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The Particularities of the Growth and Development of the Feteasca Neagra Wine Variety Depending on the Terroir

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RESEARCH ARTICLE

Abstract

Climate change at the global level causes various disturbances in viticultural ecosystems, causing varieties to adjust their annual vegetation cycle, often with negative consequences on the quantity and quality of the harvest, as well as the quality of the wines obtained. The analysis of the evolution of the phenophases of the vine vegetation, closely related to the environmental conditions, is an effective method of assessing the level of climate change. The purpose of this study was to analyze the peculiarities of growth, development and fruiting of the grapes of Feteasca neagra wine variety, in different wine-growing regions of the Republic of Moldova. Feteasca neagra wine variety was grown in three wine-growing regions, intended to obtain wines with Protected Geographical Indication (PGI): Valul lui Traian PGI (Alexandru Ioan Cuza, Bugeac and Leova), Ştefan Vodă PGI (Purcari) and PGI Codru (Speia and Nisporeni). In order to achieve the proposed goal and objectives, a series of observations, records and analyses were carried out according to the methods and standards accepted for viticulture by Moldova and OIV. Based on the experimental data, was noted that Feteasca neagra variety cultivated on the experimental land - Alexandru Ioan Cuza, had an average number of shoots per vine of 29.86, while the average number of grapes per shoot was 1.12. The number of grapes per fertile shoot was 1.4. As a result of the research, it was found that the value of the quality and productivity indices depends on the canopy management, the number of buds and shoots, as well as the pedoclimatic conditions of the region.

Keywords: Fertility; Feteasca neagra; phenophases; productivity; region; terroir; variety.

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INTRODUCTION

Climate change at the global level causes various disturbances in viticultural ecosystems, causing varieties to adjust their annual vegetation cycle, often with negative consequences on the quantity and quality of the harvest, as well as the quality of the wines obtained. The analysis of the evolution of the phenophases of the vine vegetation, closely related to the environmental conditions, is an effective method of assessing the level of climate change (Nechita et al., 2020). One of the most important factors in grape growing is terroir. It influences the organoleptic characteristics of grapes and wines. The terroir represents the growing ecosystem of the vine (topography, climate, soil, variety and rootstock) including the technological particularities of growing and obtaining wines (Zeynep et al., 2015; Artem et al., 2016; Van Leeuwen and Seguin, 2006). The soil together with other factors of the terroir, plays a decisive role in the productivity of the plantation and the chemical composition of the grapes and the wine. The influence of soil is complex, as soil affects water and mineral absorption, as well as root zone temperature. On shallow soils, the supply of water and nitrogen to the vine is moderate, which limits vine growth and yield,

but can lead to increased sugar and anthocyanin content in grapes (Coipel, 2006).

The variety Feteasca neagra has not been sufficiently studied in the ecological conditions of the Republic of Moldova. This requires an in-depth study, in order to develop the culture of local varieties. The Moldavian government makes a major effort to promote local wines, especially from indigenous varieties. The Republic of Moldova has excellent conditions for growing local grape varieties and obtaining high quality wines. Feteasca neagra being a native variety, hence cultivated in the three wine regions destined to obtain Protected Geographical Indication (PGI) wines is gaining more and more popularity. The area of vineyards planted with the Feteasca neagra variety, registered in the Vine and Wine Register a digital platform created by the National Office for Wine and Vine, where are registered the vine surfaces, is 393.5117 ha, but the interest is constantly growing.

The purpose of this study was to analyze the peculiarities of growth, development and fruiting of the wine grape variety Feteasca neagra in different wine-growing regions of the Republic of Moldova, in order to contribute to the wide spread of the variety and promote local production.

MATERIALS AND METHODS

The study was based on the grape wine variety - Feteasca neagra, grown in the three wine-growing regions intended to obtain wines with PGI as follows: Valul lui Traian PGI (Alexandru Ioan Cuza locality, Bugeac and Leova locality), Stefan Voda PGI (Purcari locality) and PGI Codru (locality of Speia, Mircesti and Nisporeni) (Figure 1). In order to achieve the proposed goal and objectives, a series of observations, records and analyzes were carried out according to the standards and methods accepted for viticulture by Moldova (Manescu et al., 1989) and OIV (2nd Edition of the OIV descriptor list for grape varieties and *Vitis* species). For each studied variant, three repetitions for 25 vines each were investigated. Vegetation phases were monitored according to the methods recommended by the OIV. The agrobiologically indices were determined according to Mănescu (Manescu et al., 1989). The soluble dry matter content in grapes was effectuated according to the method OIV-MA-AS2-02: "Evaluation by refractometry of the sugar concentration in grape musts, concentrated grape musts and rectified concentrated grape musts" and titratable acidity was effectuated according to method OIV-MA-AS313-01: „Total acidity". Pedological and agrochemical research was carried out by the Institute of Pedology and Agrochemistry and Soil Protection "Nicolae Dimo" within the project - "Quality grapes". The analysis of meteorological conditions was carried out based on the *i*-Metos local stations of the experimental sectors.

The characteristics of the wine plantations of the experimental sectors are reflected in Table 1, giving the detailed information, of interest for the terroir.

Table 1. Comparative evaluation of the vineyards of the experimental sectors (Feteasca neagra variety)

Wine region	Locality	Vines shape	Year of planting	Planting scheme, m x m	Geographical latitude, degrees	Altitude, m	Expo-zition	Slope angle, degrees	Soil type	Humus content, %
PGI Valul lui Traian	Cahul, Alexandru Ioan Cuza Vodă	Cazenave bilateral	2015	2.50 x 1.25	45.2458	85	SV, V	1 - 3	carbonate chernozem	1.72-0.52
	Comrat, Bugeac	Guyot bilateral	2008	2.75 x 1.40	46.3971	152	SV, S	1 - 3	tipical chernozem	4.05-0.83
	Leova	Guyot unilateral	2009	2.25 x 0,90	46.4875	160	S, SE	1 - 3	ordinary chernozem	2.10-0.46
PGI Stefan Voda	Ştefan Vodă, Purcari	Royat bilateral	2010	2.75 x 1.30	46.5190	121	S, SE	5 - 7	carbonate chernozem	1.39-0.52
PGI Codru	Anenii Noi, Speia	Guyot bilateral	2015	2.20 x 1.00	47.1124	85	NE, E	3 - 5	leached chernozem	2.74-0.29
	Nisporeni, Varzareşti,	Guyot unilateral	2006	2.25 x 0.90	47.3217	120	SV, V	3 - 5	carbonate chernozem	1.50-0,37
	Ungheni, Mircesti	Guyot unilateral	2014	2.20 x 1.30	47.4010	304	E, SE	5 - 7	tipical chernozem	2.32-0.63

Figure 1. Location of the experimental lots in geographical profile.

The study was carried out with the financial support of the National Vine and Wine Office in the period 2017-2019, within the project - "Quality grapes" - "Dissemination of good practices through field schools for winegrowers".

RESULTS AND DISCUSSIONS

According to Molitor and Keller (2016), the climatic conditions during distinct periods of growth (and thus yield formation) are correlated with the final harvest. Understanding the effects of weather conditions during specific periods of yield formation supports grape growers' efforts to optimize vine cultivation technology, in order to achieve adequate production levels. The quality of the wine grapes is influenced by a series of factors correlated with the specific production area, grape variety, soil type, climate (terroir), grape ripening process and winemaking technique.

Analyzing the meteorological data for Repupblic of Moldova during the experimental interval, it is found that they differ from year to year, from region to region. In the study years, the highest amount of precipitation was in 2017 (at Bugeac), while the lowest was noted in 2018 (at Purcari) (Figures 2, 3, 4).

The duration of the longest vegetation period was recorded at Alexandru Ioan Cuza, the locality being geographically located further south. The duration of the shortest vegetation period was recorded in Nisporeni, the locality being geographically located further north.

The weather conditions considerably influence the development of the vine during the vegetation period, but also during the dormancy period. Studying the weather conditions in relation to the vine, may help to avoid the danger of late spring frosts, which are frequent in Rep. Moldova. Low temperatures during flowering negatively influence the formation of berries, while winter frosts often affect buds and perennial wood.

It can be noted that the linear trend for the vegetation period increased from south to north in 2017, and decreasing in 2018-2019.

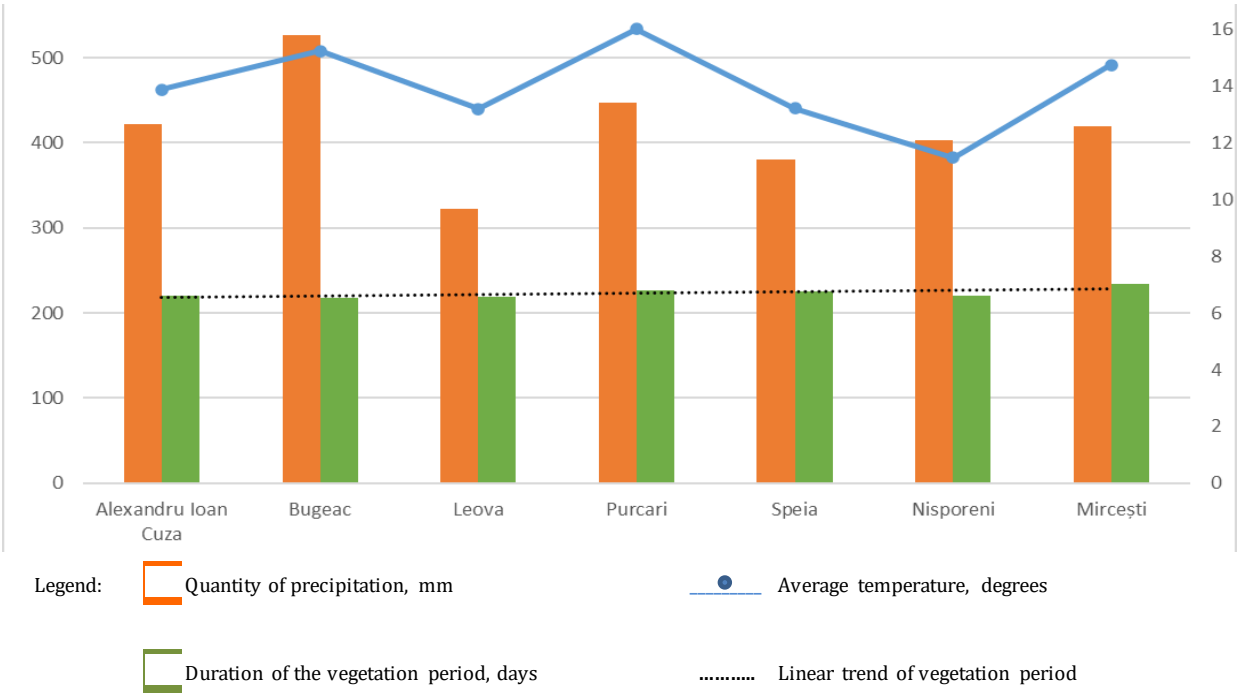

Figure 2. Weather conditions and duration of the of the vegetation period in 2017.

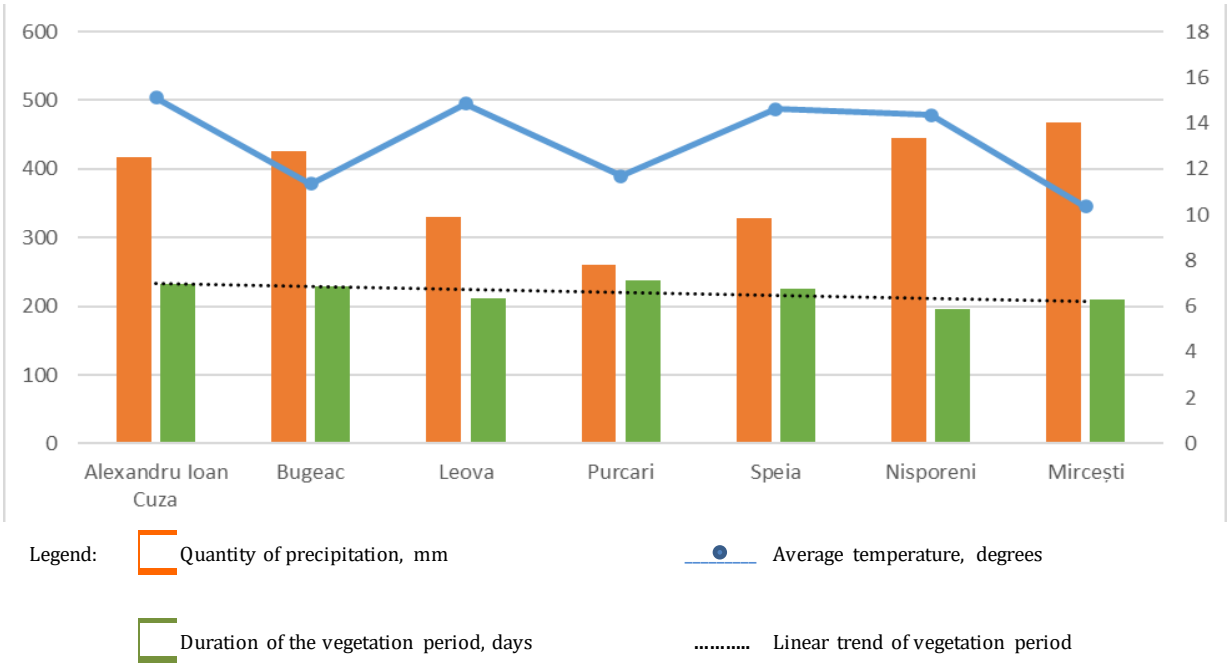

Figure 3. Weather conditions and duration of the of the vegetation period in 2018.

Figure 4. Weather conditions and duration of the of the vegetation period in 2019.

The weather conditions, dependent of the cultivation area and of the year, directly influenced the agrobiological indices of the grape vines. The CFR values ranged from 0.70 to 1.59 with $DL_{0.95}$ at 0.52. The CFA values ranged from 1.17 to 1.68 with $DL_{0.95}$ at 0.61. The significance levels ranged from weak to strong, and were both positive and negative. The IPR values ranged from 139.50 to 238.16 g/shoot, with $DL_{0.95}$ at 32.64 g/shoot. The significance levels ranged from weak to strong. The IPA values ranged from 200.90 to 251.39 g/shoot, with $DL_{0.95}$ – 31.42 g/shoot. The significance levels ranged from weak to strong (Table 2).

Table 2. Agrobiological indices of the vines depending on the cultivation region

Locality	Buds per vine, pcs.	Growing buds per vine, pcs.	Growing bds per vine, %	Shoots per vine, pcs.	Fertile shoots per vine, pcs.	Fertile shoots per vine, %	The relative fertility rate (CFR)	The absolute fertility rate (CFA)	Relative productivity index (IPR), g.	Absolute productivity index (IPA), g.
Alexandru Ioan Cuza	69.72	55.30	79.32	29.86	24.04	80.53	1.12	1.40	168.58	209.34
Bugeac	22.52	17.36	77.07	16.73	11.49	68.64	0.97	1.48	182.76	267.67
Leova	28.65	22.80	79.58	17.27	11.01	63.75	0.88	1.33	143.85	216.76
Purcari	33.77	27.13	80.34	25.87	15.13	58.49	0.70	1.17	139.50	219.22
Speia	70.88	58.18	82.09	39.80	37.71	94.74	1.59	1.68	238.16	251.39
Nisporeni	41.86	33.95	81.12	25.40	22.58	88.89	1.22	1.38	183.33	206.25
Mircești	19.14	17.09	89.28	15.07	10.52	69.81	0.86	1.18	147.21	200.90
$DL_{0.95}$							**0.52**	**0.61**	**32.64**	**31.42**

According to the data reflected in Table 3, it was found that the highest amount of soluble dry substances was obtained from grapes from the southern localities. This also determined the increased sugar content in those berries. The conditions of the region and the year directly influenced the intensity of the color of the grapes and the wine, the extractiveness and the increased alcoholic strength of the wine, as well as other qualitative indices. For soluble dry matter content, the $DL_{0.95}$ was 2.13 %, with significance levels ranging from weak to strong, both

positive and negative. For titratable acidity content, the $DL_{0.95}$ was 1.86 g/dm^3, with significance levels also ranged from weak to strong, both positive and negative.

Table 3. Uvological and quality indices depending on the year and region of cultivation

Locality	Year	The weight of the grape, g	Berries, pcs.	The weight of the 100 berries, g	The weight of the skin of the 100 berries, g	The weight of the seeds of the 100 berries, g	Soluble dry matter content, %	Titratable acidity content, g/dm^3
Alexandru Ioan Cuza	2017	215.37	143	115.52	5.70	3.02	23.4	7.9
	2018	262.48	165	117.68	11.33	6.99	27.6	8.1
	2019	198.13	131	105.27	7.61	6.41	25.8	6.2
Bugeac	2017	257.10	176	137.90	6.80	3.60	22.8	8.8
	2018	366.90	280	127.80	12.30	7.59	26.8	9.0
	2019	163.18	180	86.70	6.27	5.28	24.8	5.5
Leova	2017	173.10	132	162.30	7.20	3.40	20.9	10.5
	2018	280.27	218	124.90	11.80	7.26	25.3	9.2
	2019	176.56	103	165.80	13.80	7.50	23.3	6.3
Purcari	2017	259.30	138	176.60	8.20	4.40	20.2	9.3
	2018	139.40	87	155.30	15.80	8.50	25.4	8.7
	2019	228.30	156	141.50	18.48	9.24	26.0	6.3
Speia	2017	175.20	115	93.97	4.63	2.45	26.7	8.3
	2018	202.30	108	90.70	8.73	5.39	24.3	7.8
	2019	196.46	149	135.40	20.80	6.90	26.2	7.6
Nisporeni	2017	188.60	115	101.16	4.99	2.64	24.3	8.1
	2018	201.30	106	90.25	8.69	5.36	25.2	7.9
	2019	147.90	99	143.40	10.50	5.94	25.0	6.0
Mircesti	2017	281.60	169	158.60	10.60	4.40	23.5	6.8
	2018	350.20	255	135.10	14.52	7.90	25.4	7.5
	2019	240.40	140	127.73	9.24	7.78	24.6	7.1
$DL_{0.95}$		**28.53**	**19.2**	**21.41**	**2.93**	**1.67**	**2.13**	**1.86**

The multifactorial linear regression equation for dry matter content obtained the form:

$$Y=15.23-15.2X_1+35.26X_2+10.23X_3+5.21X_4$$

X_1- the amount of annual precipitation, mm;

X_2 - the sum of useful temperatures during the vegetation period, degrees;

X_3 - average temperature of July, degrees;

X_4 - average temperature of August, degrees.

The correlation coefficient (r) demonstrated a close relationship between the dependent factors and the dry matter content, obtaining a value of 0.83. The latter allowed the determination of the coefficient of determination ($d=r^2$), which was 0.6724, with an influence level of 67.24%

The multifactorial linear regression equation for dry matter content obtained the form:

$$Y=12.91-13.49X_1+28.64X_2-15.23X_3-17.65X_4$$

The correlation coefficient (r) demonstrated a close relationship between the dependent factors and the titratable acidity content, obtaining values of 0.86. The latter allowed the determination of the coefficient of determination ($d=r^2$), which was 0.7396, with an influence level of 73.96%.

The studied agrobiological indices, depending on the cultivation region, allow to practically determining the technological parameters for each region. This may allow obtaining quality grapes for wine, according to the terroir.

CONCLUSIONS

As a result of the research, it was found that the grape quality and productivity indices of vines depends on the culture system, the number of eyes and shoots and the pedoclimatic conditions of the region. The meteorological conditions considerably influence the development and the quality of grapes during the vegetation period, but also during the dormancy period. Studying the weather conditions in relation to the vine, contribute to avoid the danger of late spring frosts, which are frequent in Moldova. Finally, specific technological process may be considered to protect vines, considering low temperatures during flowering which negatively influence the formation of berries, and winter frosts that may affect buds and perennial wood. The studied agrobiological indices, depending on the cultivation region, allow practically determining the technological parameters for each region – buds / shoots / clusters per vine. This will allow obtaining quality grapes for wine, according to the terroir.

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Conflicts of Interest

As the sole author of the article, I declare that based on the materials reflected in this article there is no conflict of interest with other persons or entities.

REFERENCES

1. Artem V, Antoce AO, Ranca A, Nechita A, Enache L, Postolache E. The influence of terroir on phenolic composition of red grapes. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Horticulture. 2016; 73(2):109-115. https://doi.org/10.15835/buasvmcn-hort:12173
2. Coipel, J, Begoña RL, Catherine S, Van Leeuwen C. „Terroir„ effect, as a result of environmental stress, depends more on soil depth than on soil type (*Vitis Vinifera* l. Cv. Grenache noir, Côtes Du Rhône, France, 2000). Journal International des Sciences de la Vigne et du Vin. 2006; 40(4):177-185. https://doi.org/10.20870/oeno-one.2006.40.4.867
3. 2nd Edition of the OIV descriptor list for grape varieties and *Vitis* species. [Internet]. https://www.oiv.int/sites/default/files/2022-12/Code%202e%20edition%20Finale.pdf
4. Mănescu C, Georgescu M, Dejeu LC. Controlul biologic al productiei in pomicultura si viticultura. Bucureşti, Editura Ceres. 1989.
5. Molitor D, Keller M. Yield of Müller-Thurgau and Riesling grapevines is altered by meteorological conditions in the current and previous growing seasons. 2016; 50(4). https://doi.org/10.20870/oeno-one.2016.50.4.1071

6. Nechita A, Zaldea G, Damian D, Filimon R, Pisticiuc I, Filimon VR. The evolution over time of the development of vegetation phenophases of the vine varieties cultivated in the Copou Iaşi wine center in the context of climate change. Scientific Papers Journal Horticulture Series. 2020; 63(1):89-94. https://www.uaiasi.ro/revista_horti/files/Nr1_2020/vol%2063_1_2020%20(14).pdf
7. Van Leeuwen C, Seguin G. The concept of terroir in viticulture. Journal of Wine Research, 2006; 17(1):1-10. https://doi.org/10.1080/09571260600633135
8. Vine and Wine register. [Internet] https://rvv.gov.md/publicpart/overview.jsf
9. Zeynep DC, Selin YK, Merve D, Hasim K, Burçak İ, Ege K, et al. Effects of terroir on the terpene compounds of Muscat of Bornova Native white grape variety grown in Turkey. BIO Web of Conferences. 38th World Congress of Vine and Wine. 2015; 5(1). https://www.bio-conferences.org/articles/bioconf/abs/2015/02/bioconf_oiv2015_01004/bioconf_oiv2015_01004.html https://doi.org/10.1051/bioconf/20150501004