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Bioecological Edificators of Gray-Brown Soils in Ganja-Gazakh Massif (Azerbaijan)

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Abstract Since Azerbaijan is a country with little soil, the cultivation of environmentally friendly industrial crops is very important and relevant in recent years and is one of the most important issues for soil scientists in the study of soil ecology. At present, the world has clearly defined the ecological direction in the use of natural resources, giving preference to the preservation of the natural environment and the development on this basis of resource-saving projects for the rational use of natural resources. The uniqueness of the nature of the Ganja of the Kazakh massif, as a habitat for zonal plants and animals, requires the development of modern methods for ecological assessment. The Republic of Azerbaijan is one of the most widespread countries for growing grapes. Collection orchards play an important role in the conservation of the grape gene pool. At the experimental station in Ganja, 258 native and introduced varieties are grown. The purpose of our research is to study the agrochemical and biological properties of soils of grape agrocenosis in the current ecological state of wet soils of natural cenosis, and the involvement of wet soils in agriculture. Hybrid forms like Tavkeri x Xindoqni; Tavkrevi x Gara Lkemi; Tavkveri x Medrese; Bayanshira x Saparavi; Bayanshira x Semilyon; Aloqote x Bayanshira; Sisaq x Bayanshira; Katta Kurqan x Tabrizi; Agshani x Gara shiraz; Agshani x Iskenderiyye muscat were taken as materials for research in agrocenosis. The study of phenological phases is closely connected with meteorological conditions and water regimes, which allows us to determine the need for heat, light, moisture and other elements of the external environment at different stages of the growing season. As a result of agroecological studies carried out on wet soils of natural cenosis, arable land has been identified and our analysis is very important for transferring them to grape and sunflower agrocenosis. Mathematical processing of diagnostic data of the main types and subtypes of soils of the massif and the long-term yield of the main agricultural crops - vineyard, sunflower, and cereals showed a close correlation between them.

Keywords Humification, Phytomass, Agro-Ecological Parameters, Ecological Edificators, Grape Ecotops

1. Introduction

Azerbaijan has 9 out of 11 global climatic zones, which are characterized by the development of unique and endemic soil types. Ganja-Gazakh region covers the western part of Azerbaijan. Along the banks of the Kur River stretches from the confluence of the river to the southern foothills of the Greater Caucasus. Particular attention is paid to the development of viticulture and winemaking, which are priority areas in the development of the country's economy, and important government decisions are made to develop this industry. Agrotechnical measures on the site where each grape variety is grown are carried out in accordance with the biological characteristics of the variety, taking into account soil and climatic conditions [5,6].

From this point of view, agroecological scientific

research based on the ecological characteristics of local and introduced grape varieties grown in the Ganja-Gazakh region, one of the vineyard regions of the republic, is considered relevant theoretical and practical tasks. The Ganja-Gazakh economic-geographical region includes the cities of Ganja and Naftalan of republican significance, Agstafa, Dashkesan, Gedabek, Goranboy, Goygol, Gazakh, Samukh, Shamkir, Tovuz administrative regions. It is located in the west of Azerbaijan, in a favorable economic and geographical position. Its area is 12,482 km^2, which is equal to 14.4% of the country's territory [9].

One of the leading areas of soil science today is the study of the development of modern soil processes and soil regimes. The importance of this direction is determined by the development of methods for studying soil processes. Long-term and systematic irrigation in the Ganja-Gazakh massif forms a completely new water and soil regime. Soils formed under these conditions differ from zonal soils in the development of biological activity and the process of soil formation. The amount of waste from the vine plays a significant role in soil processes [7,8,10,11].

Modern methods have been used to study the productivity, hydrothermal system, microflora and microfauna of natural gray-brown soils in the southeastern zone of Azerbaijan. At each selected site, soil sections were laid to the depth of the parent rock. The thickness of this horizon is 0-24 cm, which is heavy loamy, cloddy, and slightly compacted. The humus horizon gradually transforms into a relatively low-humus A/B horizon. The study of natural and cultural cenosis has shown that there is a close relationship between abiotic and biotic factors. Biological productivity is directly proportional to the sum of temperatures above 10 ℃ [1,2].

2. Object and Methods of Research

The scientific results obtained from our research show that a number of local and introduced grape varieties have optimal pruning shape, eye strain, optimal stem corn cut length and storage volume in the vine, etc., in accordance with the differential agricultural practices of each variety that has been identified.

The studies were carried out on native grape varieties (bisexual flower type - Tabrizi, Bayanshira, Garashany, Cardinal hybrids), as well as on introduced varieties Parkent, Ped Globus, Alfons Lavelle, Outumun Royal, Prima, Sultanina, Centennial Seedlis and other varieties, and local varieties of sunflower.The consideration of gray-brown soils as a transitional link between brown and gray soils made it possible to fundamentally approach the problem of zonal change and the integrity of subtropical soils. In the course of the research, otanic characteristics of varieties, the main morphological characteristics of shoots, leaves, flowers, clusters, cherries and seeds, biological characteristics - phenology, color and maturation of single shoots, shedding of flowers, yield of berries M.A. Lazerevsky (1963) and V.I. Appointed by Hand Drawn (2005). Herbarium materials were collected, the floristic composition was determined, and the soil samples were taken from cuts up to 1.90 meters deep for laboratory analysis. In order to highlight the important role of vegetation in the process of soil formation and especially in the formation of humus, the surface phytocomplex and root mass of plants were determined in different seasons of the year.

The amount of phytomass was determined twice a year during the period of maximum vegetation development (the second decade of May). The determination of the aerial parts of plants was collected from 1 m^2 of area. The number of plant species prevailing in the collected herbarium materials was determined. In order to highlight the important role of vegetation in the process.

Soil formations, especially in the formation of humus, determined the surface phytocomplex and root mass of plants in different seasons of the year. The amount of phytomass was determined once a year during the maximum growing season (end of May). Above ground parts of plants for determination, they were collected in 5-fold replication from 1 m^2 of area. Grass cut 2 cm above the soil surface, sunflowers and grapes were harvested, dried in the open air and then the dry weight was determined. The amount of root mass was studied on the basis of a monolithic method (25 × 25 cm) 3 times at a depth of 0–24, 24–50 cmwith plant species prevailing in the collected herbarium materials. Samples were taken from certain areas for soil analysis. Water extract (short and full) E.B. Arinushkina, water-physical properties (hygroscopic moisture) - N.A. Kaczynski; absorbed bases - K.K. Hedroits; carbonates $CaCO_3$ and CO_2 - with a calcimeter; The content of total nitrogen and humus - according to Tyurin; using a pH-ionometer-pH-meter. The study of nematodes was carried out in bright light using the Berman funnel grid method. For the study of microorganisms, meat-peptone agar, starch-ammonia agar, Sabouraud nutrient medium were used. The assessment of the individual sustainable development of plants has been widely studied in recent years by the degree of change in the morphological features of fluctuation asymmetry (FA) of leaves. The material for the study was collected at the end of July after the completion of intensive leaf growth. A total of 250 leaves were collected from 10 tree samples from each study area. Leaf samples were taken from a height of 1.5-2 m along the entire perimeter of the trees. On each sheet, the length of five morphometric characters was measured. Knowledge of the phenology of plant species growing in each region is important in determining the timing of various agrotechnical operations (pruning, watering, fertilizing, spraying, harvesting), the correct choice of pollinators, etc. is very important.

3. Results and Discussion

Taking into account that soil gradation is based on the properties that determine its fertility, taking into account the specific conditions of agriculture, when compiling a gradation scale, irrigated and rainfed soils are evaluated. The grape plant can grow on a wide variety of soils, but depending on the soil, the quantity and quality of the crop and especially the quality of the wine change. Each variety requires certain soil conditions to obtain maximum yields and high quality products, and the right choice of soil for grape cultivation (taking into account the characteristics of the variety) is extremely important.

Common mountain gray-brown soils were rated 55 points, and dark chestnut mountain soils 60 points. The calculations carried out showed that the appraisal score of the land of the Gazakh region is 81, the Khanlar region is 58, the Shamkhor region is 72. And the total of Ganja-Gazakh massif is 69 points.

The blooming of shoots of grape hybrids occurs in the 1st and 2nd decade of April. The next phase in grape varieties is flowering. Flowering occurs on May 11 and June 1-10. It becomes massive 5 days after the start of flowering and the process is completed within 12 days.

In some varieties, the fruits ripen early (Bayanshira x Saperavi), in others late (Tavkveri x Gara Lkeni) and in some medium (Tavkveri x Xindqoni). When planting vines, their height is taken as the main criterion in the selection of nutrients for the vines, in the selection of the rate of load on the vines. The average length of shoots of hybrid forms of selected grape varieties is 198-282 cm.

The maximum molecular moisture capacity is 20.06-22.59%. The average absorption rate on gray-brown soils for the first hour of observations is 3.8-11.1 mm per minute. The total amount of water absorbed in 6 hours is 579-249 mm. A fairly uniform distribution of basic oxides along the soil profile was revealed. There is no leaching and removal of any oxides from the mineral part of the soil. The amount of mobile amorphous compounds in uncultivated soils of natural cenosis is higher than in the soils of agrocenosis where grain crops are grown.

The table below shows the agrochemical properties of some soil samples taken from the agrocenosis of the Ganja region (Table 1, 2, 3).

Of particular importance and relevance is the comparative study of possible changes in certain physicochemical and biological properties in natural and agrocenoses. The following table presents the biological activity of the main indicators that determine the current ecological state of the study area.

Cellulose decomposition was 12% in soil layers 0-24, decreasing with depth and approaching 9%. The maximum indicator of humus was 3.04%.

Table 1. Some parameters of biological activity

Horizonts, depths,sm	Organic carbon %	Water-soluble humus %	Cellulose decomposition rate, %	Temperature °C	Productivity s/ha
AI 'a 0-24	1.9	0.031	12	1.2-26	36-45
AI " 24-50	1.7	0.023	9	3.0-22	25-30

Table 2. Some parameters of chemical structure

Horizonts, depths,sm	Humus %	Nitrogen %	$CaCO_3$ %	Amounts of lost bases mg/ekv	Ca/Mg mg/ekv	pH	SiO_2/ Al_2O_3 mg/ekv	SiO_2/ Fe_2O_3 mg/ekv
20-27 $AU_{a,z}$	3.04	0.21	7	36	3.1	7.9	5	19
15-25 $AU_{a,z}$	2.71	0.18	8	29	2.8	8.0	4	20
12-18 AB_h	1.55	0.16	11	25	2.6	8.2	6	18
15-20 V_{sa}	0.83	0.12	12	21	1.9	8.4	5	19
>20 $C_{s,cs}$	0.57	0.09	10	20	1.6	8.5	4	19

During the environmental assessment of the land, the content of the main microelements in the soils of the grape agrocenosis was specified. It has been established that according to many indicators, the vineyards are not sufficiently provided with nutrients: in digestible protein, phosphorus, carotene and microelements, the deficiency is 20-23%.

Some microelements (mg/kg) have been studied (Mn, B, Cu, Co, Zn, Mo) in different layers. In samples taken from the topsoil, the values were high and the depth had already been reduced (Table 3).

The vegetation of any natural and climatic zone forms the primary production of solar energy. The revealed amount of decomposed plant matter is associated not only with the state of the phytostructure, but also with other biological features of the studied soils. Particular attention is paid to the group and species composition of soil biota and their activity, which determine the complex stages of transformation (humification and decomposition) of phytomass residues (Table 4, 5).

Groups of invertebrates found in nature and agrocenosis can be studied as bioecological edifactors in gray-brown soils. The correctness of the obtained results was checked using mathematical statistics and the correlation coefficient. From 1 kg of soil at a depth of 0-24 cm, 6.9 mg of CO_2 was released in 1 hour, at a depth of 6.1 mg of CO_2 24-50 cm, from a depth of 24-50 cm - 10.1 mg/h. In irrigated gray-brown soils, samples taken from a depth of 0–24 cm and from a depth of 24–50 cm emitted CO_2 at 15.5 and 10.4 mg/h. With increasing depth, the amount of carbon dioxide decreases.

Table 3. Agrochemical indices and microelements

Layers,depths,sm	Total %			Assimilated mg/kg			Microelements mg/kg					
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	Mn	B	Cu	Co	Zn	Mo
0-24	0.18	0.20	3.1	28	26	284	649	36.8	20.6	5.0	29.9	2.63
24-50	0.12	0.15	2.9	24	24	220	529	24.8	16.9	3.9	26.1	2.19
50-100	0.05	0.08	2.6	18	9	90	309	17.2	9.7	1.9	16.9	1.8

Table 4. Main water-physical characteristics

Layers depths,sm	Granulometric composition		Soil silt factor	Aggregation speed	Volume weight g/sm^3	Water permeability	Dry residue %
	<0.001	<0.01					
20-27 $AU_{a,z}$	24	51	47	31	1.10	2.1	0.12
15-25 $AU_{a,z}$	27	59	46	29	1.18	2.0	0.13
12-18 AB_h	23	58	40	26	1.23	1.9	0.17
15-20 Vsa	22	53	39	21	1.26	1.6	0.20
>20 $C_{s,cs}$	20	49	41	20	1.37	1.1	0.29

Table 5. Biological activity of gray-brown soils (Kastonozems)

Layers depths,sm	CO_2 %	Biogenicity		Enzymatic activity			Total humi-dity %
		Microor-ganisms 10^3/g.soil	Soil invertebrates ekz/m^2	Invertase mg.gluc./1g soil	Proteasa mg.tior/ 1g.soil	Katalase mg.O_2 1 min.	
AI 'a 0-24	0.3-0.5	$5 \cdot 10^3$	21	22	16	$5.2 \cdot 10^3$	20-27
AI " 24-50	0.1-0.3	$5.1 \cdot 10^3$	19	16	11	$14 \cdot 10^3$	19-24

The results of many years of research carried out in order to restore the ecological balance, increase productivity and rational use of the gray-brown soils of the Ganja-Kazakh massif made it possible to draw the following conclusions and recommendations for production. The total number of plant species on pastures has been established, most of which are annual or ephemeral plants (52%); perennial grasses (41%); other species are shrubs (7%). Along with the unique plants that make up biodiversity, the pastures are home to many (49%) non-weedy plants, 6.8% of which are poisonous. Under the influence of carbonate content and gypsum content, there are differences in the development of vine roots in gray-brown soils. The trunk and branches of grapes develop better in alkaline soils than in carbonate ones. The aboveground mass is 1670 g, and the length is 25.10 m, while in carbonate varieties these values are 50% less. Sunflower roots, with their enzymatic activity, can provide the need for phosphorus for plants at the expense of organic phosphorus compounds, if any, in the substrate. As depth increases, the amount of carbon dioxide decreases. The amount of waste from the vine plays a significant role in soil processes. In vineyards on brown soils, from 2–3.75 t/ha of leaves and 3.75–43.24 t/ha of waste accumulate in the soil per year. Consequently, 5.5–13.0 t/ha of organic matter is accumulated annually in soils, from 213 and 67 kg/ha of ash elements. Thus, the vine has a positive effect on soil processes. The aboveground mass is 1670 g, and the length is 25.10 m, while in carbonate varieties these values are 50% less. Sunflower roots form enzymes that break down glucose phosphate, ribonucleic acid, glycerophosphate and sucrose. 1 g of sunflower roots decomposes 0.325 mg of ribonucleic acid, 0.389 mg of glycerophosphate and 0.208 mg of glucose phosphate in 3 hours.

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4. Conclusions

For the first time, the biomorfological, agroecological, technological and economically important peculiarities of local and introduction table and wine grape varieties were studied by us under conditions of the Ganja-Gazakh area with the purpose of determination of their cultivation prospects and suitability for wine-making. As result it was found that when pollinating was conducted on the stage of blossom of 50% of flowers, the average weight of bunches considerably increased and as a result, visibly the study of indicators of productivity. Researches were aimed at study of influence of artificial and additional pollination on productivity, harvest quality, trade appearance and other characteristics of several grape varieties with functionally female and hermaphroditic flower types (blossom of 25, 50 and 75% of flowers). In soils under vineyards by biogenic ash, more elements accumulate than under other cultures. Therefore, the vine has a positive effect on soil processes. Sunflower roots and grapes determine the high productivity of the above-ground mass. Sunflower roots degrade ribonucleic acid more vigorously than the roots of other plants. Sunflower roots form enzymes that break down glucose phosphate, ribonucleic acid, glycerophosphate and sucrose. 1 g of sunflower roots decomposes 0.348 mg of ribonucleic acid, 0.391 mg of glycerophosphate and 0.208 mg of glucose phosphate in 3 hours. Under the influence of carbonate content and gypsum content, there are differences in the development of vine roots in gray-brown soils. The trunk and branches of grapes develop better in alkaline soils than in carbonate ones. The aboveground mass is 1670 g, and the length is 25.10 m, while in carbonate varieties these values are 50% less. Sunflower roots, with their enzymatic activity, can provide the need for phosphorus for plants at the expense of organic phosphorus compounds, if any, in the substrate. As depth increases, the amount of carbon dioxide decreases.

Recommendations

The studied herbal plant, as well as local and introduced technical, table grape varieties of the female flower type are recommended for widespread cultivation on the farm, as they have positive phenological, highly productive, phytopathological, technologically useful and high-quality uvalological features. In viticulture, it is recommended to plant male flower specimens of grapes around the field and in between for their pollination. Pollination of grape varieties is carried out mainly in the morning, and pollination occurs at 50% and 75% flowers open.

REFERENCES

[1] Aliyeva M.M. Vegetation and its importance in the formation of meadow brown soils. Bulletin of Science and Practice. Issue 5, Volume 7. pp. 75-79, Russia, Nijnevartovsk. 2021

[2] Babayev M.P., Hasanov V.H., Huseynova S.M. Morphogenetic characteristics, nomenclature, and taxonomy of the soils of Azerbaijan. 448 p. Baku, 2011. Book

[3] Benjamin G.J. Impact of soil organic carbon on soil physical behavior. European journal of soil science. pp. 133-149, Switzerland. 2013

[4] Busse M. Christian P. Global changes and forest soils. Developments in soil science. Volume 36. pp. 120-150 Book series Elsevier 2019

[5] Castelini M. Pedotransfer functions for estimating soil water retention curve of Sicilian soils. Archives of agronomy and soil science. Volume 65, N 10, pp. 123-134 Taylor and Francis UK London 2019

[6] Hasanova T.A. Mammadova G.İ., Bunyatova L.N., Gahramanova A.Y. Importance of biodiagnostics and irrigation grey-brown soils, Universal Journal of Agricultural Research, Volume 9, No 3, pp. 63-69, 2021. DOI: 10.13189/ujar.2021.090301.

[7] Hasanova T.A., Asgarova G.F. Phytomass of Gray-brown Soils Forming in Arid Ecosystem of Azerbaijan. Bulletin of Science and Practice Scientific Journal Publishing Center Science and Practice. ISSN 2414-2948 ©Publishing Center Science and Practice, pp. 110-115 Nizhnevartovsk, Russia. Volume 7 Issue 9 2021 https://doi.org/10.33619/2414-2948/70.

[8] Ibadullayeva S.J., Nasirova A.İ. Forage quality of the species of *Malva* L. genus and definition of organic remainders in the cut areas, International Journal of Agriculture and crop sciences. pp. 6-19. Impact factor: 0.84- B. London-UK. 2013

[9] Jafarova Sh.Z. Contemporary Fertility Character of the Guba-Khachmaz Zone Mountain-Forest Brown Soils in the Azerbaijan Republic. Journal of Agricultural Science and Engineering, Vol.1, No.2, Jun. pp. 95-100, USA, Boston 2015, Pub. Date: May 28, 2015.

[10] Mammadova A.O., Mammadova R.N. Investigation of the possibility to use *Quercus macranthera Fisch. Et C.A. Mey.* woody plant in the management of the sustainability of the forest ecosystem//Plant & Fungal Research. 3(2). pp. 30-37. Azerbaijan, Baku, 2020.

[11] Mammadova A.O., Mammadova R.N., Qafarova B.T. Research of phytoindicative ability of *Quercus longipes Stev*. for ecological assessment of the natural environment samur-devechi lowland // Advances in Biology & Earth Sciences, pp. 29-37. 6 (1). Baku, 2021