

## THE INFLUENCE OF ECOLOGICAL FACTORS ON THE NORMAL GROWTH AND DEVELOPMENT OF GRAPEVINES IN CLIMATE-CHANGED AGRO-LANDSCAPE CONDITIONS

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Imereti, It is one of the main regions of viticulture in Georgia. The location, relief, local microclimate and favorable soil factors allow for the development of the traditional branch of agriculture - viticulture and the production of various types of high-quality wines. In Georgia, the vine is recognized as a culture of national importance and, taking into account economic factors, interest in it has been growing even more in recent years. However, in order to obtain a final high-quality product, it is necessary to select optimal soil-climatic conditions for growing vines. The climate, relief and soil diversity of the Imereti wine-growing region have historically created excellent conditions for the development of quality viticulture and winemaking, however, the global warming of the climate, unsystematic exploitation of the soil and the extreme conditions caused by these factors that have developed in recent decades have also affected this region and have posed unprecedented challenges to the viticulture sector, as well as other areas of agriculture. We are monitoring the processes when optimal conditions for the production of a particular crop are transformed into unfavorable conditions and have a negative impact on both the growth and development of the crop and the quality of the final product. The aim of the research is to introduce modern agronomic measures and test modern means proven in different countries in our reality, the ultimate goal of which is to reduce stress factors and improve the quality of the final product. We also want to make sure that it is possible to improve average and less favorable climatic and soil conditions to the point where it becomes possible to produce high-quality raw materials under these conditions.

**Keywords:** vine, bioclimate, soil, agrolandscape.

Georgia is rich in active viticulture centers, which we can also find in Western Georgia. Vine cultivation and vineyard rehabilitation are underway throughout the country. Viticulture is often the main source of income for farmers or simply families, which gives the country's vine culture economic importance and value. Viticulture is also actively practiced in Imereti. Georgia is distinguished by the diversity of soil cover, which creates the opportunity to obtain high-quality products from an agricultural point of view (Textbook Viticulture. 2021). Our

study area includes the specific bioclimatic soil conditions of Western Georgia - in the humid subtropical zone. This type of soil, common in Georgia, is characterized by difficult relief conditions from an agricultural point of view. Our research object includes soils of heavy mechanical composition, the excess moisture of which is determined by the abundance of surface water and the proximity of groundwater. Due to the heavy mechanical composition of the soil, rotting begins soon from the arable layer, which is the main reason for the instability of the water-air regime (Lortkipanidze. Soils of Imereti and Agriculture. 1997). (Urushadze.Bjilidze.Lominadze. Soil Science. 2011 ). Climate change, amid global warming, has led to similar changes and complications, which are becoming more severe over the years. Based on the structure of the leaves, which is affected by moisture, it is difficult to identify a specific variety. Finding the possibility of a vineyard cultivation background. It is necessary to improve the physical properties of the soil by forming the necessary complex agro-ecological environment. The goal of our experiments is to create optimal conditions for the production of industrially high yields for grape varieties common in this region, which has been brought about by landscape changes against the background of climate change (Lortkipanidze, Kelenjeridze. Practical course in agro-improvement. 2015) .

In difficult climatic conditions, it becomes more difficult to supply nutrients from soil with low humus content in a form that can be absorbed by the plant, and their deficiency causes great harm in viticulture. Cultivation of vines in a climate-changed environment is complicated and associated with risks, the goal of our research is to mitigate these risks.

In order to determine how useful the mentioned research soil is for grape cultivation, we organized a soil cutting to start the experiment in late autumn, and sent the soil samples taken for chemical analysis to the state-accredited laboratory "Multitest". The analysis results are presented in the form of a table (Table No. 1; Table No. 2).

Table No. 1

Sample laboratory registration number	Sample identification data		Humus %
202300037/1	0-10 cm	1	3.22
202300037/2	10-30 cm	1	3.17

Table No. 2

Sample laboratory registration number	Sample identification data		Nutrient elements - %			PH ( H <sub>2</sub> O )	Moisture %
			N (common)	P <sub>2</sub> O <sub>5</sub> (common)	K <sub>2</sub> O (common)		
202300038/1	0-20 cm	1	0.15	0.12	0.37	6.01	24.44
202300038/2	20-40 cm	1	0.11	0.11	0.29	5.93	27.00
202300038/3	40-60 cm	1	0.07	0.08	0.34	5.55	25.42

The chemical analysis results show that the yellow earthy soils we studied are low in humus and excessively moist.

**N** - Nitrogen varies within 0.15-0.07%, respectively, the nitrogen content is low. Since its content in the soil:

Below 4 is low;

4-6 - average;

6 - above high security.

**P<sub>2</sub>O<sub>5</sub>** - phosphorus To be assimilated Form Our On soils Varies between 0.12-0.08% Within the framework , respectively To be assimilated Phosphorus Quantity Research On the plot It is low because it is below 2.5;

Between 2.5-6 is the norm;

Between 6-9 - good;

9 - more than high security.

**K<sub>2</sub>O**- As for the potassium content, it varies in the soil from 0.37-0.29%, therefore, the mentioned soils are characterized by a low potassium content. Because

Less than 10 - low collateral;

10-20 medium;

And more than 20 are high-security.

The lack of each macro or micro element in the study area caused various complications: plant growth and development was delayed, the influence and importance of nutritional elements on the growth and quality indicators of the vine throughout the vegetation period was clearly evident. In particular: **N** - nitrogen deficiency was clearly observed in our study area (Figure №1), yellowing of the leaves began from the bottom of the vine seedlings, this symptom is similar to a symptom of water shortage, although we did not have this factor, against the background of frequent rains and excessive soil moisture. Such a deficiency of nitrogen can also cause various complications, in particular, it is one of the main nutritional macro elements of the plant and is included in the composition of all simple and complex proteins, protein is not formed without nitrogen, life is impossible without protein . Protein contains a large amount of nitrogen, it is 16% of the total protein mass. Nitrogen deficiency in

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our study area caused yellowing of leaves, shortening of internodes, poor plant development, leaf necrosis, and wilting (Figure 2).



(Picture №1) (Picture №2)

**P** - Phosphorus is one of the main macroelements for plants. Its deficiency leads to unstable development of the root system, which has also developed on our plot and is visible. Noticeable became Vegetation At a distance In our plot of land . Phosphorus With a deficit Leaves Marginal The parties accepted Purple Coloration . During the monitoring process, it was observed Arthropods Abbreviation , plant Weak Development And Small Size Bunches (picture #3) (picture #4). **P** - Phosphorus Plant Proteins Participates in the formation of the structure .



(Picture No. 3) (Picture No. 4)

**K** Potassium is essential in the process of fruit formation, as it plays an important role in the formation of cell walls. Due to its deficiency, cracks developed on the skin of grape berries on

our plot. During the experiment, the real form of potassium deficiency was revealed - the vine leaves began to turn yellow from the edges of the leaf, which turned brown and withered during the vegetation process.

The optimal pH (reaction) for grapes ranges from 6-7.5. According to chemical analysis, the soils common in our study area have a weak acidic reaction, with a pH of 5.55-6.01, which confirms that the available phosphorus is bound in the soil. Accordingly, a lack of phosphorus inhibits the development of the rhizosphere, which leads to a deficiency of nutrients, since the underdevelopment of the root system hinders the absorption of necessary nutrients. To adjust the soil acidity to the optimal level, we applied burnt manure to the I-plot in early spring and incorporated it into the soil, and to the II-plot we applied a modern alternative to burnt manure, “Kodahumus 20”, 4 times throughout the vegetation period. “Kodahumus 20” is an organic preparation based on humic acid, intended to improve the physical and chemical properties of the soil. It promotes the conduct of biological processes in the rhizosphere - around the root, improves the soil structure, makes the nutrients in the soil available to the plant in unabsorbed forms, and improves water retention. We purposefully applied it to the study area to alleviate the problems arising from climate change. We monitored the effect of these two organic fertilizers throughout the vegetation period. By the end of the year, we had the monitoring results ready. In late autumn, at the end of the vegetation period, we repeated the chemical analysis of the soil to determine the effects of organic fertilizers, what changes they caused in the soil, and whether they alleviated the impact of the difficult terrain on the vine culture ( Tables № 3, № 4).

Table No. 3 with burnt manure

Sample laboratory registration number	Sample identification data		Humus %	Ph (water extract)
202400363/1	Figure 1	0-15 cm	4.02	
202400363/2	Figure 1	15-30 cm	2.81	
202400363/3	Figure 1	0-20 cm		5.81
202400363/4	Figure 1	20-40 cm		5.80
202400363/5	Figure 1	40-60 cm		5.54

Table No. 4 with 20 of Kodahumus

Sample laboratory registration number	Sample identification data		Humus %	Ph (water extract)
202400364/1	Figure 2	0-15 cm	2.73	
202400364/2	Figure 2	15-30 cm	2.36	
202400364/3	Figure 2	0-20 cm		6.32
202400364/4	Figure 2	20-40 cm		6.20
202400364/5	Figure 2	40-60 cm		6.09

The analysis results show that the percentage of humus increased from 3% to 4% with the use of burnt manure, which had a slight effect on the soil reaction, while Kodahumus had a greater effect on the change in the soil reaction and corrected the weakly acidic soil to neutral, although it had a slight effect on the humus content of the soil at the beginning. Based on the experiment, it seems that it is better to introduce Kodahumus, because by changing the soil reaction we will be able to correct the humus, and by changing the humus, the soil pH will not change significantly. It is worth noting that during the vegetation period of 2024, no nutrient deficiency was detected on the plot treated with Kodahumus, which means that this preparation created an optimal environment for the vine in the soil, corrected the pH, thus the nutrient elements in the soil became available to the plant and it was fully absorbed, which cannot be said about the plot treated with manure.

In 2024, we repeated the chemical analysis of the soil and determined the level of available NPK in the soil in our study area. We compared and revealed the effect of burnt manure and cod humus on the change in macroelements in the soil. (Tables No. 5, No. 6).

Table No. 5 with burnt manure

Sample laboratory registration number	Sample identification data		Nutrient elements - %		
			N (consumable)	P <sub>2</sub> O <sub>5</sub> (consumable)	K <sub>2</sub> O (consumable)
202400468/1	0-20 cm	1	5.46	10.60	30
202400468/2	20-40 cm	1	4.48	8.60	25.4
202400468/3	40-60 cm	1	3.92	2.56	5.9

Table No. 6 with 20 of Kodahumus

Sample laboratory registration number	Sample identification data		Nutrient elements - %		
			N (consumable)	P <sub>2</sub> O <sub>5</sub> (consumable)	K <sub>2</sub> O (consumable)
202400468/1	0-20 cm	1	5.25	8.28	30.9
202400468/2	20-40 cm	1	4.13	8.12	27.8
202400468/3	40-60 cm	1	3.08	4.80	29.9

The analysis results show that, unlike last year, the amount of NPK available in the soil has significantly increased, both in the sector treated with rotted manure and in the plot treated with composted humus. The data is almost the same, with minor differences.

Based on the experiment, we can conclude that "Kodahumus 20" is a modern alternative to burnt manure. These two organic fertilizers equally change the humus level and PH index in the soil, accordingly, they equally affect the increase in the NPK content. The costs are equal. One circumstance that should be taken into account is that "Kodahumus 20" is a sterile organic fertilizer, while burnt manure is non-sterile, which creates a high risk of spreading various pests and diseases, contributing to the formation of an optimal environment for unwanted harmful organisms. If we look at the monitoring data, we can clearly see that in the area treated with burnt manure, we had more diseased and damaged plants than in the area treated with "Kodahumus 20". Unlike the area treated with manure, in the area treated with "Kodahumus 20" there was no boron deficiency in the grape bunches. The chemical analysis results also show that "Kodahumus 20" has a faster effect on soil acidity. This confirms that a better form of organic fertilizer is the modern alternative to burnt manure - "Kodahumus 20" ( Kelenjeridze. Agriculture based on agrochemistry. 2015 ) .

In the context of climate change, in addition to various pests and diseases, false leaf spot also creates favorable conditions for its development. This problem turned out to be significantly detrimental to the quality of our products on our study plot. Before taking appropriate measures, a large part of the crop was damaged by false leaf spot (Figure 5 ). In early spring, we removed the bark from the vines in the vineyard using rough-surfaced gloves so as not to cause mechanical damage to the plant. In early spring, as soon as the temperature rose (16

C<sup>0</sup>), we treated the vineyard against false leaf spot with the preparation "Lanat" made on the basis of "Metomylum", which is a fast-acting systemic insecticide for combating a wide range of harmful insects. Since the vines had not yet ripened their buds in early spring, we used a systemic drug for treatment. We chose this drug because of its ovicidal (against eggs) action, which allows us to combat both larvae and adult insects, as well as insect eggs. "Metomil" belongs to the class of carbamates. We treated the entire vine, internodes, horns, inter-row and inter-row, with the drug. Throughout the entire vegetation period, we treated the

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vineyard several times with an insecticide effective against false leafhopper, alternating the active substance in order to avoid resistance. In the ripening phase, we had significantly reduced the harmfulness of false leafhopper (Figure № 6), only a few roots were affected, which we eliminated with appropriate measures ( Chachkhiani. Measures to combat pests and diseases of grapevine culture. 2015).



(Picture No. 5) (Picture No. 6)

The health of a plant's root system is important for the growth and development of a crop. During the summer heat, when the plant consumes a large amount of water, due to strong transpiration, the vines grown in our study area did not have a healthy root system. Due to excess moisture and lack of air, rot developed, the roots could no longer provide the plant with the necessary amount of water, and the plant began to wither. (Razmadze. Regenerative Agriculture . 2022). On June 9, 2023, in a newly planted vineyard, due to root rot, we replaced dead seedlings with healthy vines, which was caused by excessive soil moisture and heavy mechanical properties. We removed the black polyethylene and immediately after planting, we first watered it with water, because the soil was dry due to the heat, and then we poured the penthiopyrad-based preparation "Afet" (against root rot) into the roots, which we mixed with the biostimulator for roots, Kodamine Radicular. The proportion of "Afet" was 1.5 mg per 1 liter of water, because we wanted to avoid root rot due to excessive soil moisture. Daily observations showed that the plant had slowed down in growth, and yellowing was observed on the leaves, which was a sign that the plant still had problems with root growth and development and rot. The probable cause of the root rot was Fusarium and Pythium fungi, since we could not identify them. We used a mixture of penthiopyrad, "Metalaxyl M" and mancozeb. For stimulation, we added a root stimulator based on amino acids and macroelements - "Codamine Radicular" and poured this mixture into the roots on July 2. In

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the context of high humidity, we repeated this mixture on July 12. We continued monitoring and as a result, the vine began to grow and the yellowing slowly disappeared ( Figure 7 ) (Figure 8 ).

"Codamine Radicular" - a biostimulant with a balanced content of plant-derived amino acids, phosphorus and potassium. The drug has a dual effect: it nourishes the plant and gives it additional energy, promotes the development of a healthy, extensive root system. It gives the plant additional energy, promotes its rapid recovery and growth and development.



(Picture No. 7) (Picture No. 8)

### Conclusions:

1. Based on the experiment, the importance of macro ( NPK) elements on the growth and development of the vine was revealed;
2. As a result of the experiment, the desired type and form of organic fertilizer was identified;
3. pH range for plants has been determined ;
4. The soil reaction at the research site is weakly acidic ( PH – 5.5/6.1) - and the binding of the assimilable form of phosphorus occurred in the absorption complex, which affected the normal development of the vine root system, weakly developed roots, root rot developed under the influence of excess moisture. By improving the agroecological environment: using one of the research methods, adjusting the PH to the optimal limit and adding trenches around the root system. With these measures, we removed excess moisture from the area and created an

optimal environment in the soil for nutrient absorption. As a result, the root system restored normal vegetation;

5. During the vine growing season at the test site, we identified pests and diseases in accordance with bioclimatic conditions, determined the appropriate control method, and correctly selected the drug, taking into account the active substance;

6. The thickness of the loam on the heavy mechanical composition of the yellow-earth loam soil caused the deterioration of the physical properties of the studied soil. We planned to improve the physical properties by implementing mechanical and technical measures.

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