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PRODUCTIVITY ELEMENTS AND QUALITY INDICES IN SOME RED WINES GRAPE VARIETIES - COMPARATIVE STUDY

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Abstract

The study aimed to evaluate the productivity parameters and quality indices of three grape varieties for red wines. The study was conducted in the 2023-2024 wine year, in the area of the Recaș Wine Center. Three grape varieties for red wines were considered in the study: "Fetească Neagră" (Gv1), "Pinot Noir" (Gv2) and "Cabernet Sauvignon" (Gv3). The vegetation diagram recorded 125 days for Gv1, 146 days for Gv2, and 145 days for Gv3 from the start of vegetation to the ripening of the grapes. Grapevine varieties showed differentiated values for productivity parameters and productivity indices of productivity, yield, and quality. Close values were recorded for total vine shoots (Tvs), but variant Gv2 was noted for fertile vine shoots (Fvs), and trunk inflorescence number (Tin). The Gv1 variant stood out for average grape weight (Agw), and the Gv3 variant stood out for yield (Y/plt). Regarding quality indices, the Gv3 variant presented higher values for total soluble solids (TSS), and anthocyanin content (Ant). The results are important for the management of vineyard plantations in relation to the yield and quality indices considered.

Key words: *correlation, productivity elements, quality indices, red wine cultivars, vineyard plantation management.*

INTRODUCTION

The long history of grapevine cultivation is supported by consistent databases, with textual, archaeobotanical, archaeological, iconographic, and morphometric information, traditions and traditional practices, etc. (Limier et al., 2018). The grapevine is considered a plant species, with an essential role in the long history of humankind (Vignani & Scali, 2024).

The high plasticity of the grapevine was evaluated and quantified in relation to eco-anatomical elements specific to wood (e.g. age, maturity), specific to leaves, fruits, seeds, environmental conditions, etc. (Limier et al., 2018). Morphological and genetic traits of the vine have undergone certain changes as a result of the "domestication" process, genotype selection and improvement programs, and technological practices in vine cultivation (Wen et al., 2018; Grassi & Arroyo-Garcia, 2020).

Associated with the effects of climate warming, changes in conditions for vines have been recorded in areas dedicated to the crop; the expansion of cultivated areas has been recorded; and new areas suitable for vines have been presented (Bănuță et al., 2024; van Leeuwen et al., 2024; Corbeels et al., 2025; Lisek & Popińska, 2025). In the context of climate change, the selection of varieties adapted to the specifics of the growing area was considered important (Baltazar et al., 2025). To improve adaptive mechanisms of the grapevine, different future scenarios based on genetic modifications were considered (Vignani & Scali, 2024).

Although the grapevine has high natural biodiversity, some studies have drawn attention to "cultivated biodiversity", the "concentration" of the number of varieties, and the possibility of "diversity decline" in the grapevine (Boursiquot et al., 2025). For the purpose of objectively studying biodiversity and trends of change identified in grape germplasm, certain "adapted indices" have been introduced to ensure neutrality and objectivity in specific studies and investigations (Boursiquot et al., 2025).

Interactions of the vine with the soil and climate, as a "terroir" ecosystem, have been studied in terms of vegetative growth, the formation of berries in grape clusters, and the qualitative compositional suitability of red grapes for quality wines (van Leeuwen et al., 2018). Climate change and the "soil - climate" interaction have been quantified in vegetative growth and in viticultural performance in

quantitative and qualitative terms (Vanden Heuvel & Centinari, 2021).

High variability was recorded in grapevines in shoots and small berries in relation to ripening, compared with developed shoots and larger berries (Wisdom & Considine, 2022). Although it has high adaptability, the grapevine responds to environmental factors, stressors, and technological factors through variations in yield and production quality (Tănase et al., 2022; Gayretli et al., 2024; Catania et al., 2025).

The influence of some abiotic and biotic stress factors was analyzed in relation to the negative effects they presented on yield values and some quality indices in the vine under specific technological conditions (Lu et al., 2023).

Factors, but especially combinations of soil and climatic factors, have influenced the yield of white wine varieties differently than red or rosé wine varieties, and the authors concluded the need to develop research to quantify the interactions of environmental factors with an impact on the formation of grapevine yield (Fernandez-Mena et al., 2023).

The morphological specificity of the vine and the response to influencing factors are important for optimizing the balance between vegetative growth, yield, and quality of grape production (Karn et al., 2024). Different adaptation and response mechanisms have been reported in the grapevine, in relation to climate change, the succession of vegetation stages, yield, and quality indices of wine production (Costea et al., 2023; Bonfante et al., 2025). The development of floral organs, inflorescence formation, vegetative initiation, and yield aspects in grapevines has been studied in relation to the vegetative dormancy period (Li et al., 2025).

Through cultivation technology, the expression of "terroir" can be corrected in relation to the purpose of the final wine production (van Leeuwen et al., 2018). Through comparative analysis, the impact of different types of organic and mineral fertilizers on the soil (physical and chemical parameters) and on vine yield of the vine was evaluated (Wu et al., 2024). Treatments with organic and mineral fertilizers, biofertilizers, and biostimulators generated differentiated effects in the soil and plants in two grapevine varieties cultivated in acidic soil conditions with low humus content (Lisek & Popińska, 2025). Technological practices (e.g. post-harvest practices), such as stimulating pruning and foliar treatments, were promoted in order to favor the differentiation of secondary floral buds (Li et al., 2025). Soil maintenance systems through mechanical work and covering with a vegetal carpet (vegetable carpet by sowing) have been studied in relation to the root system of the vine and the sustainability of vineyards (Lenari et al., 2025).

The impact of climate change has been recorded in the yield and quality of wine production, and recent studies have communicated "adaptive measures", which target biological material and elements of technology for the adoption of medium and long-term strategies to compensate for climatic constraints (Villalobos-Soublett et al., 2022).

The yield potential of some red wine grape varieties, in different soil conditions and semi-arid areas, was evaluated in relation to water regime and irrigation methods (Ma et al., 2023).

To ensure the sustainability of vineyards, "yield gaps" in vines have been studied and analyzed in relation to soil and climatic factors of influence (Fernandez-Mena et al., 2023). Under conditions of moderate, experimentally induced water stress, an increase in the content of accumulated soluble sugar and the amount of nitrogen (metabolized by yeasts) in grape berries on the vine was recorded (Ma et al., 2023).

Appropriate models and selection methods were used to objectively identify specific zonal indicators with effects on grapevine yield gaps (Fernandez-Mena et al., 2023). Relief elements and specific soil indicators (e.g. fertility indicators) were identified through multiple regression analysis as “significant predictors” for morphological parameters, productivity, and quality elements in the vineyard (Karn et al., 2024).

This study aimed to compare three red grape varieties, “Fetească Neagră”, “Pinot Noir” and “Cabernet Sauvignon”, cultivated in the Recaș wine-growing area, based on elements of productivity, yield and grape quality indices.

MATERIALS AND METHODS

The study was conducted in the area of the Recaș Wine Center, Timis County, Romania, during

the 2023-2024 wine years. The geographical position, through the specific relief (altitudes between 100-300 m, predominantly southern exposure, SE-SW), the soil conditions (zonal and azonals soils - luvosol class) and the climate (hydrothermal coefficient 1.15, heliothermal index 2.37, bioclimatic index 7.18, and oenoclimatic aptitude index 4.665), gives the area a viticultural favorability recognized nationally and internationally. In the wine year 2023- 2024, the average precipitation was 69.5 mm in 2023, and 54.2 mm in 2024. Active precipitation totaled 835 mm in 2023 and 650 mm in 2024. Mechanical works, applied periodically, ensured the maintenance of the vineyard. The bud load on the vine was consistent with each variety and the cultivation technology in the area. Three grape varieties were considered in the study: "Fetească Neagră", "Pinot Noir" and "Cabernet Sauvignon" (Figure 1). The study was conducted according to the flow chart (Figure 1). For reasons of graphic representation, the presented abbreviations were considered in the article.

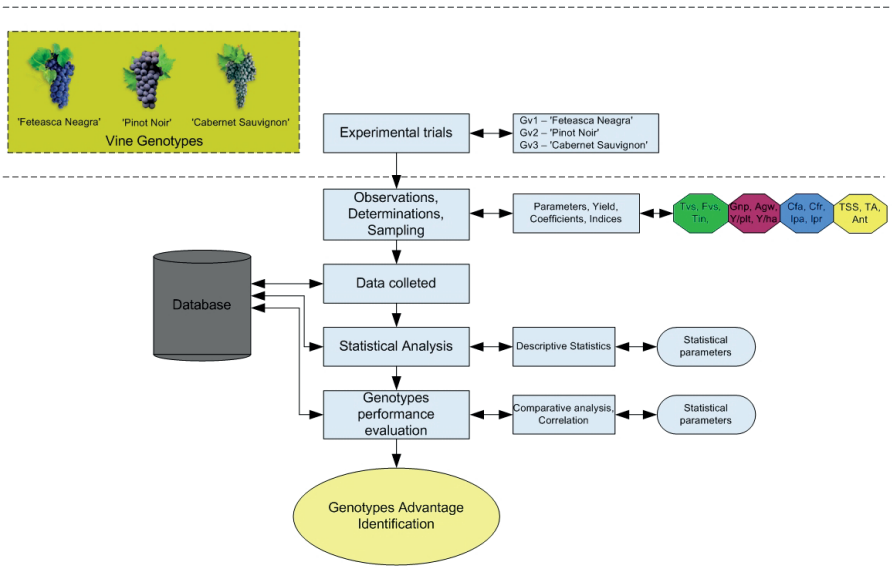

Figure 1. Flow chart

The three genotypes were evaluated in terms of: productivity elements (Tvs – total vine shoots; Fvs – fertile vine shoots; Tin – trunk inflorescence number; Agw – average grape weight), yield (Y/plt – yield per plant; Y/ha – yield per unit area); performance coefficients and indices (Cfa – Coefficient of absolute fertility, Cfr – Coefficient of relative fertility, Ipa - Index of productivity absolute, and index of productivity relative – Ipr), quality indices (TSS – total soluble solids, TA – total acidity, Ant - anthocyanins).

The determination of some parameters was done by numerical counting (e.g. Tvs, Fvs, Tin), by weighing with a laboratory balance (e.g. Agw), by calculation (e.g. Y/ha; Cfa, Cfr, Ipa, Ipr). The quality indices were determined by laboratory methods, respectively the refractometric method (TSS, °Brix), the titrimetric method (TA, g tartaric acid/L), UV-VIS spectrophotometry (Anthocyanins, mg Ant/L, calculated as malvidin-3-glucoside).

The experimental data were analyzed to comparatively evaluate the three grape varieties for each parameter considered. Correlation analysis was used to evaluate the interdependence between the parameters considered. The calculation module in EXCEL, the PAST software v.4.17. (Hammer et al., 2001), and the JASP software v 0.16.2 (2022)

were used for data analysis and graphical representations.

RESULTS AND DISCUSSIONS

Under the study conditions, the three grapevine genotypes presented differentiated values for the evaluated parameters.

In the case of elements associated with grapevine shoots, Tvs recorded values between 12.40±0.31 (Gv3) and 13.40±0.31 (Gv1), Fvs recorded values between 10.20±0.48 (Gv3) and 11.80±0.48 (Gv2), and Tin recorded values between 12.20±1.92 (Gv2) and 18.80±1.92 (Gv2) (Table 1).

Table 1. The productivity elements of the grapevine varieties analyzed

Grape variety	Tvs	Fvs		Tin
	(No)	(No)	(%)	(No)
Gv1	13.40	10.60	79.10	12.20
Gv2	12.60	11.80	93.65	18.80
Gv3	12.40	10.20	82.26	16.20
SE	±0.31	±0.48	±4.42	±1.92

Comparative analysis of Tvs values showed a positive difference of the Gv1 genotype compared to the experiment average ($\overline{Tvs}$ = 12.80) in conditions of statistical safety ($p<0.01$, **), and differences without statistical safety ($p>0.05$) in the case of Gv2 and Gv3 (Table 2).

Table 2. Comparative analysis results for the Tvs parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	13.40	12.60	12.40
Sample mean	12.80		
95% conf. interval	(12.392 13.208)	(12.392 13.208)	(12.392 13.208)
Difference	0.60	0.20	0.40
95% conf. interval	(0.19176 1.0082)	(-0.20824 0.60824)	(-0.0082409 0.80824)
t	-3.3891	1.1297	2.2594
p (same mean)	0.0095	0.2913	0.0538
Significance	**	Ns	ns

In the case of the Fvs parameter, the average of the experiment was at the level = 10.87. In relation to the calculated average value, the Gv2 genotype presented a positive difference ($p<0.01$, **), and the Gv3 genotype presented a negative difference ($p<0.05$, o). In the case of the Gv1 genotype, the difference did not present statistical safety (Table 3). The graphic representation illustrates the level of values achieved by genotypes and the averages calculated at the experiment level (Figure 2).

Table 3. Results of the comparative analysis for the Fvs parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	10.60	11.80	10.20
Sample mean	10.87		
95% conf. interval	(10.227 11.506)	(10.227 11.506)	(10.227 11.506)
Difference	0.27	0.93	0.67
95% conf. interval	(-0.37312 0.90646)	(0.29354 1.5731)	(0.026876 1.3065)
t	0.9611	-3.3640	2.4028
p (same mean)	0.3646	0.0099	0.0430
Significance	ns	**	o

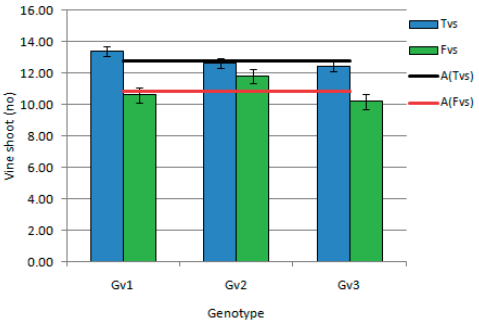

Figure 2. Graphical representation of Tvs and Fvs parameters by genotypes and experimental average
Note: Tvs – Total vine shoot; Fvs – fertile vine shoot; A(Tvs) – average of Tvs; A(Fvs) – average of Fvs

In the case of the parameter Tin (total inflorescence number), the average value calculated at the experiment level was $\overline{Tin}$ = 15.73 (Table 4, Figure 3). The Gv2 genotype presented a value higher than the average ($p<0.05$, *), and the Gv1 genotype presented a value lower than the average ($p<0.05$, o). In the case of the Gv3 genotype, the difference did not present statistical certainty ($p>0.05$).

The increase in the number of shoots was associated with an increase in grapevine yield but negatively influenced the diameter of the berries, and for the quality of the bunches, control of the bunches on the plant was recommended (Somkuwar et al., 2012). The

association of shoot characteristics (e.g. development, size) and grape berries with ripening suggested differentiated management of the vine through technological work, in relation to plant vigour (Wisdom & Considine, 2022).

Table 4. Comparative analysis results for the Tin parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	12.20	18.80	16.20
Sample mean	15.73		
95% conf. interval	(13.178 18.289)	(13.178 18.289)	(13.178 18.289)
Difference	3.53	3.07	0.47
95% conf. interval	(0.97763 6.089)	(0.51097 5.6224)	(-2.089 3.0224)
t	3.1881	-2.7670	-0.4211
p (same mean)	0.0128	0.0244	0.6848
Significance	o	*	ns

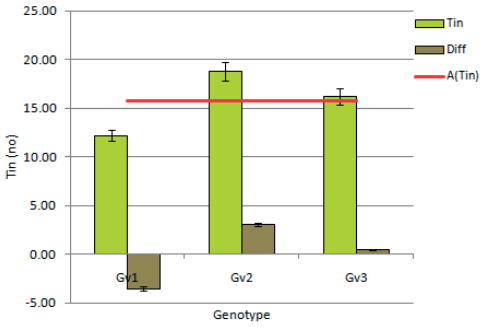

Figure 3. Graphical representation of the Tin parameter by genotypes and experimental average

The number of nodes, the number of shoots,, and other productivity elements in the vine showed variations in relation to the pruning system and influenced the ripening of the berries, the yield,, and the quality indices of the grapes (Epee et al., 2024).

Productivity elements (Gnp; Agw), and yield (Y/plt; Y/ha) were determined for the three grapevine genotypes (Table 5). Grape number on plant (Gnp) recorded values ranging between 14.56±1.34 (Gv1) and 15.44±1.34 (Gv2). Average grape weight (Awg) presented values ranging between 0.124±0.004 kg (Gv2) and 0.139±0.004 kg (Gv1). Yield per plant (Y/plt) recorded values ranging between 1.91±0.17 kg/plt (Gv2) and 2.46±0.17 kg/plt (Gv3). Similarly, Y/ha recorded a low value in the case of Gv2, 8.70±0.76 t/ha, and a high value in the case of Gv3, 11.20±0.76 t/ha (Table 5).

Table 5. Elements of productivity and yield in grapevine varieties

Grape variety	Gnp	Agw	Y/plt	Y/ha
	(No)	(kg)	(kg/plt)	(t/ha)
Gv1	14.56	0.139	2.02	9.20
Gv2	15.44	0.124	1.91	8.70
Gv3	18.96	0.130	2.46	11.20
SE	±1.34	±0.004	±0.17	±0.76

The comparative analysis showed the level of differences and statistical significance for the productivity elements.

In the case of Gnp (grape number per plant) the average value calculated at the experiment level was $\overline{Gnp}$ = 16.32 (Table 6, Figure 4). The Gv3 genotype recorded a value higher than the average, with a statistically significant difference ($p<0.01$**), while the other two genotypes presented differences without statistical significance in relation to the average value (Table 6).

Table 6. Results of the comparative analysis for the Gnp parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	14.56	15.44	18.96
Sample mean	16.32		
95% conf. interval	(14.532 18.108)	(14.532 18.108)	(14.532 18.108)
Difference	1.76	0.88	2.64
95% conf. interval	(-0.028237 3.5482)	(-0.90824 2.6682)	(0.85176 4.4282)
t	2.2696	1.1348	-3.4044
p (same mean)	0.0529	0.2893	0.0093
Significance	ns	ns	**

In the case of the Agw parameter, the average value calculated at the experiment level was $\overline{Agw}$ = 0.131 kg (Table 7, Figure 4). Compared to the average value, the Gv1 genotype recorded a higher value, with a statistically significant difference ($p<0.05$, *), and the Gv2 genotype presented a lower value ($p<0.05$, o).

In the case of yield per plant (Y/plt) the average calculated value was = 2.13 kg/plt (Table 8), and in the case of yield per unit area (Y/ha) the

average calculated value was $\overline{Y/ha}$ = 9.70 t/ha (Table 9).

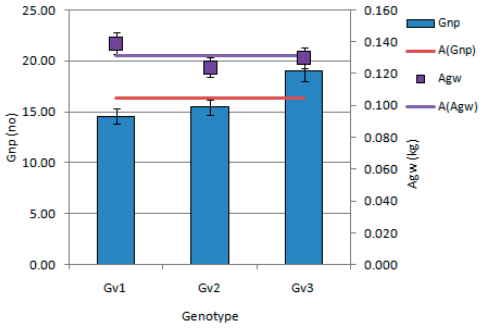

Figure 4. Representation of Gnp and Agw parameters by genotypes and experimental average

Table 7. Comparative analysis results for the Agw parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	0.139	0.124	0.130
Sample mean	0.131		
95% conf. interval	(0.12531 0.13669)	(0.12531 0.13669)	(0.12531 0.13669)
Difference	0.008	0.007	0.001
95% conf. interval	(0.0023124 0.013688)	(0.0013124 0.012688)	(-0.0046876 0.0066876)
t	-3.2435	2.8381	0.4054
p (same mean)	0.0118	0.0219	0.6958
Significance	*	o	ns

Table 8. Comparative analysis results for the Y/plt parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	2.02	1.91	2.46
Sample mean	2.13		
95% conf. interval	(1.9056 2.3544)	(1.9056 2.3544)	(1.9056 2.3544)
Difference	0.11	0.22	0.33
95% conf. interval	(-0.11436 0.33436)	(-0.0043644 0.44436)	(0.10564 0.55436)
t	1.1306	2.2611	-3.3917
p (same mean)	0.2910	0.0536	0.0095
Significance	ns	ns	**

Compared to the average calculated values, the Gv3 genotype presented values above the average (Figure 5), under conditions of statistical safety ($p<0.01$, **), and in the case of the other two genotypes the differences did not present statistical safety ($p>0.05$).

Table 9. Results of the comparative analysis for the parameter Y/ha

Statistical parameters	Gv1	Gv2	Gv3
Given mean	9.20	8.70	11.20
Sample mean	9.70		
95% conf. interval	(8.6844 10.716)	(8.6844 10.716)	(8.6844 10.716)
Difference	0.50	1.00	1.50
95% conf. interval	(-0.51559 1.5156)	(-0.015591 2.0156)	(0.48441 2.5156)
t	1.1353	2.2706	-3.4059
p (same mean)	0.2891	0.0528	0.0093
Significance	ns	ns	**

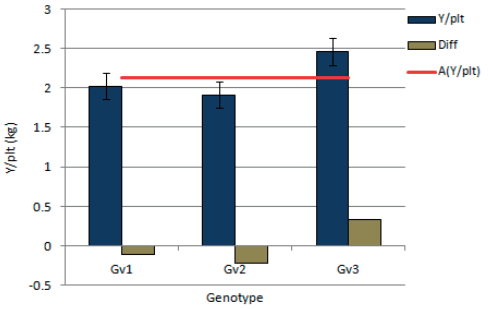

Figure 5. Graphical representation of the Y/plt parameter by genotypes and experimental average

Coefficient of absolute fertility (Cfa), coefficient of relative fertility (Cfr), index of absolute productivity (Ipa), and index of relative productivity (Ipr) were calculated for the three grapevine genotypes (Table 10). The Cfa coefficient recorded values between 1.34 (Gv1) and 1.82 (Gv2). The Cfr coefficient recorded values between 1.00 (Gv1) and 1.64 (Gv2). The Ipa index recorded values between 186.30 (Gv1) and 232.70 (Gv3), and the Ipr index recorded values between 139.00 (Gv1) and 203.40 (Gv2).

Table 10. Values of productivity coefficients and indices

Grape variety	Cfa	Cfr	Ipa	Ipr
Gv1	1.34	1.00	186.30	139.00
Gv2	1.82	1.64	225.70	203.40
Gv3	1.79	1.48	232.70	192.40
SE	±0.16	±0.19	±14.44	±19.89

Quality indices, total soluble solids (TSS), total acidity (TA), and anthocyanins (Ant) were determined on must samples from the experimental variants (Table 11). The TSS index

recorded values between 218.00±2.96 °Brix (Gv2) and 228.00±2.96 °Brix (Gv3). The TA index recorded values between 5.10±0.12 g/L (Gv3) and 5.50±0.12 g/L (Gv2). The Ant index recorded values between 0.34±0.02 mg/L (Gv2) and 0.42±0.02 mg/L (Gv3).

Table 11. Quality indices of the studied grape varieties

Grape variety	TSS (°Brix)	TA (g tartric acid/L)	Ant mg/L
Gv1	225.00	5.30	0.39
Gv2	218.00	5.50	0.34
Gv3	228.00	5.10	0.42
SE	±2.96	±0.12	±0.02

In the case of the TSS index, compared to the calculated mean ($\overline{TSS}$ = 223.67), the positive difference ($p<0.05$, *) generated the Gv3 genotype, and the negative difference ($p<0.05$, o) was recorded for the Gv2 genotype (Table 12, Figure 6).

Table 12. Comparative analysis results for TSS parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	225.00	218.00	228.00
Sample mean	223.67		
95% conf. interval	(219.72 227.61)	(219.72 227.61)	(219.72 227.61)
Difference	1.33	5.67	4.33
95% conf. interval	(-2.6102 5.2769)	(1.7231 9.6102)	(0.38979 8.2769)
t	-0.7797	3.3136	-2.5339
p (same mean)	0.4580	0.0106	0.0350
Significance	Ns	o	*

The content of total soluble solids (TSS) is important for the quality of red wines, and some studies have reported a threshold of 22 °Bx in relation to the variation of mannoprotein content, and its influence on the composition and colour modulation of red wines (Galaz-Torres et al., 2025).

In the case of the TA index, compared to the calculated average ($\overline{TA}$ = 5.30), the positive difference ($p<0.05$, *) generated the Gv2 genotype, and the negative difference ($p<0.05$, o) was recorded in the Gv3 genotype (Table 13, Figure 6).

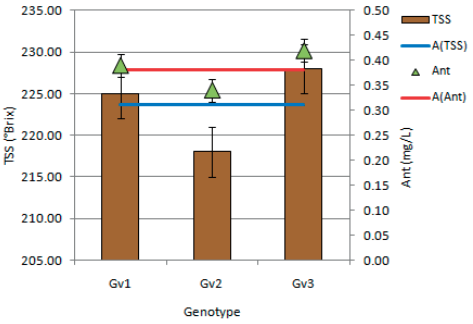

Figure 6. Graphical representation of TSS and Ant parameters by genotypes and experimental average

Table 13. Results of the comparative analysis for the TA parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	5.30	5.50	5.10
Sample mean	5.30		
95% conf. interval	(5.1447 5.4553)	(5.1447 5.4553)	(5.1447 5.4553)
Difference	0.00	0.20	0.20
95% conf. interval	(-0.15526 0.15526)	(0.044738 0.35526)	(0.044738 0.35526)
t	0.0000	-2.9704	2.9704
p (same mean)	1.0000	0.0179	0.0179
Significance	ns	*	o

In the case of anthocyanin content (Ant), compared to the calculated average ($\overline{Ant}$ = 0.38 hg/L), the positive difference ($p<0.05$, *) generated the Gv3 genotype, and the negative difference ($p<0.05$, o) was recorded in the Gv2 genotype (Table 14, Figure 6).

Table 14. Comparative analysis results for the Ant parameter

Statistical parameters	Gv1	Gv2	Gv3
Given mean	0.39	0.34	0.42
Sample mean	0.38		
95% conf. interval	(0.35332 0.41335)	(0.35332 0.41335)	(0.35332 0.41335)
Difference	0.01	0.04	0.04
95% conf. interval	(-0.02335 0.036684)	(0.013316 0.07335)	(0.0066495 0.066684)
t	-0.5122	3.3290	-2.8168
p (same mean)	0.6224	0.0104	0.0226
Significance	Ns	o	*

"Terroir" parameters, in the form of the content of mineral elements (especially nitrogen), climatic parameters (soil temperature and

humidity, climatic regime), presented specific influence in relation to the yield, the quality of grapes, and the quality of wine products (van Leeuwen et al., 2018). Grape berry size has been found to be a good indicator for estimating grape ripeness, as well as for certain quality indices, such as anthocyanins, phenolic compounds, and berry sugar (Wisdom & Considine, 2022). Different values of grape quality traits for the "Cabernet Sauvignon" variety were reported in relation to the growing regions, and the main quality indices associated with the region were anthocyanins, titratable acids, and total phenols (Ren et al., 2023).

The correlation between shoot parameters, productivity elements, yield, productivity coefficients and indices, and quality indices was evaluated based on the values recorded for the three grapevine varieties (Figure 7).

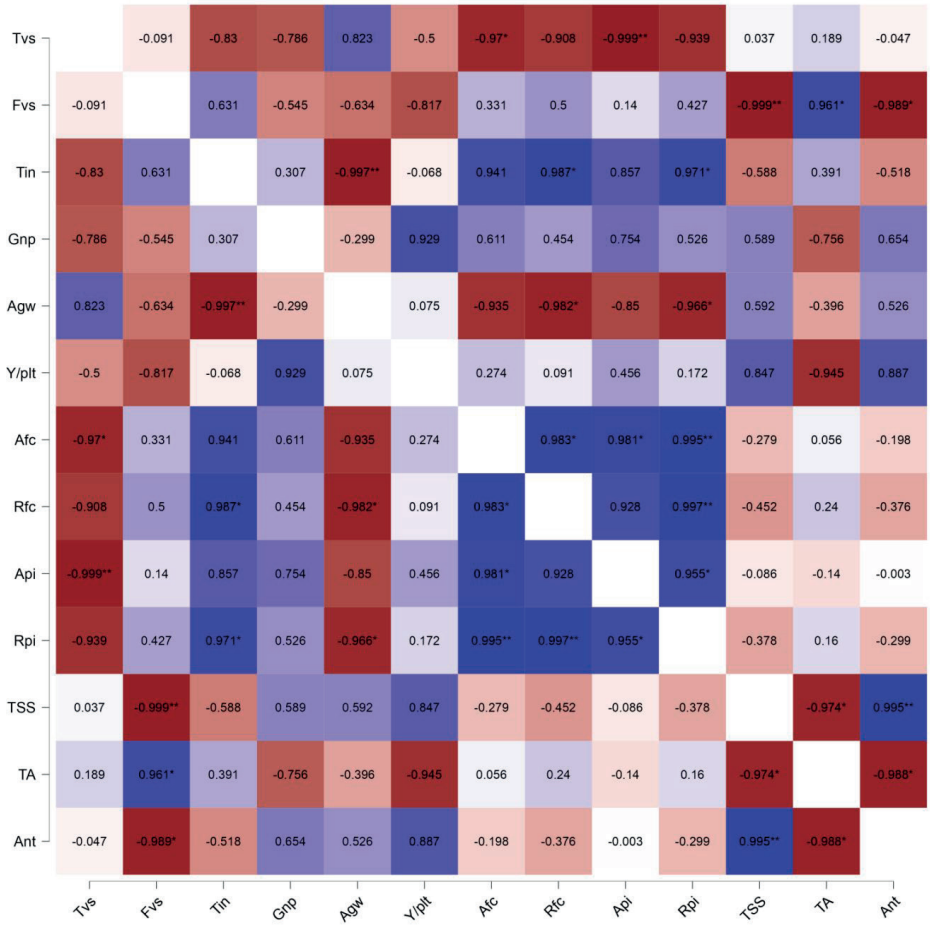

Figure 7. Correlation matrix between parameters determined in the vineyard

Positive and negative correlations of different intensity levels were recorded between the parameters considered. Certain values of the correlation coefficient are of interest, with high implication in the cultivation practice. The parameter Agw showed a positive correlation with Tvs (r = 0.823) and a negative correlation with Tin (r = -0.997**). The yield (Y/plt) showed a positive correlation, of very strong intensity, with Gnp (r = 0.929).

The TSS quality index showed a negative correlation with Fvs (r = -0.999*), with TA (r = -0.974*) and with Tin (r = -0.588) and a positive correlation with Gnp (r = 0.589), with Agw (r =

0.592), with Y/plt (r = 0.847) and with the Ant quality index (r = 0.995**).
Total acidity (TA) showed a negative correlation with Gnp (r = -0.756), with Y/plt (r = -0.945), with TSS (r = -0.974*) and with Ant (r = -0.988*). Positive correlation was recorded between TA and Fvs (r = 0.961*). The Ant quality index showed a negative correlation with Fvs (r = -0.989*), with Tin (r = -0.518), and with TA (r = -0.988*).
Based on the results recorded in the determined parameter values, and the differences calculated for each genotype, in relation to the average values, a performance diagram of the grapevine genotypes was generated (Figure 8).

	Gv1	Gv2	Gv3
Tvs	**	ns	ns
Fvs	ns	**	o
Tin	o	*	ns
Gnp	ns	ns	**
Agw	*	o	ns
Y/plt	ns	ns	**
TSS	ns	o	*
TA	ns	*	o
Ant	ns	o	*

Figure 8. Performance diagram of grapevine genotypes in relation to the parameters considered
Notes: green colour - significant positive differences; yellow colour - significant negative differences; gray - insignificant differences

Information associated with the type of correlation and the level of intensity is important for maintenance and fruiting pruning in the vine. A negative correlation (R = 0.704) was reported between shoot number and shoot length in grapevines, with effects on leaf area and berry quality indices (Kliewer & Dokoozlian, 2005). Negative relationships were reported between bud number (controlled by pruning), shoot number (controlled by maintenance work) and leaf area in grapevines, and between the change in the ratio of fruit weight to leaf area (Myers et al., 2008). A strong negative correlation (r = -0.70; 0.84) was reported during the study period between TSS and TA in grapevines (Williams et al., 2023).
In relation to the parameters Tvs, Fvs, and Tin, Gv1 and Gv2 showed advantages. In relation to the parameters Gnp and Y/plt, the genotype Gv3 showed an advantage, and in relation to Agw, the genotype Gv1 showed an advantage. In relation to Tss and Ant, the genotype Gv3 showed an advantage, and in relation to TA, the genotype Gv2 showed an advantage.

CONCLUSIONS

The grapevine varieties studied generated differentiated values for the productivity, yield, and quality indices considered in the study.
The Gv1 genotype was highlighted in the case of the Tvs parameter, with a positive difference from the experiment average ($p<0.01$, **). The Gv2 genotype was highlighted in the case of the Fvs parameter, with a positive difference from the experiment average ($p<0.01$, **) and in the case of the Tin parameter, with a positive difference from the experiment average ($p<0.05$, *).
In the case of the Gnp parameter, the Gv3 genotype was highlighted, with a positive difference from the experiment average ($p<0.01$, **). The Gv1 genotype was highlighted in the case of the Agw parameter, with a positive difference from the experiment average ($p<0.05$, *). In the case of the Y/plt yield, respectively Y/ha, the Gv3 genotype was highlighted, with a positive difference from the experiment average ($p<0.01$, **).
In the case of quality indices, the Gv3 genotype was highlighted in the case of TSS, with a difference above the average value of the experiment ($p<0.05$, *) and in the case of Ant, with a difference above the average value of the experiment ($p<0.05$, *). The Gv2 genotype was highlighted in the case of the TA index, with a difference above the average of the experiment ($p<0.05$, *).
A variable level of correlation was recorded between the parameters and indices determined for the three grapevine varieties. It is worth considering the correlation of the Gnp, Agw, and Y/plt parameters with the values of the shoot parameters (Tvs, Fvs, Tin) and the quality indices (TSS, TA, Ant) with the other parameters of the grapevine, the genotypes

studied, in order to optimize the cultivation technology and ensure performance at the level of yield and quality indices.

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