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IMPACT OF UNFAVORABLE CLIMATIC CONDITIONS IN 2025 ON CERTAIN TABLE GRAPEVINE GENOTYPES FROM THE MURFATLAR VITICULTURAL CENTER

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Abstract

Grapevine is particularly vulnerable to late spring frosts, especially during the early stages of vegetative growth. Between 26 and 30 April, a severe frost event was recorded in the Murfatlar viticultural center, with minimum temperatures reaching –1°C, which caused complete necrosis of the primary shoots at BBCH phenological stages 11-13. The present study aimed to evaluate the effects of this climatic accident on the vegetative and productive behavior of four table grapevine genotypes: Cardinal, Aurana, Muscat Hamburg, and Afuz Ali 93 Mf. The results indicated a significant reduction in the number of fertile shoots and inflorescences per vine across all analyzed genotypes, with the most pronounced losses observed in Aurana and Cardinal. The real fertility coefficient showed values below the multiannual average (2015-2024), highlighting the low fertility of secondary buds. Productivity indices were also reduced; however, the average cluster weight was maintained or slightly increased in Muscat Hamburg and Afuz Ali 93 Mf. Among the genotypes, Afuz Ali 93 Mf demonstrated the highest biological and productive stability under unfavorable climatic conditions.

Key words: *grapevine, bud fertility, productivity indices, genotypes, climatic stress.*

INTRODUCTION

In the context of ongoing climate change, the frequency and intensity of extreme weather events have increased significantly, generating considerable challenges for agricultural systems worldwide. Viticulture is particularly sensitive to climatic variability because the growth, development, and productivity of grapevines are strongly influenced by environmental conditions during the vegetative cycle. Temperature fluctuations, especially during the transition from winter dormancy to active growth, can cause significant disturbances in grapevine physiology and yield formation (Jones et al., 2005; Hannah et al., 2013).

Among the climatic hazards affecting vineyards, late spring frosts represent one of the most damaging events, particularly in temperate wine-growing regions. These frosts occur after budburst, when young shoots and developing tissues have low tolerance to subzero temperatures. Even short exposures to temperatures between –1°C and –3°C can lead to severe damage, including necrosis of primary shoots and destruction of inflorescences (Keller, 2015). Consequently, grapevine recovery largely depends on the development of secondary or tertiary buds, which usually have a lower fertility potential and a reduced capacity to ensure normal yield levels (Friend and Trought, 2007).

The impact of spring frost on vineyard productivity depends on several factors, including the phenological stage at the time of the event, the intensity and duration of low temperatures, vineyard topography, and the genetic characteristics of the cultivated varieties (Molitor et al., 2014). In recent years, earlier budburst induced by warmer winters and springs has increased the vulnerability of grapevines to late frost episodes, particularly in regions characterized by high interannual climatic variability (Leolini et al., 2018). Consequently, identifying varieties or genotypes with greater resistance to climatic stress has become an important objective in modern viticulture.

The damage caused by spring frost can significantly alter the vegetative balance of grapevines, reducing the number of fertile shoots and inflorescences and ultimately affecting yield components such as the number of clusters, cluster weight, and berry composition. However, certain grapevine geno-

types may exhibit different levels of tolerance and recovery capacity, which may partially mitigate yield losses (Keller, 2015). Therefore, evaluating the response of different varieties to frost events is essential for improving vineyard management strategies and selecting plant material better adapted to changing climatic conditions. The damage caused by spring frost can significantly alter the vegetative balance of grapevines, reducing the number of fertile shoots and inflorescences and ultimately affecting yield components such as the number of clusters, cluster weight, and berry composition. However, certain grapevine genotypes may exhibit different levels of tolerance and recovery capacity, which may partially mitigate yield losses (Keller, 2015). Therefore, evaluating the response of different varieties to frost events is essential for improving vineyard management strategies and selecting plant material better adapted to changing climatic conditions.

Under these conditions, the present study investigates the effects of a late spring frost event recorded between April 26 and April 30 in the Murfatlar viticultural center on the vegetative and productive behavior of several table grape genotypes. The research focuses on assessing the impact of this climatic event on fertility parameters, productivity indices, and vegetative behavior characteristics of four grapevine genotypes: 'Cardinal', 'Aurana', 'Muscat Hamburg', and 'Afuz Ali 93 Mf'. The results provide useful information regarding the biological stability and adaptive capacity of these genotypes under unfavorable climatic conditions.

MATERIALS AND METHODS

In 2025, during the period April 26-30, a severe frost event was recorded in the Murfatlar viticultural center, with minimum temperatures reaching –1°C, which caused complete necrosis of the main shoots in the BBCH 11-13 phenophases (Figure 1).



'Cardinal' 'Aurana'

Figure 1. - Frost damage observed on young grapevine shoots

The present study aimed to evaluate the effects of this climatic event on the vegetative and productive behavior of four table grape genotypes: 'Cardinal', 'Aurana', 'Muscat Hamburg', and 'Afuz Ali 93 Mf', cultivated in the vineyards of the Murfatlar Research and Development Station for Viticulture and Oenology.

The studied varieties were grafted onto the same rootstock, Oppenheim Selection 4, clone 4, and the training system adopted was the classic Guyot, with a load of 34-38 buds per vine and a planting distance of 2.2 m between rows and 1.1 m between vines. The plots cultivated with these varieties are located on land with an east-west exposure, a 2% slope, and a calcareous chernozem soil with a clayey texture and granular-glomerular porous structure, containing 2.3% humus. In order to describe the response of grapevine varieties to the climatic factors specific to the viticultural year and the local area, observations on the succession of vegetative phenophases were carried out between November 1, 2024 and October 30, 2025, recording the date when 50% of the plants physiologically reached each stage.

To monitor climatic elements, the automatic meteorological station iMetos 3.3 was used, located in the center of the vineyard plantation at the Murfatlar Research and Development Station for Viticulture and Winemaking. Daily observations were performed and the main climatic parameters were recorded: maximum and minimum temperatures, sunshine duration, relative air humidity, and precipitation. Based on these records, the evolution of abiotic stress during the viticultural year November 1, 2024-October 30, 2025 was determined and compared with the multiannual average (2015-2024).

To characterize the heliothermal and water resources during this interval, several synthetic ecological indicators were used: the real heliothermal index (Branas et al., 1946), the hydrothermal coefficient (Seleaninov, 1936), the grapevine bioclimatic index (Constantinescu et al., 1936), the oenoclimatic aptitude index (Teodorescu, 1987), the heliothermal index (IH) (Huglin, 1978), and the cool night index (IF) (Tonietto et al., 2000). Grape yield was determined at harvest by establishing the average yield per hectare. The relationships between agrobiological and productivity indicators were evaluated by calculating the Pearson correlation coefficient (r), used to determine the intensity and direction of the linear relationship between two numerical variables. The correlation analysis was performed based on the average values determined for each variety in 2025, using Microsoft Excel (Sedgwick, 2012).

RESULTS AND DISCUSSIONS

In 2025, the main specific indicators were monitored and evaluated in relation to the ecological conditions characteristic of the reference year.

For each variety, the values of the relevant agrobiological and technological indicators were recorded and interpreted, following the evolution of the vegetative cycle and phenological stages, growth dynamics, fertility and productive potential, as well as the adaptation relationships to the dominant ecological factors. Monitoring these parameters allowed the identification of the behavioral particularities of each variety in relation to the climatic and edaphic characteristics of the area.

The comparative analysis of the main climatic elements presented in Table 1 for the average period 2015-2024 and for the year 2025 reveals several important changes in the thermal, pluviometric, radiative, and bioclimatic regime of the cultivation area of the varieties 'Cardinal', 'Aurana', 'Muscat Hamburg', and 'Afuz Ali 93 Mf'.

The thermal balances (global, active, and useful) recorded lower values in 2025 compared to the average of the period 2015-2024: the global thermal balance (Σt°g) decreased from 5336.8°C to 4934.4°C; the active thermal balance (Σt°a) from 4723.1°C to 4379.7°C; and the useful thermal balance (Σt°u) from 2677.1°C to 2253.3°C.

These decreases, ranging between 7.3% and 15.9%, together with the late frost episodes (the first episode: April 7-11, 2025 with minimum temperatures between –1.9°C and –0.9°C - BBCH 03-07, and the second episode: April 26-30, 2025 with temperatures between –1.0°C and 0.3°C in the air and–2.0°C to –4.7°C at ground level - BBCH 11-13), suggest a reduction in the thermal energy available for biogeophysical processes, reflecting a shorter period of accumulation of useful temperatures (>10 °C).

Although the annual average temperature remained constant (14.8°C), the seasonal redistribution of heat becomes evident. The average temperature in July increased slightly (from 27.0°C to 27.5°C), while August and September recorded decreases of –1.2°C and –1.5°C, respectively. This phenomenon indicates a shift of the thermal maximum toward mid-summer, with an earlier cooling of autumn. Moreover, the absolute minimum temperature in the air (–13.2°C) and at the soil surface (–16.1°C) indicates a moderation of winter thermal extremes, characteristic of a climate with milder winters.

Therefore, the thermal regime in 2025 can be characterized as moderately warm, with reduced seasonal amplitudes but with a total thermal energy lower than the multiannual average. Annual precipitation decreased from 476.3 mm (average 2015-2024) to 342.0 mm in 2025, representing a reduction of approximately 28%. During the vegetative period, the decrease was even more pronounced, from 259.5 mm to 165.2 mm, indicating a deficit of more than 40%. Such a level of precipitation, correlated with the high

temperatures during the summer period, resulted in a hydrothermal coefficient (HC) of 0.5, well below the threshold of 1 that, according to Seleaninov's methodology (apud Teodoreanu, 1980), delineates areas with a semiarid regime. Regarding the heliothermal regime, the total annual duration of actual sunshine increased from 2178.3 hours (2015-2024) to 2357.4 hours in 2025, corresponding to an increase of approximately 10% in actual radiation. In contrast, during the vegetative period, the duration of sunshine decreased slightly (from 1560.6 to 1463.8 hours), suggesting a contraction of the bioactive season as a result of the early autumn cooling. The real heliothermal index (IHr) recorded a higher value (4.4 compared with the multiannual average of 4.0), confirming an increased intensity of radiation and energy available for photosynthesis, particularly during the summer months.

Table 1. Analysis of the climatic conditions during the period 2024-2025 compared with the multiannual average for the interval 2015-2024

Analyzed climatic elements	Multiannual mean 2015-2024	Viticultural year 2024-2025
Global thermal balance (Σt°g)	5336.8	4934.4
Active thermal balance (Σt°a)	4723.1	4379.1
Useful thermal balance (Σt°u)	2677.1	2253.3
Average temperature in July (°C)	27.0	27.5
Average temperature in August (°C)	26.3	25.1
Average temperature in September (°C)	21.1	19.6
Absolute minimum air temperature (°C)	-15.0	-13.2
Absolute minimum temperature at soil surface (°C)	-18.8	-16.1
Mean annual temperature (°C)	14.8	14.8
Maximum air temperature (°C)	37.8	39.9
Total annual precipitation (mm)	475.6	342.0
Total precipitation during the vegetative period (mm)	259.5	165.2
Total annual sunshine duration (hours)	2178.3	2357.4
Sunshine duration during the vegetative period (hours)	1560.6	1463.8
Average maximum temperature in August (°C)	36.0	30.7
Average temperature in the first and second decades of June	23.7	23.3
Number of days with maximum temperatures > 30°C	74.3	61.0
Duration of the bioactive period (days)	194.0	195.0
Real heliothermal index (IHr)	4.0	4.4
Hydrothermal coefficient (CH)	0.7	0.5
Bioclimatic index (Ibcv)	13.5	15.5
Oenoclimatic aptitude index (IAOe)	5410.0	5197.2
Huglin heliothermal index (IH)	3209.3	2434.0
Cool night index (IF)	14.2	12.9

This combination of high insolation and reduced precipitation accentuates the continental and arid character of the climate, favoring an increased risk of atmospheric drought (Marinică, 2006).

The bioclimatic index (Ibcv) increased from 13.5 (multiannual average) to 15.5 in 2025, indicating an improvement in the thermal comfort of grapevines, although this aspect is counterbalanced by generalized water stress. The cool night index (IF) decreased from 14.1 (average for 2015-2024) to 12.9 in 2025, suggesting cool nights, a value very close to the threshold of temperate nights, a phenomenon favorable for sugar accumulation, acidity preservation, and aroma intensification in grapes.

Regarding the oenoclimatic aptitude index (IAOe), the values decreased from 5410 to 5197.2, while the Huglin index (IH) decreased significantly (from 3209.3 to 2434.0).

This reduction of 24.1% reflects less favorable conditions for the ripening of grape varieties with very high thermal requirements. The overall climatic values analyzed for 2025 compared with the 2015-2024 average indicate a clear trend toward the aridization and continentalization of the regional climatic

regime. Although the annual average temperature remained constant, the decrease in active and useful thermal balance, together with the significant reduction in precipitation and the increase in insolation, outlines a warm and dry regime characteristic of periods of climatic imbalance. Thus, the year 2025 can be considered a year with unfavorable agroclimatic potential, especially for grapevine cultivation, due to the late spring frosts followed by a pronounced water deficit and a reduction in useful thermal resources. The observed trends are consistent with the context of regional climatic changes recorded in recent decades in southeastern and eastern Romania, characterized by the alternation of warm and dry years with short periods of pluviometric recovery (Bogdan & Marinică, 2007; Cheval et al., 2017; Dumitrașcu et al., 2017).

The data presented in Table 2 reflect the dynamics of the phenological stages (budburst, flowering, veraison, and ripening) for the four grapevine genotypes – 'Cardinal', 'Aurana', 'Muscat Hamburg', and 'Afuz Ali 93 Mf' (Figure 2) – reported in relation to the average values for the period 2015-2024 and the specific values recorded in 2025. The analysis highlights significant differences in the rate of development and the duration of the vegetative period, correlated with the climatic conditions specific to the year 2025. This delay (1-4 days) in budburst, associated with a colder and more unstable spring, was reflected in the decrease in the active thermal balance at the beginning of the vegetative season. Flowering also occurred later than the multiannual average, by 8-11 days. This delay was caused by the deficit of accumulated heat during the early summer period (May-June), also confirmed by the reduction in the active and useful thermal balances in 2025.

Table 2. Evolution of the vegetative phenophases of the table grape varieties 'Cardinal', 'Aurana', 'Muscat Hamburg', and 'Afuz Ali 93 Mf' in 2025 compared with the period 2015-2024 at the Murfatlar Research and Development Station for Viticulture and Winemaking (S.C.D.V.V. Murfatlar)

Genotype Variety/clone	Year	Budburst	Flowering	Veraison	Ripening	No. Days from budburst to full ripening
'Cardinal'	Average*	9.04-26.04 17.04	24.05-10.06 1.06	18.07-2.08 25.07	24.08-30.08 27.08	132
	2025	20.04	12.06	24.07	29.08	131
	Difference	+3 (Delayed) **	+11 (Delayed)	+1 (Delayed)	+2 (Delayed)	-1 (Early) ***
'Aurana'	Average	12.04-22.04 17.04	25.05-9.06 1.06	22.07-8.08 29.07	25.08-30.8 27.08	132
	2025	21.04	10.06	01.08	30.08	131
	Difference	+4	+9	+3	+3	-1
'Muscat Hamburg'	Average	9.04-28.04 19.04	30.05-9.06 4.06	24.07-9.08 1.08	2.09-9.09 5.09	140
	2025	20.04	13.06	13.08	17.09	150
	Difference	+1	+9	+12	+12	+10
'Afuz Ali 93 Mf'	Average	14.04-29.04 21.04	29.05-10.06 4.06	5.08-19.08 11.08	2.09-18.09 10.09	141
	2025	22.04	12.06	19.08	23.09	154
	Difference	+1	+8	+8	+13	+13

*Multiannual mean 2015-2024; **Delayed; ***Early.

From a physiological perspective, this stage depends on the accumulation of a minimum thermal sum of approximately 200-300°C above 10°C, which in 2025 was achieved more slowly. The veraison stage (the onset of sugar accumulation in the berries) shifted significantly toward the end of summer, occurring one day earlier for the 'Cardinal' variety, while delays of approximately 3 days were recorded for 'Aurana', 12 days for 'Muscat Hamburg', and 8 days for 'Afuz Ali 93 Mf'. The delay in veraison was a consequence of the moderate temperatures recorded in July and the pronounced water deficit, which limited active growth and photosynthetic metabolism. Full ripening was the most affected stage. Compared to the multiannual average for the period 2015-2024, it was reached 2-3 days later for the 'Cardinal' and

'Aurana' varieties. For the mid-season and late varieties, 'Muscat
Hamburg' and 'Afuz Ali 93 Mf', ripening was significantly delayed (by 12-13 days). This delay was caused by the lack of useful thermal resources during the August-September period, when average temperatures were lower than the multiannual normal (−1.2°C in August and −1.5°C in September). The total duration of the vegetative period (budburst – full ripening) showed slight variation among the varieties. Early varieties ('Cardinal', 'Aurana') maintained a relatively constant duration of the vegetative period, adapting better to the climatic conditions of 2025. In contrast, the mid-season and late varieties ('Muscat Hamburg', 'Afuz Ali') experienced an extension of the vegetative period by 10-13 days, indicating a slowdown of physiological processes due to the decrease in useful thermal balance and the water deficit during the ripening period.

The ability of grapevine varieties to differentiate fruit buds and form inflorescences on shoots represents fertility. Biological fertility and productivity are essential indicators for evaluating the performance of grapevine varieties, especially in the current context of climate change, which significantly affects growth and yield parameters. Determining the fertility of varieties each year aims to identify variations in their performance under potentially unfavorable conditions, as well as to highlight genotypes that exhibit high biological stability. The comparative analysis of the data obtained in 2025, in relation to the multiannual average (2015-2024), highlights significant changes in the vegetative and productive behavior of the four studied genotypes. The indicators related to bud fertility, fruiting coefficients, and productivity indices demonstrate a general imbalance in reproductive potential, with variations specific to each variety.

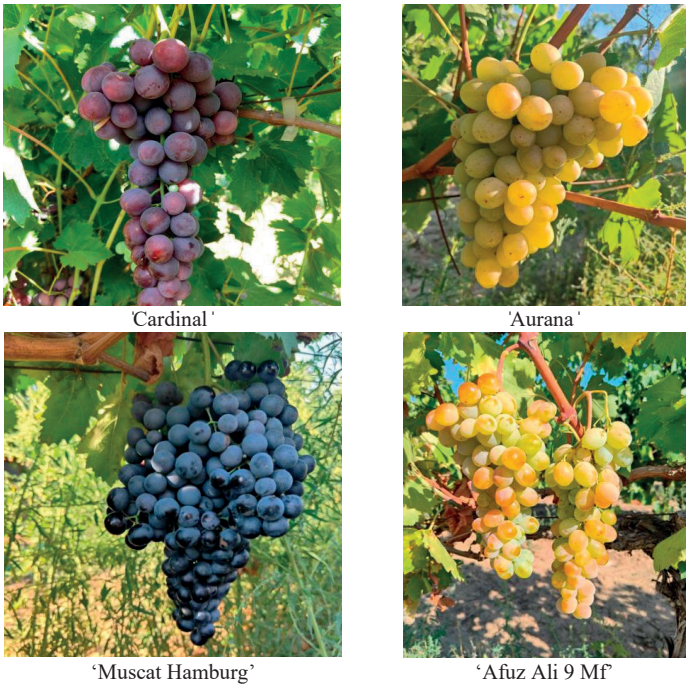

Figure 2. Appearance of the table grape varieties studied in 2025 at full ripeness in the vineyards of the Murfatlar Research and Development Station for Viticulture and Winemaking (S.C.D.V.V. Murfatlar)

The comparative analysis of the data obtained in 2025, in relation to the multiannual average (2015-2024), highlights significant changes in the vegetative and productive behavior of the four studied genotypes. The indicators related to bud fertility, fruiting coefficients, and productivity indices demonstrate a general imbalance in reproductive potential, with variations

specific to each variety. Referring to the dynamics of vegetative growth and shoot fertility, it can be observed in Table 3 that the total number of shoots per vine recorded lower values in 2025, particularly in the varieties 'Cardinal' (−42%) and 'Muscat Hamburg' (−54%), indicating reduced vegetative vigor. This decrease is attributed to unfavorable climatic conditions during the early stages of vegetative growth, specifically the late frosts recorded in April.

The number of fertile shoots decreased drastically in all genotypes, especially in 'Aurana' (−77%) and 'Cardinal' (−64%). Consequently, the coefficient of fertile shoots (LF%) was considerably reduced (from 72-62% to 45-16%), indicating low bud fertility. The number of inflorescences per vine also decreased significantly in all varieties; the reduction was more pronounced in 'Aurana' (from 15 to 3) and 'Cardinal' (from 18 to 5).

As a result, the real fertility coefficient (Cfr) recorded lower values than the multiannual average (0.2-0.5 compared to 0.7-1.0), confirming the weak fertility of secondary buds that developed after the late April frost, which affected the primary shoots in the BBCH 11-13 development stage.

The values of the absolute productivity index (Ipa) and the real productivity index (Ipr) showed significant decreases in most varieties, reflecting the reduction in production potential. However, in 2025 the average cluster weight remained relatively constant compared with the multiannual average or increased slightly in 'Muscat Hamburg' and 'Afuz Ali 93 Mf', indicating a favorable redistribution of assimilates toward the formed clusters.

Compared with the multiannual average for the period 2015-2024, the clone 'Afuz Ali 93 Mf' showed the highest physiological stability, maintaining moderate values of fertility and productivity indices even under unfavorable conditions. 'Muscat Hamburg' compensated for shoot losses through an increase in cluster weight, while 'Aurana' showed the lowest bud fertility (LF = 16%), highlighting a high sensitivity to climatic stresses, particularly late frosts and water deficit. Due to the late frosts recorded in April, grape yield was drastically affected, remaining well below the multiannual average (reference period 2015-2024) for all the studied varieties. The lowest yield was recorded for the 'Aurana' variety. Although the berries remained relatively large, the reduced number of clusters led to a significant decrease in total yield, from a multiannual average of 13.8 t/ha (2015-2024) to 4.36 t/ha. The 'Cardinal' variety was the most severely affected by the late frosts in 2025; the number of clusters was very low, and the total yield reached only 5.70 t/ha compared with the multiannual average of 12.9 t/ha (2015-2024).

Table 3. Fertility and productivity parameters determined for the table grape varieties 'Cardinal', 'Aurana', 'Muscat Hamburg', and 'Afuz Ali 93 Mf' in 2025 compared with the average for the period 2015-2024 at the Murfatlar Research and Development Station for Viticulture and Winemaking (S.C.D.V.V. Murfatlar)

Genotye Variety/Clone	Year	Total shoots per vine	Fertile shoots per vine	Fertile shoots coefficient (LF) %	Inflorescences	Fertility coefficients		Productivity indices		Cluster weight
						Cfr	Cfa	Ipa	Ipr	
'Cardinal'	Average*	19	14	72	18	0.9	1.3	379.6	262.8	292
	2025	11	5	45	5	0.4	1.0	276.0	110.4	276
'Aurana'	Average*	21	13	62	15	0.7	1.1	463.1	294.7	421
	2025	19	3	16	3	0.2	1.0	252.0	70.4	352
'Muscat Hamburg'	Average*	24	17	72	24	1.0	1.4	238.0	333.2	238
	2025	11	5	45	6	0.5	1.2	346.8	144.5	289
'Afuz Ali 93 Mf'	Average*	19	11	54	13	0.7	1.2	518.4	302.4	432
	2025	15	5	33	7	0.5	1.4	222	201.6	444

*Multiannual average 2015-2024

For the 'Muscat Hamburg' variety, although the average cluster weight increased as a result of the reduced crop load per vine, the total yield remained significantly lower. The variety partially compensated for the reduced number of clusters through their higher weight. Compared with the multiannual average, the yield was 6.04

t/ha lower (7.16 t/ha compared with the average yield of 13.2 t/ha for the period 2015-2024).
The clone 'Afuz Ali 93 Mf' proved to be more resistant and better adapted to the variable climatic conditions of this year, showing the best performance by achieving a yield close to the multiannual average (12.78 t/ha compared with 13.7 t/ha, the average yield for the period 2015-2024) (Table 4).

Table 4. Potențialul de producţie ale soiurilor de masă de la S.C.D.V.V. Murfatlar
în anul 2025 comparativ cu intervalul 2015-2024

Genotype Variety/clone	Year	Clusters/vine	Mean cluster weight g	Yield kg/but	Yield t/ha
'Cardinal'	Average*	11	292	3.30	12.90
	2025	5	276	1.38	5.70
'Aurana'	Average *	8	421	3.30	13.80
	2025	3	352	1.06	4.36
'Muscat Hamburg'	Average *	14	238	3.30	13.20
	2025	6	289	1.73	7.16
'Afuz Ali 93 Mf'	Average *	8	432	3.50	13.70
	2025	7	444	3.09	12.78

*Multiannual average 2015-2024.

The analysis of the relationships between agrobiological and productivity indicators, performed using the Pearson correlation coefficient (r) (Table 5), highlighted the existence of strong correlations between shoot fertility, the number of inflorescences, and yield components. The relative fertility coefficient (Cfr) shows a very strong positive correlation with the number of inflorescences (r = 0.966), while the absolute fertility coefficient (Cfa) is strongly correlated with the relative productivity index (Ipr) (r = 0.956), indicating a direct relationship between shoot fertility and the productive potential of the vines. At the same time, the relative productivity index shows a very strong positive correlation with yield per vine (r = 0.965), while the absolute fertility coefficient is also strongly correlated with yield (r = 0.961).

Table 5. Pearson correlation matrix among agrobiological
and productivity indicators of the studied grapevine cultivars (2025)

	Total shoots	Fertile shoots	LF %	Inflorescences	Cfr	Cfa	Ipa	Ipr	Cluster weight	Clusters/vine	Yield kg/but	Yield t/ha
Total shoots	1.000											
Fertile shoots	-0.870	1.000										
LF %	-0.996	0.911	1.000									
Inflorescences	-0.561	0.878	0.629	1.000								
Cfr	-0.739	0.943	0.790	0.966	1.000							
Cfa	-0.091	0.522	0.171	0.866	0.739	1.000						
Ipa	-0.632	0.278	0.580	0.046	0.287	-0.208	1.000					
Ipr	-0.331	0.736	0.411	0.967	0.871	0.956	-0.158	1.000				
Cluster weight	0.577	-0.102	-0.502	0.338	0.089	0.709	-0.777	0.567	1.000			
Clusters/vine	-0.561	0.878	0.629	1.000	0.966	0.866	0.046	0.967	0.338	1.000		
Yield kg/but	-0.092	0.564	0.179	0.869	0.713	0.961	-0.398	0.965	0.758	0.869	1.000	
Yield t/ha	-0.094	0.566	0.182	0.870	0.715	0.961	-0.396	0.965	0.756	0.870	1.000	1.000

The number of inflorescences and the number of clusters per vine show strong positive correlations with yield (r = 0.869), suggesting the important role of these indicators in determining production levels.
Cluster weight shows a moderate positive correlation with yield per vine (r = 0.758), indicating a smaller contribution of this indicator compared with the number of clusters. A very strong negative correlation is also observed between the total number of shoots and the percentage of fertile shoots (r = −0.996), which confirms the low fertility of secondary buds that developed after the late April frost,

which affected the primary shoots in the BBCH 11–13 developmental stage.

CONCLUSIONS

From a pedological perspective, the Murfatlar area provides excellent conditions for the cultivation of table grape varieties, with an optimal level of soil fertility, drainage, and water retention capacity. However, the analysis of the climatic parameters indicates a tendency toward aridization, with direct effects on the biological performance and productivity of the varieties.

The varieties 'Cardinal' and 'Aurana' showed increased sensitivity to thermo-hydric stress, requiring protective management practices such as irrigation and balanced pruning. 'Muscat Hamburg' shows moderate adaptation, maintaining stable vigor but with reduced fertility. The clone 'Afuz Ali 93 Mf' demonstrates the highest phenological and productive stability under the conditions of 2025 and is therefore recommended as a reference variety for semiarid viticultural areas in Dobrogea.

The correlation coefficients indicate that the variation in yield among the analyzed varieties is mainly associated with shoot fertility and the number of inflorescences formed per vine, indicators that show the strongest relationships with yield. In contrast, cluster weight contributes to a lesser extent to the differences in productivity among genotypes.

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