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THE USE OF *MISCANTHUS* SP. MULCH IN THE TECHNOLOGICAL PROCESS OF GRAPEVINE CULTIVATION

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Abstract

Evaluating the climatic factors within the limits of the sector, where the respective researches were carried out, their tendency to change, towards the creation of arid conditions, was found. The change of climatic factors imposes the need to review the cultivation technologies of agricultural plants. An element of the technological cultivation process was used mulch from plant residues, Miscanthus sp. The experiment was carried out with the laying of mulch with a layer thickness of about 5 cm, the width of the strip about 50 cm and the length in a row of 15 meters. In order to measure the parameters, sensors were fixed in the soil, which determine, in the layer of 10-15 cm: the temperature in the soil, the temperature at the surface of the soil, the humidity of the soil, the electrical conductivity of the soil, as well as the amount of sunlight that falls on the surface of the soil. The respective sensors were placed both in the mulched and non-mulched area. At the time of initiation of the experiment, the soil moisture in the layer of 10-15 cm from the surface was about 20.48%. After covering the soil with mulch throughout the vegetation period, it was found that the soil moisture, in the case with mulch, is practically twice as high as in the case without mulch. The layer of mulch from plant residues contributes to: maintaining moisture in the soil, regulating the thermal regime of the soil, preventing erosion processes, stopping the development of weeds, enriching the soil with mineral nutrients, etc. Also, the use of mulch contributes to reducing the financial and human resources for maintaining plantations by about 25%. The productivity of the plants was about 25.5–29.5% compared to the control, the amount of sugars is about 2-3% higher compared to the case without mulch.

Key words**:** *electrical conductivity, mulch, temperature, vines, moisture*

INTRODUCTION

Agriculture is highly vulnerable to the ever-increasing variability of extreme climate factors and phenomena. The change in climatic factors will affect the productivity of agricultural crops, in the sense of reducing it. In order to improve the situation, it is necessary to use resources efficiently and motivate the use of technologies to increase the productivity of agricultural crops [1, 3].
Based on the situation created, it is necessary to promote a green economy policy by motivating, stimulating through various aspects (economic-financial, technologies, products, etc.) those who, as a result of the economic activity, cause an impact on the environment. The co-interest of economic agents is required in order to carry out a sustainable activity, both from an economic point of view and the impact on the environment and be minimal. Otherwise, without the promotion of such a policy, the expected results will be minimal and the state of natural resources and the environment will continue to degrade [2, 5].
The aim of the present study was to use mulch from plant residues *(Miscanthus* sp.) in grapevine cultivation. Mulching is an agricultural procedure, which consists in covering the soil surface under the plants with various materials to improve the conditions for the development and productivity of the plants [1, 2, 3, 4].
Two main types of mulches are known - inorganic and organic. Inorganic mulch consists of various types and sizes of stone, gravel, geotextile fabric, etc. These materials do not decompose, they do not contribute to the improvement of the soil structure, so it is necessary to administer organic matter. However, inorganic mulch due to the light

spectrum can influence plant development and productivity. For example, potato (*Solanum tubersosum* L.), sweet pepper *(Capsicum* sp.) demonstrate increased productivity in the case of white mulch, tomatoes (*Solanumlycopersicum*) preferred mulch, etc. [3]

Organic mulch, in general, represents remains of plant origin. Depending on the material and climatic factors it breaks down, therefore it requires regular renewal [3, 6].

MATERIALS AND METHODS

Five varieties 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. 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 electroconductivity of the soil, as well as the amount of sunlight that falls on the surface of the soil.

With the help of the weather station, the amount of precipitation, relative air humidity, air temperature was determined: average, minimum and maximum [1,2, 3, 4, 6, 8, 10].

Photo 1. The sensor in the mulch sector.
Source: Original photo.

Photo 2. The sensor in the sector without mulch
Source: Original photo.

RESULTS AND DISCUSSIONS

In the conditions of the change of climatic factors, it is necessary to review the cultivation technologies of agricultural crops.

Evaluating the climatic factors within the limits of the sector, where the respective researches were carried out, their tendency to change, towards the creation of arid conditions, was found [1, 5, 6, 12, 13].

The average monthly temperature (^{0}C), period 2014-2021 (Chisinau) is shown in Fig. 1.

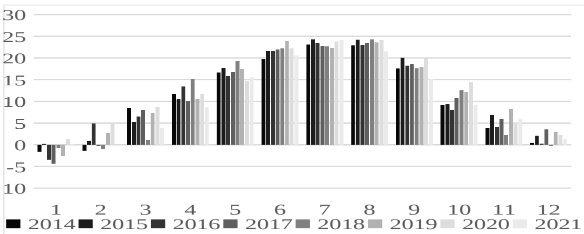

Fig. 1. Average monthly temperature (^{0}C), period 2014-2021 (Chisinau)
Source: Own calculation.

The monthly and annual temperature indices during the years 2014-2021, registered an increasing trend of these indicators (Fig. 2 and Fig. 3).

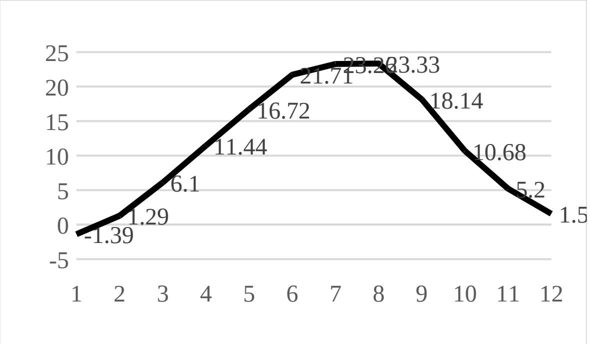

Fig. 2. The trend of the average monthly temperature (^{0}C) in the period 2014-2021 (Chisinau city)
Source: Own calculation.

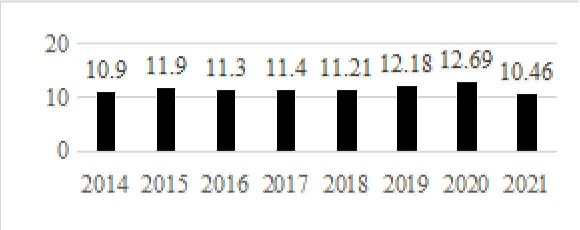

Fig. 3. Average annual temperature (^{0}C), period 2014-2021 (Chisinau)
Source: Own calculation.

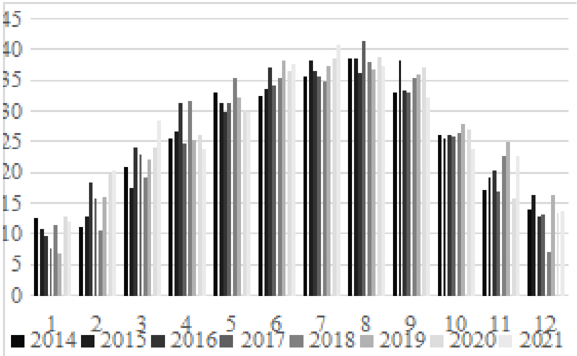

Fig. 4. Monthly maximum temperature (^{0}C), period 2014-2021 (Chisinau)
Source: Own calculation.

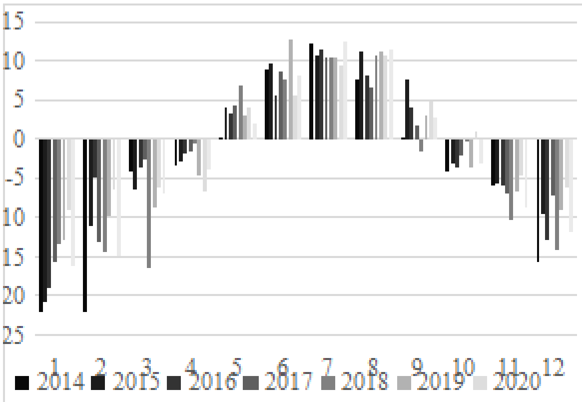

Fig. 5. Minimum temperature (^{0}C) monthly, period 2014-2021 (Chisinau)
Source: Own calculation

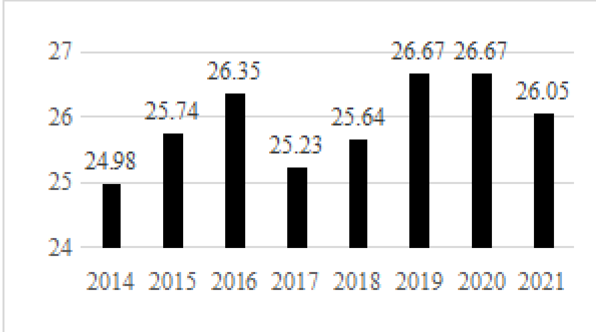

Fig. 6. Maximum temperature trend, (annual average), period 2014-2021 (Chisinau city)
Source: Own calculation.

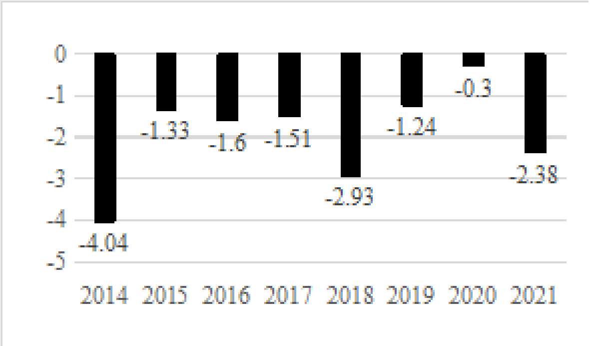

Fig. 7. Minimum temperature trend, (annual average), period 2014-2021 (Chisinau city)
Source: Own calculation.

Maximum and minimum temperature (annual average) during the period 2014-2021 it was observed that in 2014, the maximum annual average was 24.9 0C, and the minimum annual average was -4.04 0C, while in 2021, the maximum annual average was 26.5 0C, and the minimum annual average was - -2.38 0C (Fig. 6). So, the trend of maximum and minimum temperature for the period 2014-2021 is increasing (Fig. 7.).

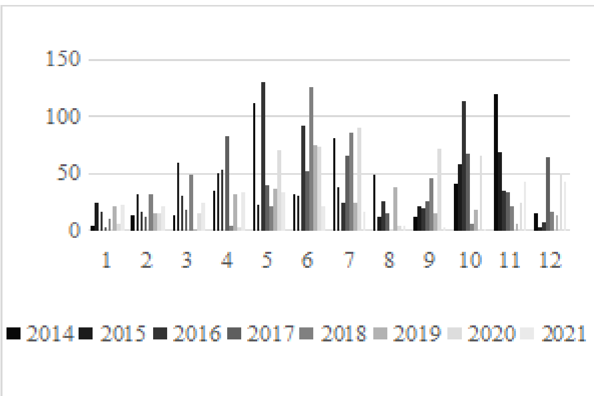

Fig. 8. Monthly amount (mm) of precipitation, period 2014-2021 (Chisinau)
Source: Own calculation.

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Analyzing the amount of atmospheric precipitations that fell between 2014 and 2021, it was found that the maximum was 566.8 mm in 2016, and the minimum was 268.4 mm in 2021. Based on the indicators of the precipitation trend for this period, we come to the conclusion that the precipitation trend is decreasing (Fig. 8., Fig. 9. and Fig. 10).

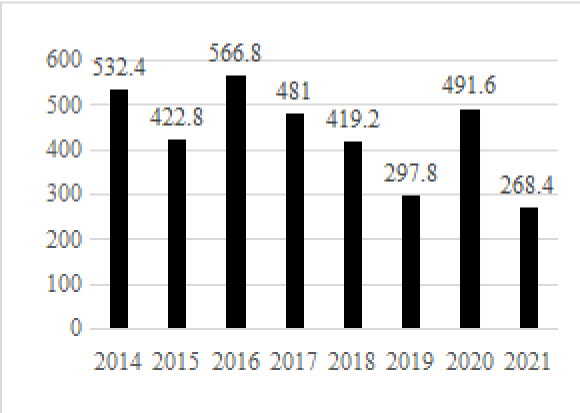

Fig. 9. Annual quantity (mm) of precipitation, period 2014-2021 (Chisinau)
Source: Own calculation.

The amount of annual precipitation has a diverse character. In the future this diversification will be quite accentuated. Calculating the total amount of annual precipitations, we arrive at the fact that we have the annual precipitation norm. If we distribute this amount of precipitation over a certain period (days, weeks, months), we find that in a long period of time (4-6 months) there is no atmospheric precipitation, but in a very short time an amount of abundant precipitation (rain showers), far exceeding the norm for that period.

Based on the fact that atmospheric precipitation has a diverse character and in the future it will intensify even more, actions are required to suppress the process of water evaporation and its preservation in the soil.

Soil mulching contributes to reducing the evaporation process and maintaining moisture in the soil, suppresses the growth of grasses, stops surface runoff and accelerates the penetration of rainwater into the soil, thus preventing the erosion process. However, the mulch helps to improve the soil structure, ensures the development of the activity of microorganisms and the root system, etc. Ultimately, all this leads to good plant growth and productive development.

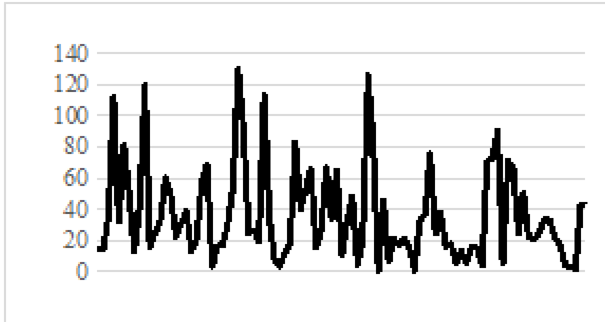

Fig. 10. Precipitation trend (mm), period 2014-2021 (Chisinau)
Source: Own calculation.

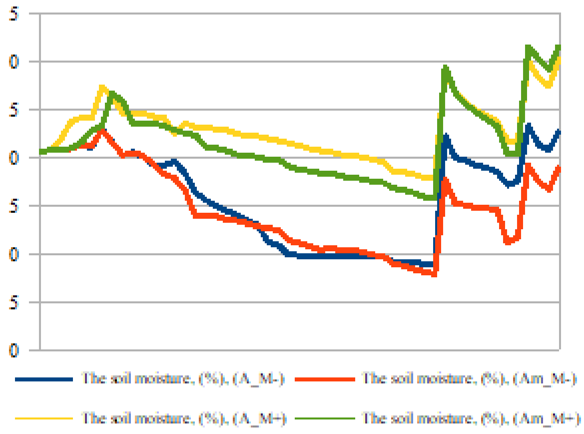

Fig. 11. The soil humidity (10-15 cm layer). (A_M- - without mulch; A_M+ - with mulch)
Source: Own calculation.

At the time of setting up the experiment, the soil moisture in the 10-15 cm layer from the surface was about 20.48%. After covering the soil with mulch throughout the vegetation period, it was found that the soil moisture, in the case with mulch, is practically twice as high as in the case without mulch (Fig. 11.).

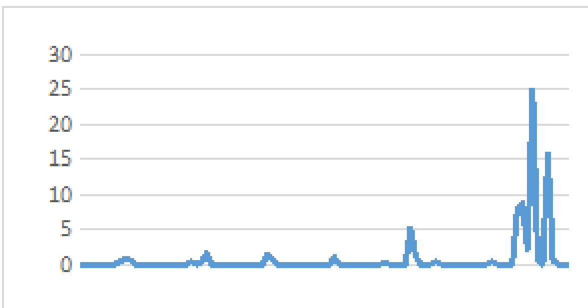

Fig. 12. The amount of precipitation.
Source: Own calculation.

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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 (Fig. 12.).

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 [5, 13].

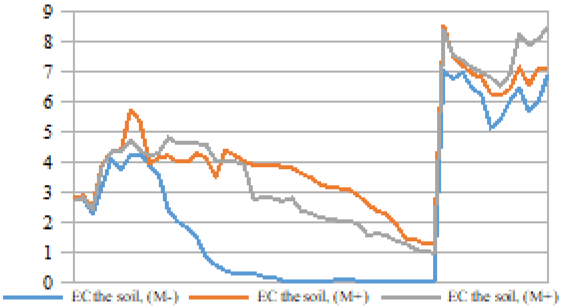

Fig. 13. The electrical conductivity of the soil. (A_M- - without mulch; A_M+ - with mulch)
Source: Own calculation.

Electroconductivity 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.

Using electroconductivity 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 electroconductivity of the soil in the case with mulch demonstrates much higher indices than in the case without mulch (Fig. 13).

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. 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 course of 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 (Photo 3, 4, 5, 6) [8, 9].

Photo 3. the process of soil erosion in the case without mulch.
Source: Own photos.

Photo 4. the process of soil erosion in the case of mulch.
Source: Own photos.

Photo 5. Mulching of the grapevine, the beginning of the period of active vegetation.
Source: Own photos.

Photo 6. Mulching of the grapevine, ripening of berries.
Source: Own photos.

According to estimates, it was found that about 40% of agricultural lands are degraded and give harvests lower than their productive capacity, and the continuous degradation of agricultural lands drastically reduces the possibilities of obtaining adequate harvests [1]. So, it is necessary to undertake rigorous measures to rectify the situation.

The costs related to the establishment of wine plantations, the exploitation of the fruitful vineyard and the deforestation expenses are recognized on the basis of the accounting of commitments in the period in which they were borne by the entity [11].

The use of mulch from the vegetable mass allows obtaining the benefits, which ultimately leave a significant economic imprint on the final product.

The inclusion of mulch in the technological process of growing vines also contributes significantly to the reduction of the carbon footprint in the atmosphere (the total emissions of greenhouse gases produced in a certain period of time). This footprint is manifested by the exclusion or partial reduction of some technological stages of plantation maintenance.

Excluding expenses for herbicides, machinery, fuels, performing treatments and manual work, all of these contribute to the elimination of weeds, because they compete for water and food, at the same time, they also create a microclimate favorable to the emergence and development of pathogens.

As a result of soil processing, it contributes to the degradation of the structure, which generates a deficient aero-hydric ratio, anaerobiosis conditions, poor development of the root system, crust formation and hindering the circulation of water in the soil, which in turn can trigger water and wind erosion of ground surface etc. In order to improve the soil structure, it is necessary to reduce the number of mechanical soil mobilization works (superficial and semi-deep), their performance, but also their passage, to ensure optimal soil moisture.

As a result of the rotting of the plant mass, which serves as mulch, it contributes to the improvement of the soil structure, the biota, ensures the replenishment of the soil with nutrients, etc. By decomposition, the mulch contributes to the restoration of the humus layer which, together with the clay in the soil, particles form the glomeruli of the soil. In structured soil, the aerohydric regime is made up of 2/3 water and 1/3 air. The mulch layer reduces the settlement-compaction process, keeping the soil structured.

Excluding the need for irrigation. The vine has a strongly developed root system that allows it to explore a large volume of soil. However, the lack of moisture has a negative effect on the development and productivity of the vine. In some cases vine irrigation is applied. As a guideline, during the period of active vegetation, it is recommended to use about 1,000 - 2,500 m^3 of water per hectare. This volume is applied as a result of carrying out 2-4 watering procedures, during the months of July - August, in one irrigation procedure 400-800 m^3 of water is used per hectare. In the irrigation expenses, it is also necessary to include the cost of the irrigation equipment (pump, irrigation network, etc.), the cost of electric energy, the remuneration of the person responsible for maintaining the irrigation system in operation, etc.

The layer of mulch prevents the loss of water through evaporation from the soil, this phenomenon being reduced 3 times.

When the soil was covered with mulch, annual shoot growth was 12–20% higher and plant productivity was 25.5–29.5% compared to the control. 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 about 25%.

CONCLUSIONS

Use of the Miscanthus sp. 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%.

REFERENCES

[1]Alexandrov, E., 2023a, Genotipurile de viță-de-vie în contextul schimbării factorilor climatici (Grapevine genotypes in the context of changing climatic factors) Chișinău, 131 p..

[2]Alexandrov, E., 2023b, A way of mitigation and adaptation to climate change.Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development.Vol. 23(1): 39-42.

[3]Alexandrov, E., 2019, Organic viticulture. Real opportunities for implementation. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 19(1): 25-30.

[4]Alexandrov, E., Botnari, V., Gaina, B., 2020, Soiuri interspecifice rizogene de viță-de-vie. Particularități de cultivare (Interspecific rhizogenic grapevine varieties. Cultivation peculiarities.). Chisinău, 95 p.

[5]Atlas, 2021, Schimbările climatice și starea actuală a peisajelor (Climate change and the current state of landscapes). Chișinău, 100 p.

[6]David, L., Andreu, M., Miguel, P., María de Toro, Jordi T., Alicia P., 2024, Organic mulches in grapevine shape bacterial communities in specific vintage and location. In: Applied Soil Ecology 201 p..

[7]Dobrei, A., Dobrei, A., 2011, Viticultura: bazele biologice și tehnologice (Viticulture: biological and technological bases). Timișoara, 210.

[8]Gaina, B., Alexandrov, E., 2023, Determination of the spectrum of volatile chemical compounds in the berry juice of interspecific rhizogenic grapevine genotypes. Romanian journal of horticulture, Vol. 4: 141-146.

[9]Georgescu, M., Dejeu, L., Ionescu, P., 1991, Ecofiziologia viței-de-vie (Ecophysiology of grapevine). București, 136.

[10]Nan, R., Dobrei, A., Alexandrov, E., Nistor, E., Nan, Al., Dobrei, A., 2021,The influence of different soil management and fertilization methods on the grapevine production costs and profitability. In: Journal of Horticulture, Forestry and Biotechnology, Vol. 25(3): 1-7.

[11]Regulamentul privind evidenţa contabilă a plantaţiilor viticole în procesul plantării, exploatării şi defrişării acestora (Regulation regarding the accounting records of wine plantations in the process of their planting, exploitation and deforestation.). Decision no. 21/24.02.2014. Ministry of Finance.

[12]Șișcanu, Gh., 2018, Fotosinteza și funcționalitatea sistemului donator-acceptor la plantele pomicole (Photosynthesis and functionality of the donor-acceptor system in fruit plants). Chișinău, 316 p.

[13]Vizitiu, D.E., Dinca, L., Donici, A., Enache, 2020, The management of soils from viticultural plantations.. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 20(1): 619-624.