Bioecological Aspects of Managing the Growth, Development and Economic Characteristics of Plants through Organic Farming under Arid Weather and Climate

Maxim Viktorovich Larionov [1,*], **Karina Faritovna Zaripova** [1], **Lusine Gagik Matevosyan** [2], **Ashkhen Artavazd Barbaryan** [2], **Rimma Hayk Osipova** [2], **Karine Shahen Sargsyan** [3]

[1] Federal State Budgetary Educational Institution of Higher Education Russian Biotechnological University (ROSBIOTEC'H University), 125080 Moscow, Russian
[2] Scientific Centre of Agriculture CJSC at the Ministry of Economy, AM 1101, Ejmiatsin, Armavir region, Armenia
[3] Chair of Forestry and Agroecology, Faculty of Agronomy, Armenian National Agrarian University, Yerevan, Armenia

[*]Corresponding author: (Maxim Viktorovich Larionov, ORCID: 0000-0003-0834-2462)

Abstract

In recent decades, serious climate changes have been observed. In the northern hemisphere, including on the European Continent, this is manifested in climate aridization. Many areas in sub-humid and semi-arid territories are subject to the invasion of dry winds against the backdrop of the clear deficit of precipitation. The complex of negative factors of aridization and instability of the meteorological phenomena is already manifested in the European Russia. The processes of aridization and instability especially affected the Black Sea Region and its northern regions, the southern regions of Russia, the Caucasus Region, as well as adjacent territories. The number of species and varieties of the agricultural plants require special care and optimization of growth and development, when aridization of weather and climatic factors occurs. Many berry crops are traditional in Europe, Russia, the number of Asian countries and other regions. The article describes the features of development and economic characteristics of cultivated plants, as well as the environmental and resource properties of soils. Their influence on agrobiological parameters, quality and productivity of the plants is shown using grapes as the example. Research on the biological regulation of the use of fertilizers on company grapes was carried out in accordance with the variety being studied, soil type, and weather and climatic conditions. The results are grouped taking into account the basic economic requirements for the characteristics of seasonal development, the condition and quality of the crop. Information was obtained on the increase in the yields and biochemical parameters of the fruits in experimental variants. The pivot tables contain processed arithmetic average results. The results are statistically significant when the errors in the arithmetic means are below 5 percent. The article reveals the technology of ecological rationalization of land use and bioresource management under aridization of meteorological and climatic conditions.

Keywords: Technology of rational land use; Variability of weather and climatic conditions; Climate aridization; Agricultural plants; Grape; Organic farming; Microfertilizers; Improving soil quality; Phenological monitoring; Plant condition monitoring; Optimization of plant growth and development; Harvest quality.

1 Introduction

The variability and instability of the weather and climatic factors, the global and interregional nature of climate change together can have the depressing effect on the many wild plants (Larionov & Volodkin, 2023; Lebedev et al., 2023; Osland et al., 2023; Vedernikov et al., 2022)

in their natural habitats, as well as on the plants under cultivation conditions (Agathokleous, 2023; Larionov et al., 2020). In the agriculture and in the complex of the plant sciences and environmental sciences, taking into account the limiting influence of the weather and climatic factors when growing crops is of decisive importance. Especially if the issue concerns territories with the arid weather and climatic conditions.

The techniques and methods of the organic farming (Leong et al., 2022; Meneguzzo & Zabini, 2021) and biologization of land use (Longhui & You, 2021; Sargsyan et al., 2025) make it possible to significantly reduce the limiting nature of weather and climate, as well as anthropogenic and technogenic pressure on the created and exploited cultural ecosystems in various landscapes. This applies to different natural zones and agroclimatic regions. In particular, the selection of the most suitable fertilizers in terms of the composition and properties (Allahverdiev, 2021) allows you to solve many bioecological, soil protection and economic problems. That is, protection of soils and improving of their morphophysical and biogeochemical qualities should be based on natural biochemical cycles in soil systems, between the soil and aquatic environment, soil and terrestrial organisms. The implementation of this approach seems possible taking into account the complex of morphological, water-physical, agrochemical and biological qualities of soils, as well as taking into account the biological and environmental properties of cultivated plants and agrobiocenoses in general.

This is especially valuable in conditions of arid climate in regions with arid and semi-arid climates (Zolotokrylin & Cherenkova, 2009; Savina et al., 2022; Yeghiazaryan et al., 2025) and even in vast areas with the subhumid climate (Voronin et al., 2005; Zolotokrylin et al., 2018; Slavskiy et al., 2024). Thus, in recent decades, aridization of weather and climatic conditions has been the powerful complex limiting environmental factor for soil and plant systems and especially for cultivated plants.

The following can be stated. During growing seasons, weather instability, frequent dry winds, atmospheric and soil drought already affect not only the traditional arid and semi-arid regions of Europe and Asia. For example, on the East European Plain, the number of ecoregions with the semiarid climate is expanding in different directions.

This unfavorable eco-climatic trend is also spreading (Lubimov & Larionov, 2016; Melnik, 2020; Volodkin et al., 2021; Slavskiy et al., 2023) across territories with the traditionally subhumid climate. In particular, in the center, southwest, south and southeast of the Russian Plain, climate aridization processes are clearly manifested. Here, relatively open steppe landscapes and forest-steppe landscapes are especially susceptible to the effects of climate warming and dry wind phenomena during the growing season. The phenomena of aridization in recent years have already characterized the south, west and east of the Non-Black Soil Zone of Russia. In the Central European Part of Russia (up to the Ryazan, Tula, Oryol, Moscow Regions and some other regions) phenomena of dry weather in the summer and general warming in the winter seasons are also recorded. This leads to loss of yields of agricultural field, garden and garden crops. There is the weakening and accelerated aging of the woody plants in agricultural shelter belts, roadside shelter belts, urban and rural landscaping. The decrease in the productivity of urban and rural gardens has been noted.

There is the loss of ecological stability and ecological functionality of tree stands for environmental and phytomeliorative purposes in the semiarid and subhumid regions of Russia and neighboring countries (Armenia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Iran and other territories). There is also the loss of the stability and the decrease in phytomass productivity in man-made and even natural forest ecosystems. Such unfavorable environmental processes are observed in many territories of the East European Plain, including in Russia.

As a result, many negative ecological processes in soils and agrophytocenoses become significant problems. Drought phenomena directly and indirectly initiate soil erosion, disruption of water-physical properties, decline in fertility and disruption of the ecological regime in soils. As a result, large areas are subject to degradation and alienation of agricultural and forestry lands. There is the rejection of lands of other target categories from the use.

Grapes (*Vitis vinifera* L.) are popular in many countries around the world. This is due to the special taste and biochemical properties of the fruit. This is evidenced by the large number of its varieties. Certain grape varieties are of great importance. This is due to the peculiarities of the climate, cultural landscapes, the level of introduction of agrobiotechnologies and the biology of the plants themselves of this species and the corresponding varieties. The viticulture is currently gaining increasing importance in the agricultural farms of modern Russia and neighboring countries.

The cultivated grapes are wonderful plant due to its diverse economic qualities. In addition to its taste properties, it has very high decorative and medicinal value. It is highly important as the ornamental shrub in urban gardening, in various arboretums, in landscaping, in agricultural food and complex crop production. From the ecological and biological point of view, grapes have the pronounced form of the shrub, refers to the woody plants. This plant has increased requirements for the environmental conditions and, above all, for the weather conditions, climate, as well as soils, moisture regimes and topography. But still, weather and climatic factors of the landscapes, physical and agrochemical indicators of soils are of particular importance for the successful cultivation of the *V. vinifera* plants.

It is shown that the success of growth of trees and shrubs in special landscape conditions depends on the set of formed adaptations to environmental factors (Doroshenko & Maksimtsov, 2016; Larionov et al., 2020a). Of particular importance is the consideration of the various limiting factors and the peculiarities of the economic exploitation of the natural and economic complexes (Amirdzhanov, 1980; Galstyan et al., 2023; Pleshakova et al., 2021; Perstnev, 2001). In all cases, it is necessary to ensure responsible and thorough controlover cultivated plants (Dogadina & Larionov, 2020; Gromova et al., 2020; Larionov et al., 2018, 2020b, 2021; Samaha et al., 2018; Volodkin et al., 2022) when organizing sustainable and highly productive agricultural biocenoses.

During the growing season, the plant passes from one stage of development to another. At the same time, its needs and interaction with the environment change. Plants have periods of maximum nutrient intake, when the large amount of mineral elements is supplied in the fairly short time. For some plants, this period is characterized by the very short period, for others, the longer supply of the mineral nutrition elements is characteristic.

In addition to periods of maximum nutrient intake, plants have critical periods of nutrient intake. The absence of one or another element at this time can negatively affect the productivity and condition of cultural phytocenoses. So, during germination period, plants are very sensitive to the lack of phosphorus, which promotes better growth and functioning of underground plant organs, during intensive formation of vegetative mass – to lack of the nitrogen.

Each environmental factor or complex of interrelated factors has different significance for the plant at different stages of its development. The ecology of the plant is staged. The same factor and in the same quantitative expression can have the positive value in one the stage and negative, harmful value in another stage. This makes it possible to trace the influence of any environmental factors and their combinations throughout the life cycle and reproduction of the plant (Agaev, 2002).

The influence of the environmental environment and its individual elements (factors) is rarely the direct mechanical influence (breakage, lodging, etc.) or is limited to such. It is expressed in changes in the internal environment of the plant, the metabolism in the cells and tissues of the plant in the long chain of the biochemical reactions and physiological processes.

Therefore, the most thorough analysis of the effect of the influence of any environmental factor is necessary in order to show the variety of transformations occurring in plant organisms.

The mineral nutrition of plants is one of the key factors that have the complex effect on the plant. It affects the overall development and ecological status of plant organisms. The optimal content of nutrients in soil ensures not only the full development of plants during the growing season, but also contributes to the formation of the conditioned crop and the preservation of certain characteristics characteristic of the variety or group of varieties. The supply of nutrients is

very important during the dormant period of plants, when the generative buds are laid for the next year.

In order for the plant to develop normally in its critical phases, it is necessary to provide it with all the elements of nutrition. For this purpose, foliar top dressing is widely used in viticulture [68]. They are especially effective when the soil is depleted of nutrients due to their increased leaching or, conversely, reduced solubility due to lack of moisture, an unfavorable pH value of the soil solution.

Therefore, in conditions of high temperatures, this method of introducing batteries is especially relevant.

It was necessary to study the effect of microfertilizers as the environmentally optimizing condition for growing cultivated plants. That is, it was important to identify how microfertilizers can facilitate and improve the development of cultivated plants during aridization of weather and climatic factors. This was the main ecological, biological and economic meaning of cultural crop production in semi-arid and arid landscape conditions. With the manifestation of the consequences of global climate change, this is relevant and economically feasible.

2 Materials and Methods

These studies and observations were carried out in the south of the Crimean Peninsula. This area is characterized by frequent droughts during the growing season. There is the deficit of atmospheric precipitation in the warm season.

The bioobject studied was the Culture-grapes. In this work, the development, bioecological and economic characteristics of the Muscat White grape variety are analyzed from the studied varieties of berry crops, year of planting 2009. The shoots of the berry crops under consideration were obtained using the following rootstock: Berlandieri × Riparia Kober 5BB. Plants were planted using the 3×1.5 meter system. The spiral cordon formation was created on high bush trunks. Plants are indissoluble, non-irrigated.

Field observations were carried out under normal weather conditions (Losev, 1994; Lukatkin et al., 2005; Polous & Voiskovoy, 2013; Uranov, 1964). The condition of cultivated plants of the species and variety under consideration was assessed. Observation of the condition and development of plants (Gibadulina et al., 2022; Larionov & Volodkin, 2021; Siraeva et al., 2020) took into account environmental conditions. Planning, implementation of experiments, observations and records were carried out using guidelines that are relevant in cultivated crop production and, in particular, in viticulture (Negrul et al., 1955; Potapov et al., 2000; Tseyko, 1967). Conveniently, these guidelines and recommendations can be used when growing plants in dry climates and aridizing meteorological conditions. Based on plant growing and bioecological guidelines (Modonkaeva, 2012), agrobiological accounting, determination of crop weight and its condition, and assessment of bioecological signs of plant growth and development were carried out. The carbohydrate content in berry juice was determined using the refractometer (ref 5×3). The research results were subjected to statistical analysis using analysis of variance “by the field experiment method” using the data analysis package Excel and Statistica.

3 Results and Discussion

At various times, woody and shrubby berry plants were previously cultivated and are currently cultivated in Europe, Asia and other parts of the world. Many of these cultures retain great economic, historical and cultural significance. Such plants include are *Ribes nigrum*, *Ribes rubrum*, *Ribes aureum*, *Ribes nigrum* × *Ribes divaricatum* × *Ribes uva-crispa*, *Ribes uva-crispa*, *P. persica var. nucipersica*, *P. persica*, *P. armeniaca*, *Cerasus vulgaris*, *C. fruticosa*, *C. avium*, *Prunus spinosa*, *P. domestica*, *Prunus cerasifera*, *Cydonia oblonga*, *Cornus mas*, *Rubus idaeus*, *R. arcticus*, *R. caesius*, *R. fruticosus*, *R. vulgaris*, *Vaccinium uliginosum*, *V. corymbosum*, *V. myrtillus*, *V. vitis-idaea*, *Rosa majalis*, *Sorbus aucuparia*, *Amelanchier ovalis*, *Crataegus*

laevigata, *C. monogina*, *C. pontica*, *C. rhipidophylla*, *Vitis vinifera*, *Hippophaë rhamnoides*, *Sambucus nigra*, *S. racemose*, *Empetrum nigrum*, *Mespilus germanica*, *Lonicera edulis*, *L. caerulea*, *Viburnum opulus*, *V. lantana*, *Ficus carica*, *Citrus limon*, *C. reticulata*, *Punica granatum*, *Olea europaea*. The fruits of these plants in the number of European countries and Russia are used as food or for adding as ingredients to various dishes, for the preparation of tinctures, decoctions, jams, and medicines. In nature, many species of these plant representatives occupy fairly large areas. In cultivation, these plants are even more widespread. The great importance of these plants lies in heir quality as honey plants. Moreover, their use for landscaping, landscape design, environmental and phytomeliorative purposes is found in Europe, Russia and the number of other regions of the world. At the same time, they have high economic demand. This demand lies in food, medicinal, decorative, cultural, educational, scientific values and the variety of uses. In this work, we will focus on the analysis of the possibility of managing the bioecological, economic and resource qualities of the cultivated grapes (*Vitis vinifera*) in the organic farming against the backdrop of variability in weather and climatic environmental factors.

However, it is important to point out the following. Grapes (*V. vinifera*) are popular and economically in demand agricultural crop in Europe (Antoce & Cojocaru, 2018), Asia (Seckin et al., 2023; Sharma et al., 2020), South America (Ullah et al., 2022) and many other regions of the modern world. For the population of the Black Earth region and for the Non-Black Soil Regions of Russia, the Volga, the region of the Black Sea, this plant also retains its economic value. Moreover, to date, the need for the cultivation of cultivated grapes has increased. This is necessary in various territories of Russia and neighboring countries due to landscape, meteoroclimatic, geomorphological, hydrographic, edaphic and environmental features.

The following information was obtained on the research and observation territory. The type of soil on the site is brown mountain non – carbonate. The mechanical composition is loam. The humus content is 1.48 %, the soil pH is 6.9.

The demonstration scheme consisted of two variants-the experimental one (the use of fertilizers from the companies "Agrinos" and "Lima-Europe") and the reference one (the fertilizer system adopted in the farm).

Spraying was carried out four times during the entire growing season:

- first treatment – june 11 – "before flowering"; agrinos 2 (2) + calcibor gel (1) + micro gel (1), and no treatment was carried out on the reference site;
- second – june 23 – "after flowering"; agrinos 2 (2) + gel fruit (2), on the reference-double vin 20: 20:20 (2) + gumiful (0,1);
- third treatment-july 6 – "berries the size of the pea"; agrinos 2 (2) + gel fruit (2), on the reference – double wine k (2) + gumiful (0,1);
- fourth treatment – august 11 – "the beginning of berry ripening". Gel calcibor (1) + gel fruit (2).

The Terms of application of the microfertilizers were chosen taking into account the need to provide plants with trace elements in the certain phase of the development.

The meteorological data: meteorological indications of the warm period of grapes on southern coast of the Crimea were favorable for its growth and development. Average monthly values of the temperature factor in the summer corresponded to the level of long-term average indicators and did not significantly exceed them – 0.2-1.2°C. During the period of april – september, 72.8 mm of atmospheric fallout occurred, which is below the average for the years of observation by 205.7 mm (64.6 %). The main precipitation amounts of 30.2 % and 27.1 % were observed in june and september, respectively. Meteorological indications are given in Table 1.

Table 1. Parameters of meteorological values during the development of berry crops in the warm season

Indicators	Periods					
	April	May	June	July	August	September
Atmospheric temperatures, °C а) average long-term б) the current year	 11.1 10.7	 16.6 15.6	 21.5 21.8	 24.8 25.9	 24.9 25.1	 25.3 23.1
Precipitation, mm а) average long-term б) the current year	 29.8 8.0	 30.3 6.0	 41.7 22.0	 39.7 8.4	 30.1 8.7	 34.1 19.7

Note: based on weather station data.

Records and observations: With the average load of 20 eyes per bush, 18 full – fledged shoots developed in the spring of 2020, and only 14 shoots with inflorescences (13 on the standard), (Table 2).

This can be explained by the instability and significant variation in atmospheric deposition during plant development during warm periods. From May to June, it was 36 millimeters, which is 65.8 millimeters less than the annual average.

Table 2. The indicators of potential productivity of the grape plants in experimental plots

Option	Quantity, pieces / one bush				Coefficients	
	Glazkov	Normally developed shoots	Fruit-bearing shoots	Inflorescences	K_1	K_2
Experience	20.0	18.3	14.1	15.0	0.8	1.1
Standard	19.2	17.7	13.0	14.3	0.81	1.11
NSR_{05}	1.7	0.9	0.9	0.9	0.06	0.11

Notes: *K1* – fruiting coefficient;

K2 – the coefficient of fruitfulness.

Source: compiled by the authors.

When harvesting the technical variety Muscat white, the increase in the average weight of the bunch of grapes in the experiment by 16.2 % (up to 172.3 g) in the comparison with the standard (148.3 g, Table 2). At the same time, the increase in grape yield was 0.9 t/ha or 18.4%.

We also observed the intensive accumulation of sugars at the stage of the grape maturation (20.4 and 19.8 g/100 cm^3).

Table 3. The influence of microfertilizers on the economic performance of grape berries

Option	Average cluster mass, one gram	Total clusters, pieces / one bush	Yield level, kilogram / one bush	Yield level, ton / one hectare	Carbohydrate content, gram / 100 cm^3
Experience	172.3	17.0	2.45	5.8	20.4
Standard	148.3	14.3	2.2	4.9	19.8
NSR_{05}	5.9	0.9	0.12	-	0.4

Source: compiled by the authors.

The values of the indicators in Table 3 show that in the experimental variants the grape yield increases. Also, the quality of fruits by the weight of grapes is also significantly higher. The yield of carbohydrates is also significantly higher. Therefore, the experiments carried out and their results are useful in economic use.

Similar field experiments and observations were carried out in 2020-2023 in other types of landscapes and agroecosystems using the example of the Lower Volga Region, Middle Volga Region, Black Earth Region, region of the Non-Black Earth of Russia, Caucasus Region and other territories. Similar results were obtained against the background of summer heat and aridization. Microfertilizers show their environmental and economic efficiency and soil-improving effect. The applied methodological approach and idea are also relevant for arid, semiarid and subhumid landscapes in different natural zones and physiographic provinces. It is possible to engage in farming even on soils that are poor in composition and saturation of plant nutrients. Anthropogenic-technogenic phenomena unfavorable for soils and soil biota are also limited.

The microfertilizers used are unique example of the organic farming in conditions of variability and aridity of the weather and climatic factors. Many morphological, agrophysical and agrochemical properties of the soils used are improved. In some cases, the level of the soil fertility increases by 7-10 percent or more. On average, up to 10-20 percent of the soils contain nutrients higher than nutrients. The level of the carbon sequestration in the soils increases by 1.1-1.5 times. The increase in the productivity of above-ground plant biomass, inclusive of increasing the yield and quality of berries of cultivated plants, indicates the optimization of their growth and development and the sustainable deposition of the organic carbon in the phytomass. Thus, the fundamental principle of rational, resource-saving and resource-producing environmental management in crop production is implemented. Thus, obtaining high and high-quality yields of economically important plants is quite possible by improving the ecological and resource qualities of soils. Moreover, this can be achieved against the backdrop of adverse consequences from the interregional and global climate with the trend towards desiccation of the air basin and soil drought, and the decrease and deficiency of the atmospheric precipitation. Thus, by managing the ecological and agrochemical status of soils with appropriate agrotechnical measures, it is possible to involve land with signs of depletion and degradation, alienated and waste lands, into crop production.

The practice of viticulture on the territory of the Crimean Peninsula is very significant. But it is necessary to take into account the complex of the environmental factors and indicators of developmental biology and conditions for ensuring high yields.

This has been realized by the conducted research and observations. Therefore, the goal of the work has been fully achieved.

The experiments performed and the results as the research basis are aimed at facilitating the passage of the main phenological phases by grape plants. Particular importance is attached to ensuring sustainable and abundant fruiting, as well as monitoring this process. The fact is that this cultivated plant also requires increased economic and labor costs (Sharma et al., 2020; Ullah et al., 2022). However, many authors (Agaev, 2002; Amirdzhanov, 1980; Antoce & Cojocaru, 2018; Doroshenko & Maksimtsov, 2016; Modonkaeva, 2012; Negrul et al., 1955; Perstnev, 2001; Potapov et al., 2000; Samaha et al., 2018; Seckin et al., 2023; Sharma et al., 2020; Tseyko, 1967; Ullah et al., 2022) note the relevance and need to optimize the growth, development and fruiting of grapes. Indeed, many scientists have noted the advisability of studying and analyzing the role of the weather and climate change on the development and productivity of the grapes [Modonkaeva, 2012; Seckin et al., 2023; Tseyko, 1967; Ullah et al., 2022), as well as on the economic qualities of the fruits and subsequent products from them (Agaev, 2002; Antoce & Cojocaru, 2018; Doroshenko & Maksimtsov, 2016; Modonkaeva, 2012; Perstnev, 2001; Sharma et al., 2020). The same applies to the number of other berry crops.

The number of important points can be added. Some plant representatives are promising for wider cultivation on used and degraded lands, as well as on some alienated and reclaimed

territories. This applies to the number of the wild and the number of not very common cultivated plants with unique medicinal, culinary, spicy, essential oil, melliferous, ornamental and/or other economically valuable characteristics: *Allium ursinum*, *A. victorialis*, *Alliaria petiolata*, *Origanum vulgare*, *Fragaria vesca*, *Rumex acetosa*, *Rheum officinale*, *Mentha aquatica*, *M. spicata*, *Corydalis cava*, *Thymus serpyllum*, *T. vulgaris*, *Pulmonaria officinalis*, *Viola odorata*, *V. tricolor*, *V. lutea*, *Hepatica nobilis*, *Eruca sativa*, *Brassica juncea*, *Melissa officinalis*, *Coriandrum sativum*, *Apium graveolens*, *Beta vulgaris subsp. vulgaris var. vulgaris*. Traditional food and medicinal crops can be grown everywhere, even on environmentally and economically problematic lands. In the conditions of the instability of the soil moisture, precipitation deficiency, occasional atmospheric droughts, and intense wind conditions, it is a priority to provide cultivated plants with the bioclimatic optimum at the levels of occupied plant layers, as well as the ground layer in the corresponding created cultural phytocenoses.

The applied method of bioecologicalization of land use may be of interest when growing other types and varieties of berry crops and when planning other types of crop production. It is obvious that our method of bioecologization of agriculture allows plants to overcome unfavorable meteo-climatic and edaphic factors. This manifests itself, among other positive bioecological and economic benefits, in increased plant productivity and improved fruit quality.

We believe that optimization and stabilization of the soil and ecological conditions in croplands is of great importance in this matter. The methods of the organic farming and, inclusive, biologization determine the most favorable biogeochemical background of soils for the realization of the biological and economic qualities by the cultivated plants.

The great importance of our work lies in the implementation of conditions for improving and protecting soils, creating conditions for an ecological optimum for plant development and increasing the productivity of agrophytocenoses. The farming method we have considered implements the principle of rational bioresource management and land use. The use of microfertilizers helps to increase the resource and economic qualities of cultivated plants, improve the resource qualities and ecological state of soils, carbon sequestration, and the general increase in the pool of carbon and other nutrients in soils. The conditions for sustainable agricultural crop production, ensuring the environmental and toxicological safety of agricultural food products, food and economic security in subhumid, semi-arid and arid landscapes with unstable and unfavorable manifestations of meteorological factors are also being implemented.

After all, the general trend of climate change initiates aridization of the environment, destruction and degradation of soils through the transformation of relevant meteorological processes, as well as with an increase in economic and technogenic pressure on phytocenoses and landscapes. Therefore, methods of organic farming and, inclusive, bioecology in crop production can significantly reduce dependence on hydrological and weather conditions, global and regional climate changes and ecological transformation of landscapes.

4 Conclusion

The most important qualitative biochemical parameter of the grape harvest (and other berry crops) is its sugar content (carbohydrate content). The mass concentration of carbohydrates during the harvesting period was relatively high and amounted to 20.4 grams and 19.8 grams (on the reference).

Research on the biological regulation of the use of fertilizers on the grapes of the companies "Agrinos" and "Lima-Europe" in the considered landscapes of the northern region of the Black Sea on the technical variety "Muscat White", revealed their impact on showed their impact on the quantitative and qualitative parameters of the fruit (and in general, the yield) of the berry crop in question. This is very significant and interesting in the overall economic and environmental aspect. In the experimental version, the significant increase in the average mass of the bunch of grapes was noted (by 24 gram). At the same time, the increase in yield was 0.9 t/ha (18.4 %) compared to the standard.

The introduction of the microfertilizers of the certain micro – and macronutrient composition during foliar top dressing in the most important physiological phases of the grape plant increases

the stress resistance of the grape plants and contributes to the formation of the necessary quality of the crop.

The determination of the environmental conditions is of great importance for determining the productivity of the plants with special economic characteristics. In this case, we are talking about grape bushes. Indeed, in the conditions of the Crimean Peninsula, vineyards can feel good. To do this, it is important to take into account weather, climatic, landscape and environmental factors. It is also necessary to take into account the species and varietal bioecological characteristics of agricultural plants, which affects the economic qualities provided that microfertilizers are used.

In the warm and arid climate, it was important to determine the productivity of vegetative and generative organs, which indicates the yield of the grapes. Statistically significant results were obtained. They are relevant and may have broad economic significance. Research in this area continues. In general, the plants of the agricultural crop under consideration have high bioecological stability, high productivity and economic prospects. This valuable berry crop is recommended for general cultivation, including in sub-humid regions and in regions with aridization of weather conditions and climate.

It is absolutely necessary to develop food crop production in arid regions. To do this, it is necessary to correctly select fertilizers, agricultural equipment and focus on the biological and ecological characteristics of the cultivated plants themselves. Indeed, viticulture has prospects in the above and other regions.

Taking into account meteorological conditions is important in plant growing practice. It is important to indicate the following. The processes of aridization and desertification are distinct not only in the south of the Russian Plain. This was previously thought. But in other territories, arid phenomena occur frequently. Currently, in vast areas of semiarid regions and even in sub-humid regions (and in some cases in areas of the humid zone) of the East European Plain, unfavorable conditions for crop production are occurring. Also, such meteoroclimatic processes and their variability are cumulative limiting factor for natural vegetation. The aridity of climate change in recent years and the often unreasonable (irrational) nature of land use represent the complex limiting factor in agricultural farming. Unfortunately, aridization of weather and climatic phenomena represents the limiting factor for soil formation and at the same time the destabilizing condition for the ecological and economic functionality and stability of soils.

Rational methods of mechanical tillage of soils and methods of organic farming can to the certain extent minimize and even neutralize the degradation effects on soils and agrophytocenoses. Today, the trend towards organic farming and biologization of agriculture is very relevant and economically significant, taking into account geomorphological, soil-ecological, ecological-geological, hydrographic, weather-climatic and anthropogenic-technogenic factors in almost any area.

As a result, the life cycle of the cultivated plants was optimized with the trend towards increasing resistance to limiting environmental factors and increasing productivity. Growth and development were greatly facilitated. Faster and better fruiting was observed. Not only the yield increased, but also the quality of the crops. That is, both from the economic and hygienic point of view, significant effects are achieved when using the above methods of organic farming. The work is of scientific and applied significance for agriculture, agroecology, bioresource science, and rational land use. The results of the work are of great fundamental importance in general for the biochemistry, physiology and ecology of plants, for the further development of the theory and practice of creating sustainable and highly productive cultural phytocenoses. Taking into account the conceptual framework and practice of adaptive agrolandscape science and rational environmental management, the techniques used make it possible to obtain maximum crop yields per unit of cultivated area. At the same time, plant development is realized within the limits of the ecological and physiological optimum against the background of variability of weather factors, aridization of climatic conditions and degradation phenomena initiated by them in soils. The selected version of fertilizers showed versatility and high efficiency in improving resource qualities and buffer properties, optimizing the ecological regime in soils and optimizing

biogeochemical cycles between soils and agrophytocenoses using the described example.

The environmental problem of depletion and degradation of agricultural lands is especially pressing. Given the limited work on agroforestry and the insignificance of activities to introduce organic farming into crop production practice, the problems of land loss of resource and economic characteristics become more urgent every year. The issue of returning degraded, alienated and reclaimed lands to economic circulation and involvement in agricultural crop production remains open in many territories. Although such lands can be brought into crop production under certain influences through organic farming and the consequences of the bioremediation effect.

Based on the research, observations and analysis of the information obtained, the following can be stated. Using the example of the agricultural plant under consideration, the possibility of managing its bioecological and economic potential is shown. The possibility of improving the agrochemical and ecological qualities of soils under agrophytocenoses against the background of arid weather and climatic conditions and other unfavorable environmental factors has also been identified. Many agriculturally inconvenient lands can be brought into crop production, including through the use of organic farming techniques.

Data availability: The datasets generated during the current study are available from the corresponding author on reasonable request.

Consent to Publish declaration: Not applicable.

Ethics and Consent to Participate declarations: Not applicable.

Competing Interest declaration: The authors declare no conflicts of interest.

References

Agaev, N. A. (2002). Influence of microelements on the yield and quality of grapes. *Horticulture and VIticulture of Moldova*, 8, 41–42.

Agathokleous, E., Frei, M., Knopf, O. M. et al. (2023). Adapting crop production to climate change and air pollution at different scales. *Nature Food*., 4, 854–865. https://doi.org/10.1038/s43016-023-00858-y

Allahverdiev, E. R. o. (2021). Influence of the optimization of the norms of organic and mineral fertilizers on the yield of green mass and indicators of the quality of fodder on stubble crops of mixed crops. *Agrarian Bulletin of the*, 207(4), 2–8. https://doi.org/10.32417/1997-4868-2021-207-04-2-8

Amirdzhanov, A. G. (1980). *Solar radiation and vineyard productivity.* Gidrometeoizdat, Moscow.

Antoce, O. A., & Cojocaru, G. (2018). Characterization of Quality Potential of Feteasca Neagra Grapes Cultivated in Different Romanian Wine. *Regions Agriculture for Life for Agriculture*, 1(1), 238–243. https://doi.org/10.2478/alife-2018-0035

Carbonne, B., Muneret, L., Laurent, E. et al. (2023). Conservation agriculture affects multitrophic interactions driving the efficacy of weed biological control. *Journal of Applied Ecology*, 60(3). https://doi.org/10.1111/1365-2664.14475

Dogadina, M., & Larionov, M. (2020). Optimization of living conditions for seedlings of flowering shrubs. *BIO Web of Conferences*, 25(5), 05012. https://doi.org/10.1051/bioconf/20202505012

Doroshenko, T. N., & Maksimtsov, D. V. (2016). *Fruit growing with the basics of ecology.* KubGAU, Krasnodar.

Galstyan, M. H., Larionov, M. V., Sayadyan, H. Y., & Sargsyan, K. S. (2023). Assessment of Ecological and Toxicological State of Soils and Waters in the Neighborhood of Mining Industry Enterprises in the Armenian Highlands. *Life*, 13(2), 394. https://doi.org/10.3390/life13020394

Gibadulina, I. I., Larionov, M. V., & Maslennikova, N. N. (2022). Anatomical and morphological features of the leaves of Tilia cordata Mill. as an indicator of the adaptive capabilities of the species to the conditions of the urban environment. *IOP Conference Series: Earth and Environmental Science*, 988(3), 082002. https://doi.org/10.1088/1755-1315/988/3/032082

Gromova, T. S., Larionov, N. V., & Larionov, M. V. (2020). Vitality of woody plants as the aggregate basis of the ecological condition of urban and suburban ecosystems of the Khopyor River Region. *Modern Science: actual problems of theory & practice. Series of "Natural and Technical Sciences"*, 7, 20–27. https://doi.org/10.37882/2223-2966.2020.07.11

Iderawumi, A. M., & Kamal, T. O. (2022). Green Manure for Agricultural Sustainability and Improvement of Soil Fertility. *Farming and Management*, 7(1), 1–8. https://doi.org/10.31830/2456-8724.2022.FM-101

Larionov, M. V., & Larionov, N. V. (2018). The composition and characteristics of the dendroflora in the transformed conditions of the Middle Reaches of the River Khoper. *IOP Conference Series: Earth and Environmental Science*, 115(1), 012009. https://doi.org/10.1088/1755-1315/115/1/012009

Larionov, M. V., & Larionov, N. V. (2020). Ecological and aesthetic significance of an auto-trophic component of artificial ecosystems in ensuring of the environmental comfort and the public health protection. *IOP Conference Series: Earth and Environmental Science*, 421(8), 421, 082002. https://doi.org/10.1088/1755-1315/421/8/082002

Larionov, M. V., & Logacheva, E. A. (2020). An ecological analysis of the composition and condition of woody plants in urban and suburban ecosystems of the Khopyor River Region. *IOP Conference Series: Earth and Environmental Science*, 421(6), 062025. https://doi.org/10.1088/1755-1315/421/6/062025

Larionov, M. V., & Volodkin, A. A. (2021). Parameters of the state and biological stability of woody plants from native flora in conditions of artificial and natural phytocenoses. *Natural and Technical Sciences*, 1, 13–16. https://doi.org/10.25633/ETN.2021.01.01

Larionov, M. V., & Volodkin, A. A. (2023). Features of the Territorial Distribution, Composition and Structure of Phytocenoses with the Participation of Fraxinus excelsior, Their Resource Qualities, Ecological and Economic Importance (Southeastern Part of the East European Plain). *Life*, 13(1), 93. https://doi.org/10.3390/life13010093

Larionov, M. V., Dogadina, M. A., Tarakin, A. V. et al. (2021). Creation of artificial phytocenoses with controlled properties as a tool for managing cultural ecosystems and landscapes. *IOP Conference Series: Earth and Environmental Science*, 848(1), 012127. https://doi.org/10.1088/1755-1315/848/1/012127

Larionov, M. V., Larionov, N. V., Gromova, T. S. et al. (2020). Factors of soil and atmospheric air degradation and their influence on the state of plants in urban and suburban ecosystems. *Samara Journal of Science*, 9(2), 78–85. https://doi.org/10.17816/snv202113

Lebedev, V. M., Lebedev, E. V., Sorokopudov, V. N., & Larionov, M. V. (2023). Root Nutrition, Photosynthesis, and Net Primary Production in Tree Stands of the genus Picea at the Organism Level within the Range in Russia. *Lesnoy Zhurnal - Forestry Journal*, 1, 38–50, WOS:000946351400003. https://doi.org/10.37482/0536-1036-2023-1-38-50

Leong, Y. E., Tan, J. L., & Kwong, P. J. (2022). Knowledge and Acceptance Level of Vegetable Farmers on Organic Farming and Biological Control in Kampar, Perak. *ASM Science Journal*, 17(1). https://doi.org/10.32802/asmscj.2022.941.

Longhui, Y., & You, H. (2021). Effects of cold-season green manure on soil biochemical properties and the microbial community in a Castanea henryi orchard, China. *Acta prataculturae Sinica*, 30(11), 62–75. https://doi.org/10.11686/cyxb2021177

Losev, A. P. (1994). *Workshop on agrometeorological crop production*. Gidrometeoizdat, St. Petersburg.

Lubimov, V. B., & Larionov, M. V. (2016). Prospects Of Employing The Ecological Method Of Plant Introduction While Establishing The Man-Made Ecosystems Of Different Designated

Use. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 7(4), 1481–1486, WOSUID: WOS:000410760200192.

Lukatkin, A. S., Levin, V. K., Leshchankina, V. V., Silaeva, T. B., Kolmykova, T. S., Barmin, N. A., Chugunov, G. G., & Pervova, A. Ya. (2005). *Field methods for plant research*. Mordovian University, Saransk.

Meco, R., Moreno, M. M., Lacasta, C., & Valencia, M. (2013). Efect of organic barley-based crop rotations on soil nutrient balance in a semiarid environment for a 16-year experiment. *Applied and Environmental Soil Science*, 2012, 1–8. https://doi.org/10.1155/2012/826236

Melnik, A. F. (2020) Influence of climate aridity on technologies cultivation of winter wheat. *Bulletin of Agrarian Science*, 1(82), 41–46. https://doi.org/10.15217/48484

Meneguzzo, F., & Zabini, F. (2021). Sustainable Crop Protection and Farming. In: *Agri-food and Forestry Sectors for Sustainable Development*. *Sustainable Development Goals Series.* Springer, Cham. https://doi.org/10.1007/978-3-030-66284-4_5

Modonkaeva, A. E. (Ed.). (2012). *Methodological recommendations for the evaluation of technical grape varieties*. NIViV "Magarach", Yalta.

Negrul, A. M., Chigrin, V. N., & Kuzmin, A. Ya. (1955). *Culture of grapes.* Sel'hozgiz, Moscow.

Osland, M. J., Chivoiu, B., Feher, L. C., et al. (2023). Plant migration due to winter climate change: range expansion of tropical invasive plants in response to warming winters. *Biological Invasions* 25 2813–2830. https://doi.org/10.1007/s10530-023-03075-7

Perstnev, N. D. (2001). *Viticulture.* Tipografia centrala, Chisinau.

Pleshakova, E., Ngun, C., & Reshetnikov, M. (2021). Evaluation of the ecological potential of microorganisms for purifying water with high iron content. *Water*, 13(7), 901. https://doi.org/10.3390/w13070901

Polous, G. P., & Voiskovoy, A. I. (2013). *Basic elements of field experience methodology*. AGRUS, Stavropol.

Potapov, V. A., Faustov, V. V., & Pilshchikov, F. N. (2000). *Fruit growing*. Kolos, Moscow.

Samaha, C., Sassine, Y., & El Sebaaly, Z. (2018). Effect of lithovit amino 25 (organic nitrogen fertilizer) on seedless table grapes cultivated under greenhouse and in open field (thesis). https://doi.org/10.13140/RG.2.2.30806.70723

Sargsyan, K. S., Tovmasyan, G. A., Gharakhanyan, K. A., Yeghiazaryan, A. G., & Galstyan, M. H. (2025). Ecological state of the natural and agricultural phytocenoses as the marker of ecosystem services: Taking into account differences in natural and anthropogenic conditions under global climate change. *J. Geogr. Sci.*, 35(11), 2335-2362. https://doi.org/10.1007/s11442-025-2415-3

Savina, K., Kosarev, A. V., Mikerov, A. N., & Pankratova, Yu. (2022). A Dynamics of the parasitological state of drinking water sources of the population in the conditions of climate aridization. *Sanitarnyj vrač (Sanitary Doctor)*, 8, 547–560. https://doi.org/10.33920/med-08-2208-03DOI:10.33920/med-08-2208-03

Seckin, G. U., Taşeri, L., Gülcü, M. et al. (2023). Medium Humidity Grape Production and Determination of Storage Conditions. *BAHÇE*, 52 (Özel Sayı 1), 221–226.

Sharma, A. K., Upadhyay, A. K., & Upadhyay Somkuwar, R. G. (2020). Grape growing: Opportunities for better returns. *Progressive Horticulture*, 52(2), 134–143. https://doi.org/10.5958/2249-5258.2020.00018.4

Siraeva, I. S., Larionov, M. V., & Larionov, N. V. (2020). Environmental assessment of health indicators of woody plants in natural and man-made conditions. *Samara Journal of Science*, 9(1), 100–106. https://doi.org/10.24411/2309-4370-2020-11116

Slavskiy, V., Litovchenko, D., Matveev, S., Sheshnitsan, S., & Larionov, M. V. (2023). Assessment of Biological and Environmental Factors Influence on Fire Hazard in Pine Forests: A Case Study in Central Forest-Steppe of the East European Plain. *Land*, 12(1), 103. https://doi.org/10.3390/land12010103

Slavskiy, V., Matveev, S., Sheshnitsan, S., Litovchenko, D., Shokurov, A. et al. (2024). Assessment of Phytomass and Carbon Stock in the Ecosystems of the Central Forest Steppe of the East European Plain: Integrated Approach of Terrestrial Environmental Monitoring and Remote Sensing with Unmanned Aerial Vehicles. *Life*, 14(5), 632. DOI: https://doi.org/10.3390/life14050632.

Tseyko, A. I. (1967). Methodology for constructing field experience in viticulture with a given (increased) accuracy. *Proceedings of the FSBSI Magarach*, 16, 83–86.

Ullah, S., Hussain, A., Rajwana, I. A. et al. (2022). Standardization of Growing Media for Grapes Nursery a Production. *Journal of Plant and Environment*, 3(2), 115–124. https://doi.org/10.33687/jpe.003.02.3788

Unger, M., & Lakes, T. (2023). Land Use Conflicts and Synergies on Agricultural Land in Brandenburg, Germany. *Sustainability*, 15(5), 4546. https://doi.org/10.3390/su15054546

Uranov, A. A. (1964). *Observations on summer field practice*. Prosveshchenie, Moscow.

Vedernikov, K. E., Bukharina, I. L., Udalov, D. N., Pashkova, A. S., Larionov, M. V. et al. (2022). The State of Dark Coniferous Forests on the East European Plain Due to Climate Change. *Life*, 12(11), 1874. https://doi.org/10.3390/life12111874

Volodkin, A. A., & Larionov, M. V. (2021). Changes in the Structure of Forest Communities in Penza Region under the Influence of Natural Factors. *IOP Conference Series: Earth and Environmental Science*, 808(1), 012064. https://doi.org/10.1088/1755-1315/808/1/012064

Volodkin, A. A., Volodkina, O. A., & Larionov, M. V. (2022). Dynamics of reproduction of forest plantations in the forest-steppe zone of the Middle Volga Region. *IOP Conference Series: Earth and Environmental Science*, 979(1), 012101. https://doi.org/10.1088/1755-1315/979/1/012101

Voronin, P. Yu., Konovalov, P. V., Bolondinskii, V. K., Kaipiainen, L. K., & Mao, Z.-J. (2005). Decline in the Primary Productivity of Northwestern European Forests as a Consequence of Climate Aridization. *Russ J Plant Physio*, 52, 454–458. https://doi.org/10.1007/s11183-005-0067-9

Yadav, M. K., Satapathy, S., Das, P. et al. (2023). Ecological Interactions of Invasive Insects and Native Plant Species in Changing Climate. *Journal Of Advanced Zoology*, 44(S-5), 190–199.

Yeghiazaryan, G. M., Galstyan, M. H., Sayadyan, H. Y., Paronyan, A. M., Hakobjanyan, I. L., et al. (2025). The influence of the hydrogel on quality of the soil resources, on the bioecological properties of plants and on the productivity of cultural phytocenoses against the background of arid weather and climatic anomalies. *Journal of the Saudi Society of Agricultural Sciences*. https://doi.org/10.1007/s44447-025-00078-9.

Zolotokrylin, A. N., & Cherenkova, E. A. (2009). The area of the dry plain lands of Russia. *Arid Ecosystems*, 1, 5–12.

Zolotokrylin, A. N., Cherenkova, E., & Titkova, T. B. (2018). Bioclimatic Subhumid Zone of Russian Plains: Droughts, Desertification, and Land Degradation. *Arid Ecosystems*, 1, 7–12. https://doi.org/10.1134/S2079096118010122