Effect of Climate Change on Pedological Modifications and Soil Aridity Process in Vineyards

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The general warming of climate disturbed the evolution of natural factors: water and soil, climate changes in the vineyard ecosystems and the summers became hotter and drier, the autumns are longer, the winters are shorter and seldom excessive, droughts are common and wet periods are excessively rainy. Soil contains plant nutrients, minerals, organic matter and seeds. It can also contain pesticides and toxic heavy metals. Building disturbs and loosens soil and can create large volumes of dust and debris. We consider that the results of these researches will have a special utility for both private farmers and companies, because in this area of NE region of Romania the viticulture has tradition and brings important income to growers. The goal of this paperwork was to analyses the influence of some factors such as variety of grapes and applied agro techniques on the growth and development of the grapevine and especially the impact of the applied technology on the productive potential of the surface unit, in order to improve some maintenance technologies of this species and the choosing of the best varieties which respond the best to the climate changes. The suitability of the grapevine culture results from the interference of the main ecological requirements of the species: light (light energy), temperature (solar energy), water (soil and air humidity), soil (root culture medium), nutrients and the air (the composition) for growth and development and the natural setting, which the area can offer to the studied species. The crop yield depends primarily on variety, on the interaction with the pedo - climatic factors and the applied technology. The necessity of the chosen topic is justified by the importance of the technological factors on the grapevine culture.

Keywords: climate changes, soil, aridity, evolution, productivity, vineyard ecosystems, growers, maintenance technologies

In the paper is mentioned *the warming of the climate system is unequivocal, as shown by the observations on increasing of air and oceans temperature, massive melting of glaciers and on the global raising of the average sea level.*

The climate change and the degradation land phenomena due to the human activities are in present a certainty. Aridity and even desertification are present in Romania [1].

Viticulture conveyor that constructs the assortment of grape varieties was improved by creating new varieties with early maturing age, with better adaptability to the ecosystem in which they were created, with superior characteristics of production and quality due berry and grapes size, core consistency and diversified skin coloration shaded in different colors, making them attractive to consumers. The first varieties of grape-vines with known genetic origin, they have been created since the sixth decade of the last century, and outstanding achievements obtained in improving varieties were presented and published over the years, through many specialty papers, over the years [2].

The assessment of the vulnerability of cultivation has been the object of numerous studies based on eco-physiological models [3].

It should be emphasized that Romania has an Integrated national system for soil monitoring, surveillance, control and decisions to reduce the share of pollutants resulting from agricultural and management sources of organic residues resulting from animal husbandry services in vulnerable and potentially vulnerable areas to nitrate pollution, within the structures of the National system on the integrated monitoring of water resources and of protected areas, managed by the National Research and Development Institute for Soil Science, Agro-chemistry and Environment. Romania receives funds through the European Economic Recovery Plan (EERP) in order to comply with the priorities established through the Health Balance of the Common Agricultural Policy (CAP) [4].

According to the IPPC, the *concentrations of CO_2 and methane have increased by* 36 and 148% r*espectively* from 1750 to 2007, higher than any time in the last 600,000 years. Furthermore, readings at Mauna Loa, the world's *benchmarksite* for CO_2 readings, showed atmospheric CO_2 surpassing 400 ppm for the first time in 4.5 million years, an alarming level. The IPCC warns that current models suggest by the year 2100 the atmospheric concentration of CO_2 could range between 541 and 970 ppm, an increase of nearly 250% since1750. Non CO_2 gases (dark soot, ozone, and hydro flour carbons),which recent research causes just under half of current global warming, are up appreciably, as well [5].

Climate changes that have occurred in recent years, showed a national average warming of 0.3°C, more pronounced in the eastern half of the country and a lower rainfall regime [6, 7].

Also, in the Technical Report no. 13/2007 [8] of the European Environment Agency entitled *Climate change:*

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the cost of inaction and the cost of adaptation is stated that an increase of two Celsius degrees above the normal temperature will significantly increase the risk of climate change in a dangerous and unpredictable way, and also will increase the adaptation costs.

If between the end of the XIX-th century and the year 1975 the global warming was slow with large fluctuations, lately, especially after 2002, it accelerated considerably. In the first half decade of the XXI century the warming has an increasing rate of 0.2°C/decade [9].

The consequences of global warming were manifested in the main wine regions of the world. Analyzing the recorded temperatures during the vegetation period of the grapevine in 27 wine regions in the world, producing quality wines, found that the average temperature in the vegetation period increased by 1,3°C in the last 50 years [10-12].

The warming was not uniform on the Globe; a pronounced warming being recorded in the west regions of the USA and in Europe, while in Chile, South Africa and Australia the warming was lower. The highest increase of the average temperature was recorded in Iberian Peninsula, the south of France and California, where the increasing was greater than 2.5°C.

The consequences for the grapevine are obvious: prolonged vegetation period makes the grapevines to enter the winter unprepared; high heat of August and of the beginning of September *burn* the grapes and block the accumulation of sugars, the grapes maturation being *forced*, the grapes are depleted by the natural components responsible of wine quality (flavors, polyphenols, hydroxyl acids and so on).

The modification of the spectral composition of the light in the favor of UV radiations, more aggressive for the grapevine; the consequences was to blocking the enzymatic mechanisms for the production of polyphenol compounds in grapes and increased the CO_2 concentration [13].

Also, the climate change in the latest period, which led to modification of the indices used in establishing the viticulture vocation regions [6, 7], on the borderline culture of the grapevine, prompted us to study the eco-climatic conditions from three areas of culture, the vineyards: Iasi, Cotnari and Dealurile Bujorului, in order to promote and recommend the spreading in culture of these varieties.

The global warming produced many disturbances in the vineyard ecosystems, the grapevine varieties being forced to modify their annual cycle of vegetation, most of the time with negative consequences on the quality and quantity of grape production, including on the resulted wines [14-16].

The analysis of the climate change has an important role due to the different implications on the agricultural systems and *on pedological modifications and soil aridity process in vineyards*, in function of the climate conditions, soil characteristics and the territorial systems capacity ability to cope with change [15-17].

Already there have been observed negative effects of the climate change in some vineyards on the Globe, like: early ripening of the grapes, loss of acidity through respiration and a greater accumulation of sugars [18].

Because the global warming affects the normal development of the phonological phase of the grapevine, both at continental and regional level, a reassessment of the use of land is required, based on a detailed pedo-climatic study. Also is required the implementing of a viable vineyard strategy against future climate changes [19, 20].

Also, if the harvesting takes place earlier than usual (August or September, instead of October in the northern hemisphere), and the crop isn't irrigated, the grapes will be dehydrated [21].

The importance of understanding the impact of the climate change is the most significant in grapevine culture, where the most valuable varieties of grapes were obtained in different geographical regions; the global warming shortens the vegetation cycle of grapevine with 6-25 days to the many varieties and locations [21].

The predicted changes in the European viticulture regions in the next decades can significantly alter the spectrum and the distribution of existent varieties and also the tillage, which must be adapted depending on the decreasing of soil humidity and the content of organic matters [20-26].

The increase of temperature, the intensity of solar radiation and the content of UVB will affect the quantity and the quality of the grape production and the water shortage will become a limiting factor for the quantity and the quality of the wine [27].

The global warming produced many disturbances in the vineyard ecosystems, the grapevine varieties being forced to modify their annual cycle of vegetation, most of the time with negative consequences on the quality and quantity of grape production, including on the resulted wines.

Taken into account the importance of the grapevine culture in the researched area, the favorable ecological conditions of the area for this variety, the age in culture and the existent tradition, also the necessity of the continuous improvement of the existing varieties, during the study we planned to reach the following objectives:

- the completion of assortment with the best varieties, well adapted to the local ecological conditions;
- the calculation of the economic efficiency on grapevine varieties in order to capitalize this culture;
- he economic optimization of the technologies at the grapevine varieties.

Experimental part

Materials and methods

This study climatic them prepared at the request of University of Agricultural Sciences and Veterinary Medicine (Veterinary Medicine) Ion Ionescu de la Brad University also aims spatial-temporal variability of meteorological parameters in the range from 1990 to 2016 in the eastern part of Romania, respectively in the complex morpho-structural subunits of the Moldavian Plateau represented by hills Moldavian Plain, Barlad Plateau and Covurluiului hills.

The following parameters were taken into consideration for a period of 52 years (1961-2016): the average annual temperature; the average temperature during the growing season (IV-X); average temperature of the hottest month (July or August) and on seasons (spring III-V, summer VI-VIII, autumn IX-XI and winter XII-II); annual precipitations, during the growing season and on seasons.

Using the information from a long term experience (2001-2016), a series of correlations were established between: precipitations and the wood eliminated annually after pruning; average temperature during growing season (IV-X) and sugars accumulated in grapes; average temperature during summer (VI-VIII) and sugar concentration; average temperature during the hottest month (VII or VIII) and titratable acidity; rainfall in summer (VI-VIII) and sugars; annual rainfall and titratable acidity. Also, were analyzed studies and studies prepared for the area studied, some of which are mentioned in the bibliography.

Results and discussions

The analysis of the physical production (obtained and sold) in terms of volume, was carried out on each variety of

grapevine over three years, the production being expressed in natural and conventional units, as appropriate. It can be specified that the production expressed in conventional units represents the most concluding index of physical production as a useful economic effect, because as it's already known, it takes into account the quality of production, respectively its use value [28].

The recorded variation of physical production on product, compared to criteria used, was calculated both in absolute numbers and in relative numbers (percentage) – the version in percentage being always more relevant, more intuitive, because it reflects the rhythm of the recorded modification, the proportion of this modification is necessary to capitalize on the market larger amounts from the obtained physical production of each product.

Another issue in the case of sustainable development is connected to the gas emissions and the greenhouse effect. Of the pollutants regulated by the Kyoto Protocol, in Romania one finds the following emissions of gases causing the greenhouse effect: carbon dioxide, nitric oxides and methane, with more gases to be included in this list in the future (Fluor hydrocarbons, per fluorocarbons and sulphur hexafluoride).

Taking into account the existing data, presented in the national report of Romania regarding the modality of applying the provisions of the convention for climate changes, there is a real capacity to use specific mechanisms to apply the provisions in the Kyoto Protocol [30].

Statistics show that in the Romania of the *transition period* (mainly between 1989 and 2000), the large-scale reduction of economic production in the majority of heavily industrialized areas and the closing down of numerous factories meant a decrease of over 50% in the emissions of industrial pollutants. Unfortunately, these are only isolated cases, and the causes of these reductions are not always beneficial for Romanian economy.

As member of European Union, in the period 2007-2014, Romania has received 4.512 bilions Euros from EU by structural and cohesion funds for investments in environmental projects. Investment in environmental projects were developed through the Operational Programme Environment 2007-2014 (SOP ENV) [30].

To accomplish high income, both to cover the expenses and to create a development fund for the continue upgrading of the material base and the improvement of technology, were cultivated varieties of grapevine that are

Table 1
THE MAIN ECONOMIC INDICATORS OF THE GRAPEVINE VARIETIES IN VINEYARD COTNARI (2016)

Variety	Production tone/ha	Differences from the average RON	Selling price RON (produce)	Income from sale RON	Expenses RON/ ha	Profit RON/ ha	Profit rate %	The difference compared to the control variety
Feteasca alba	7.50	-0.90	2.31	8662	4815	3847.5	79.91	0.00
Grasa de Cotnari	7.10	-1.30	2.30	8165	4958	3207	64.68	-15.22
Francusa	10.50	2.10	2.20	11550	5550	6000	108.11	28.20
Tamaioasa romanesca	8.50	0.10	2.20	9350	5100	4250	83.33	3.43
Average on species by area	8.40	0.00	2.25	9431.8	5105.75	4326.13	84.01	4.10

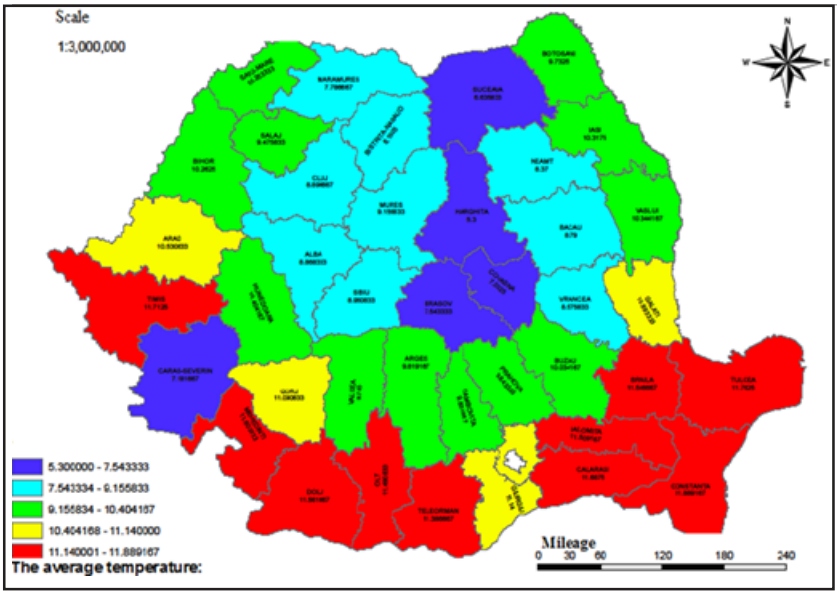

Fig. 1. Map of average temperature in Romania

Greenhouse gases	2000	2005	2015
Reference scenario			
CO_2 total emissions	162334.8	187794.0	228535.7
CH_4 total emissions	33531.0	36740.0	43125.0
N_2O total emissions	8480.0	10240.0	12704.0
total emissions	204345.8	234774.0	284364.7
Minimum scenario			
CO_2 total emissions	158445.9	178926.0	201547.5
CH_4 total emissions	33445.0	33712.0	36368.0
N_2O total emissions	81280.0	9024.0	10112.0
total emissions	200019.0	221662.0	247927.5
Maximum scenario			
CO_2 total emissions	150807.9	156432.0	167655.5
CH_4 total emissions	32879.0	32164.0	32227.0
N_2O total emissions	7744.0	7904.0	8256.0
total emissions	191430.9	196500.0	209138.5

Table 2
THE GREENHOUSE GASES EMISSIONS (GG CO_2 EQUIVALENT/YEAR)

Data provided by National Research and Development Institute for Soil Science Agrochemistry and Environmental Protection

required on the market and have a high degree of capitalization: Francusa, Tamaioasa romaneasca, Feteasca alba, etc.

Therefore, the use of varieties with a high biological potential, resistant to diseases and pests, well adaptable to the local pedo-climatic conditions, as well as the applying of an appropriate culture technology have made possible the achievement of a production at an established quantitative level, and positive results for most varieties of grapevine taken into consideration.

On the other hand, the use of varieties resistant to diseases and pests is particularly favorable because is eliminated the use of some chemicals to combat pathogens and pests, which are very expensive.

To this add getting healthy products, free of chemical residues, the diminishing of pollution and the protection of the consumers.

For some varieties: Grasa de Cotnari, the profit rate is lower than the control variety due to mismatch between the applied technology and the harvest.

Profitability per hectare doesn't mean any cost savings at the expense of production, but by expenditure on rational and economic way to increase production, that the product units have a cost as low as possible. In other words, if the production intensifies, the economic efficiency increases, too.

Our studies have shown, especially in the last decade, an outrunning of the vegetative phenological phase of the grapevine, with one-two weeks for burgeoning and flowering and with two-three weeks for grape ripening (table 3).

Table 3
THE ON-GOING THE OF VEGETATIVE PHENOLOGY PHASE IN THE MAIN VINEYARDS IN ROMANIA
(THE MULTIANNUAL AVERAGE/ THE AVERAGE YEARS 2002-2016)

Vegetative phenological phase	Vineyard							
	Iasi	Odobesti	Bujoru	Murfatlar	Dealu Mare	Minis	Blaj	Dragasani
The start of buds development	6.05-16.05	10.04-7.05	30.03-16.05	9.04-6.05	12.04-30.04	15.04	8.04-9.05	30.03-2.05
	14.04-29.04	7.04-27.04	5.04-4.05	9.04-5.05	8.04-30.04	3.04-25.04	2.04-24.04	29.03-28.04
Blooming	20.05-28.06	24.05-14.06	22.05-31.06	20.05-15.06	1.06-15.06	10.06-15.06	26.05-28.06	23.05-14.06
	3.06-18.06	17.05-10.06	23.05-12.06	23.05-15.06	20.05-10.06	13.05-20.06	27.05-22.06	21.05-9.06
Ripe	26.07-5.09	17.07-23.08	20.07-22.08	8.08-28.08	4.08-18.08	10.08-25.08	26.07-10.09	4.07-22.08
	23.07-25.08	28.07-24.08	18.07-14.08	6.08-27.08	25.07-20.08	21.07-17.08	25.07-28.08	2.07-20.08
Maturation	5.09-16.10	5.09-28.10	23.08-23.10	4.09-6.10	9.09-26.09	28.08-20.10	11.09-19.10	5.09-11.10
	27.08-4.10	10.09-2.10	25.07-28.09	8.09-24.09	15.09-30.09	23.08-5.10	17.09-8.10	16.09-10.10

Variety	Fertile shoots %	Fertility coefficient FCA FCR		Productivity index PAI PRI	
Paula	33	1.0	0.45	205	92
Gelu	47	1.15	0.55	230	110
Aromat de Iasi (control)	52	1.25	0.73	200	116

FCA – fertility coefficient absolutely, FCR – fertility coefficient relative
PAI – productivity absolutely index, PRI –productivity relative index

Table 4
FERTILITY AND PRODUCTIVITY OF STUDIED VARIETIES, IN IASI-COPOU VINEYARD CENTER

The impact of the climate change was beneficial for the accumulation of sugars in grapes, registering negative effects in terms of grape acidity and the content of anthocyanin and flavones, which have shown significant decreases especially in the viticulture areas affected by the drought and/or extreme temperatures during August and September.

Research on the phenophases sequence and physiological perfection completed by the studied varieties, in relation to ecological factors characteristic for 2015, shows that the phenophases of vegetation were conditioned by the level and cumulative action of climatic factors and by the hereditary specific of the variety. The bud bursting occurred for Paula variety on th th April 25 2015, followed by Gelu variety, on 26 April 2015, both after Aromat de Iasi, on 23 April 2015 (table 4), being influenced by high temperatures in late April.

Flowering took place between 30 May to 2 June, Paula and Gelu varieties being brought forward with 4-7 days towards witness variety and with about two weeks towards normal years. Cold weather and high atmospheric humidity during flowering led to an uneven and closed flowering, and the processes of pollination, fertilization and binding berries have been affected, aspects that will be reflected in the quantity and especially the quality of the production. Grapes variety was marked by Paula variety (9 July), followed by Gelu variety (15 July), and the grapes could be consumed since 8 August (Paula variety) and after 15 August the Gelu variety, while the witness after 25 August. Cycle of active vegetation period at studied varieties totaled 189-192 days, the end of vegetation taking place on 3th November due to occurrence of frost. The fertility and the productivity as elements that define the ability of a variety for fructification and production have been strongly influenced by climatic conditions of the year 2015.

The percentage of fertile shoots had values below the potential of each variety, as well the coefficients of fertility and indices of productivity. Compared to the reference variety, Aromat de Iasi, Paula and Gelu varieties had lower fertility, with values of the fertility coefficient absolutely above unit 1.0 or 1.15, and with the relative one of 0.45 and 0.55. The absolute and relative productivity was also small. Cumulative action effect of the climatic factors of stress can be found in grapes production and its quality.

Thus, buds losses due to frosts in winter, cold and wet weather during flowering and berries binding as well as strong drought and hot weather during grapes growth and ripening, have led to lower grapes production, which not reached to the known quality parameters (table 5).

The new varieties of table grapes Paula and Gelu, realized very small productions, far below from normal years values, being strongly affected by winter frost, when a large part of the fruit buds were destroyed. And crop quality 267 was affected mainly by unfavorable conditions during the growing season; the grapes obtained being smaller, by 200 g at Gelu variety and 205 g at Paula variety, with smaller berries. The sugar accumulations were helped by the very hot weather during grapes ripening. The results obtained in 2015 regarding the culture of new varieties for table grapes in Iasi Vineyard, impose mandatory measures to protect the vines in winter by burying the safety canes from the base, ensuring the recovery possibility of vegetative and production potential. Bucur and Dejeu [32] found that under the influence of the variability of climate conditions from one year to another, the vegetative growth, leaf surface area and the accumulation of dry substance in annual organs of the grapevine experienced large variations depending on hydrological and heliothermal regime.

The global warming of the climate, experienced more strongly in the latest years in Romania as in other countries of the world, is a trigger factor of an endless chain of consequences, which affects in a sensitive manner the social economic activities and the quality of life.

By global warming the specialists understand the increasing of the average temperature, recorded in the last two centuries and measured in the very proximity of ground and oceans' water.

In years with high temperatures and hydric deficit, like in periods 2012-2016, the leaf surface area and the dry substance accumulated in the annual organs of the grapevine (wood, leaves and grapes) recorded values lower than half compared to the values in the favourable years (1.73 m^2/vine, comparing with 3-4 m^2/vine and 1.070 g/vine comparing with cu 2.331 g/vine) (tables 6-11).

Table 5
GRAPES PRODUCTION AND ITS QUALITY DURING YEAR 2015 IN IASI-COPOU VINEYARD CENTER

Variety	Grapes production			Quality of production			
	Effective kg/vine	Calculated t/ha	Wares %	Average weight of 100 berries,g	Average weight of 100 berries,g	Sugars g/L	Total acidity, g/L H_2SO_4
Paula	0.75	2.85	76	205	328	170	2.9
Gelu	2.4	9.1	80	200	318	168	2.1
Aromat de Iaşi (control)	1.71	6.0	65	160	22.0	175	3.5

Table 6

THE VEGETATIVE ELEMENTS OF THE VINE DEPENDING ON THE CLIMATE CONDITIONS (FETEASCA REGALA, 2012-2016) VINEYARD COTNARI

Specification	Load (eyes /m2)	2012	2013	2014	2015	2016
Wood cutting one year removed (kg / vine)	10	0.252	0.890	0.860	1.110	1.152
	15	0.258	1.014	1.330	1.306	1.188
	20	0.375	1.384	1.712	1.465	1.428
Average		0.295	1.096	1.300	1.293	1.256
Leaf area (m2 / hub)	10	1.64	3.25	2.37	3.45	2.85
	15	1.66	3.35	2.53	3.67	4.17
	20	1.90	4.04	3.14	3.65	4.36
Average		1.73	3,54	2.68	3.59	3.79
Total solids accumulated annual bodies (kg / vine)	10	832	2252	1381	1261	2172
	15	1037	2253	1696	1461	2165
	20	1340	2020	1894	1474	2656
Average	1070	2175	1657	1398	2331	

Table 7

TESTING THE EXISTENCE OF CORRELATION BETWEEN YIELDS AND VARIETIES

Specification	Indicator	Yields		
		Yields 2013	Yields 2014	Yields 2015
Yields and varieties of grapes	Pearson Correlation	0.12451203*	0.147277*	0.112574748
	Sig. (2-tailed)	0.038714154	0.014325	0.061331686
	N	276	276	277

*Correlation is significant at the 0.05 level (2-tailed)

Table 8

TESTING THE EXISTENCE OF DIFFERENCES BETWEEN YIELDS OBTAINED VARIETIES (ANOVA)

Yields	Differences	Sum of Squares	Mean Square	F	Sig.
Yields 2013	Between Groups	184.378	6.585	2.051	0.002
	Within Groups	793.125	3.211		
	Total	977.502			
Yields 2014	Between Groups	158.772	5.670	1.739	0.015
	Within Groups	805.604	3.262		
	Total	964.376			
Yields 2015	Between Groups	174.273	6.224	1.898	0.006
	Within Groups	813.220	3.279		
	Total	987.493			

Table 9

TESTING THE EXISTENCE OF SIGNIFICANT CORRELATION BETWEEN YIELDS AND COUNTIES

No.	Correlations	Yields_2013	Yields_2014	Yields_2015
1	Pearson Correlation	0.172**	0.189**	0.217**
2	Sig. (2-tailed)	0.004	0.002	0.000
3	N	276	276	277

**Correlation is significant at the 0.01 level (2-tailed).

Adaptation of Romanian viticulture ecosystems in the new competitive and environmental context of global warming

In terms of hours of sunshine, in 2014 in the NE Region of Romania there were 1854,8 h, comparing with the multiannual of 1795.7 h, with a plus of 59,1 h, especially in April and June. July, August and September were very sunny. Highlighting the significant relationships analyzed variable.

The correlation coefficient indicates the presence of low intensity and direct links between yield and grapes varieties, it having a low value/reduced/little (0.124 in 2013 year, 0.147 in 2014 year, and 0.112 in 2015 year):

- Assumptions: H0: correlation coefficient is not significantly different from zero; the two variables are not significant correlation; H1: the correlation coefficient is significantly different from zero, the two variables there is a significant correlation;

- Sig significance coefficient is lower than the threshold α of 0.05 for the years 2013 and 2014 yields and yields

Table 10
TESTING THE EXISTENCE OF DIFFERENCES BETWEEN PRODUCTS OBTAINED BY COUNTIES

ANOVA		Sum of Squares	Mean Square	F	Sig.
Yields 2013	Between Groups	69.449	13.890	4.130	0.001
	Within Groups	908.054	3.363		
	Total	977.502			
Yields 2014	Between Groups	100.365	20.073	6.273	0.000
	Within Groups	864.011	3.200		
	Total	964.376			
Yields 2015	Between Groups	83.738	16.748	5.022	0.000
	Within Groups	903.754	3.335		
	Total	987.493			

Table 11
TESTING THE EXISTENCE OF THE CORRELATION BETWEEN PRICES AND VARIETIES

Correlations		Price 2013	Price 2014	Price 2015
Price-varieties	Pearson Correlation	0.139*	0.237**	0.272**
	Sig. (2-tailed)	0.020	0.000	0.000
	N	281	281	281

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.10 level (2-tailed)

higher for 2015; rejecting H0 2013 and 2014 and accepted for 2015.

- Interpretation: It can guarantee a 95% probability that the correlation coefficient is significantly different from zero for the years 2013 and 2014, so between vine variety and yield significant correlation exists, but it is not significant for the year 2015, which means that between yield and variety there is a significant correlation.

- Assumptions: H0: between groups composed of each variety no significant differences regarding the return of 2013/2014/2015 years; H1: between groups composed of each variety are significant differences in the yield of 2013/ 2014/2015 years.

- What significance Sig value 0.002/0.015/0.006, lower than the materiality threshold α of 0.05, the null hypothesis H0 and H1 accepted.

- Interpretation: The risk of 5%, we can say that there are significant differences in the yield of 2013/2014/2015 years in the groups formed by each vine variety analyzed.

The correlation coefficient indicates the presence of low intensity and direct links between Yields and counties cultivating vines, this having a low value/reduced/little (0.172 in 2013 year, 0.189 in 2014 year, and 0.217 in 2015 year):

- Assumptions: H0: correlation coefficient is not significantly different from zero; the two variables are not significant correlation; H1: the correlation coefficient is significantly different from zero, the two variables there is a significant correlation;

-Sig significance coefficient is lower than the threshold α of 0.10 for all three years, which means that they reject H0 and H1 accepted.

-Interpretation: It can guarantee a 90% probability that the correlation coefficient is significantly different from zero, so between counties and Yields there is a significant correlation.

- Assumptions: H0: between groups composed of all the regions there are significant differences in terms of product 2013/2014/2015; H1: between groups composed of each county there are significant differences in terms of product 2013/2014/2015.

- How Sig significance value is 0.0005, lower than the materiality threshold á of 0.05, the null hypothesis H0 and H1 accepted.

- Interpretation: The risk of 5%, we can say that there are significant differences in the groups formed yields in years 2013/2014/2015 every county analyzed.

The correlation coefficient indicates the presence of a low intensity direct link between prices and varieties of vine, it having a low value/reduced/little (0.139 in 2013 year, 0.237 in 2014 year, and 0.272 in 2015 year):

- Assumptions: H0: correlation coefficient is not significantly different from zero, the two variables (price

Table 12

THE EVOLUTION OF EXPENDITURE GRAPEVINE VARIETIES RESEARCHED AREAS – ROL*

Vineyard	Variety	Production tone/ha (Year 2016)	Differen-tiation comapre average	Price of sale-ROL	Income from sale ROL	Expenses ROL / ha	Profit ROL/ ha	Profit rate %	The difference from control variety	The difference from the average varieties
Iasi	Feteasca alba	9.50	-0.29	2.31	10972.5	6474	4498.5	69.49	0.00	-13.36
	Feteasca regala	13.60	3.81	2.30	15640	6836.4	8803.6	128.78	0.00	45.93
	Riesling Italian	7.50	-2.29	2.08	7800	4440	3360	75.68	0.00	-7.17
	Babeasca gri	15.80	6.01	2.20	17380	6540	10840	165.75	0.00	82.90
	Grasa de Cotnari	4.90	-4.89	2.20	5390	5385	5	0.09	0.00	-82.75
	Francusa	9.30	-0.49	2.30	10695	6291	4404	70.00	0.00	-12.84
	Tamaioasa romanesca	7.90	-1.89	2.30	9085	5340	3745	70.13	0.00	-12.71
Average of variety on region		9.79	0.00	2.24	10994.6	5900.9	5093.73	82.84	0.00	0.00
Cotnari	Feteasca alba	7.50	-0.90	2.31	8662.5	4815.00	3847.5	79.91	0.00	-4.10
	Grasa de Cotnari	7.10	-1.30	2.30	8165	4958.0	3207.0	64.68	-15.22	-19.32
	Francusa	10.50	2.10	2.20	11550	5550.0	6000.0	108.11	28.20	24.10
	Tamaioasa romanesca	8.50	0.10	2.20	9350	5100.0	4250.0	83.33	3.43	-0.67
Average of variety on region		8.40	0.00	2.25	9431.8	5105.7	4326.13	84.01	4.10	0.00
Bujoru	Feteasca alba	8.20	-2.73	2.30	9430	5860.0	3570.0	60.92	0.00	-21.18
	Feteasca regala	11.30	0.38	2.30	11995	4680.0	7315.0	156.30	95.38	74.21
	Riesling Italian	7.00	-3.93	2.08	7280	5120.0	2160.0	42.19	-18.73	-39.91
	Babeasca gri	17.20	6.28	2.20	8920	5278.8	3641.2	68.98	8.06	-13.12
Average of variety on region		10.93	0.00	2.22	9406.2	5234.7	4171.55	82.10	21.18	0.00

*Own calculations

and variety) there is a significant correlation; H1: the correlation coefficient is significantly different from zero, the two variables (price and variety) there is a significant correlation;

- Sig significance coefficient is lower than the threshold α of 0.05 for the three years prices thus rejecting H0.

- Interpretation: It can guarantee a 95% probability that the correlation coefficient is significantly different from zero for 2013 and with a probability of 90% for the years 2014 and 2015, so between vine varieties and prices are a significant correlation.

The deficient rainfall contribution during the growing season, the diurnal average consumption of the grapevine and soil water evaporation led to a final soil water reserve of 1127 m^3/ha, with a shortage of 726 m^3/ha, compared to the minimum limit of soil moisture (table 11).

The large volume of material and energy consumption and respectively the costs required by this crop imply a good knowledge of the specific production for achieving this culture, and energy consumption depending on the climate, capitalization period, and issues related to market and consumer requirements (table 12).

As shown in certain varieties there are negative differences toward the average varieties in the area and these lead to loss in grapes quality. But as it is known, the price of grapes depends on the quantity of sugar which in turn is dependent on pedo-climatic factors.

Due to the excessive drought during maturation and on the background of beading, grape berries did not reach the size and weight characteristic for the varieties. Small production per trunk was reflected in the quality – the size of the grapes and of the berry. Also in the second decade of September appeared the withering of grapes.

In phytosanitary terms, the state of vegetation was generally good. In June and July were recorded very high temperatures, thus creating conditions for the development of the fungus Uncinula necator (powdery mildew).

During the vegetation period there have been warnings and were performed phyto-sanitary treatments, differentiated as follows:

- six treatments to prevent the downy mildew (Plasmopara viticola);

- seven treatments to prevent and combat the powdery mildew (Uncinula necator).

Treatments applied were complex, depending on the compatibility of the used products.

The onset of the dormancy occurred since 30 October 2014. The dynamic of wood maturation was assessed by observing the bark colour of the canes. The degree of wood aging was between 56, 32% and 73, 45%. The variety Muscat Hamburg was strongly affected by the frost and hardly recovered its vegetative apparatus.

Therefore, the use of varieties with a high biological potential, resistant to diseases, drought and pests, which adapt well to the local pedo-climatic conditions, as well as the applying of an appropriate culture technology, etc. have made possible the achievement of a production at an established quantitative level, and getting positive results for most varieties of grapevine analyzed.

On the other hand, the use of varieties resistant to diseases and pests is particularly favourable because is eliminated the use of some chemicals to combat pathogens and pests, which are very expensive. To this, adds getting healthy products free of chemical residues, the diminishing of pollution and the protection of the consumers.

The intensive increasing of the physical volume of the sold production (obvious differentiated, according to

market demand) was achieved mainly based on the increase of the average yield per hectare and on the quality of products and also based on the rationalizing of the production factors and the reducing of production losses.

Conclusions

The vineyards from the NE Region of Romania are more and more affected by the climate change occurred in the last decade. The trend in climate evolution leads to environmental changes which cause metabolic changes, disrupting the processes of growth and development, with positive or negative influences against the quality and viability of the plants. The quantitative and qualitative diminishing of the yield and the damage of the vines in vineyards due to the early autumn frosts, excessive negative temperatures, late spring frosts and harsh drought during vegetation period determines important losses to the viticulture patrimony.

From a pluviometric point of view becomes obvious a downward trend in the annual quantities of rainfall, more pronounced in the centre of the country with slight increases in the north-east and in some regions in the south.

To determine the tendency/ periodicity of the climate elements, of natural resources and their influence on viticulture the database was continually updated and these data will be used to optimize the zoning of the grapevine in the perspective of expansion of viticulture areas/replanting of existing areas and exploitation of hilly vineyards.

The observations on the succession and physiological evolution of the phenological phase of vegetation, covered by the main varieties analyzed, in relation with the specific ecological factors, point out that they have been conditioned in a complex manner by the level and the cumulative action of the climatic factors and the specific hereditary of the varieties.

The studies conducted in the last 3 decades concluded that the tendency of climate warming observed in the wine regions in the entire world will continue.

Remarkable results are obtained to an annual average temperature above 10ºC especially in grapevine varieties for red wines and in varieties for grapes.

The lower threshold for the growth of grape berries is 20°C and for their aging is 17°C, for the wood aging is 12°C. Photosynthesis needs an optimum of about 30°C, with a minimum of 6-7°C and a maximum of 35-40°C.

The upper biological threshold of the temperature for the grapevine above the ground in the case of a normal humidity is about 45-50°C, and during drought, it lowers at 35-40°C.

The overall thermal balance (St°g) represents the sum of daily average positive temperatures recorded during the vegetation period. For the conditions of our country St°g has values between 2700 and 4000°C.

The active thermal balance (St°a) represents the sum of daily average temperatures, higher than 10°C, during the vegetation period. For our country this indicator has values between 2600 and 3800°C.

The useful thermal balance (St°u) represents the sum of daily average temperatures, during the vegetation period which exceed the value of 10°C ($\sum_{1.IV}^{31.X} t^0 - 10^0C$). For our country this indicator has values between 1000 and 1800°C.

The temperature values are specific to the general climate with particularities depending on the macroclimate, topoclimate and microclimate. At microclimate scale the air temperature is not evenly and it records quite big differences between the ground level and the height of 2 m, up to which usually develop the grapevines.

Viticulture year 2015 was characterized by absolute minimum temperatures below freezing limit for vine (-27.6°C), a cold and rainy spring, a hot summer and dry with daily average temperatures higher with 1-4°C compared to normal ones, with accumulated rainfall during June-July-August of only 89.6 mm.

Studied varieties were affected by frost, the fruit buds viability being of 20-32%.

Vegetation phenophases were brought forward almost with two weeks, compared to years with normal weather conditions.

Fertility of studied varieties has been below their genetic potential; between 33 and 47% of the started shoots from the vine trunk being fertile.

Under the influence of mentioned climatic factors, the studied varieties, Paula and Gelu did not complete their known potential for quantitatively and quality.

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