25%; plant productivity increases by 25-29%.
Analyzing the amount of precipitation that has fallen, we find that it represents a sufficient amount annually, but dividing this amount over certain periods of time we notice that it is uneven. During several months there is no precipitation, but in a short period of time all this amount can fall. From the research results, the climatic year is decisive for the vine culture for the productions obtained. The lowest productions were evident in the years when the precipitation was reduced and not evenly distributed during the vegetation period and the high temperatures during the summer that led to prolonged drought.

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