Studies Regarding New Genotypes for Table Grape Varieties Adapted to the Restrictive Conditions of North-Eastern Romania

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Abstracts: Table grapes' genotypes are cultivated in ecosystem that exhibit a high degree of favourability from the point of view of the eco-climatic conditions, where large and qualitative productions, with a small percentage of rejects, are guaranteed, eliminating special technical interventions.

Studies conducted on limitative biotope factors for vine culture show that the level of climatic and eco-pedological factors are favourable for the cultivation of different table grapes genotypes vine in Romania, both varieties for table grapes and wine, in well defined areas.

The new created genotypes, namely *Vitis vinifera L.* Gelu and *Vitis vinifera L.* Paula, were taken into study. These new genotypes were created at the Research Station for Viticulture and Wine making Iasi, Romania. The study followed the technological and agro-biological values of the two varieties, compared with the control samples, genotype *Vitis vinifera L.* Aromat de Iaşi, for better discussing their production potential and quality characteristics, all influenced by the degree of adaptation to the climatic conditions that are in constant change.

Keywords: Drought, Eco-climatic phenophases, Production potential, Resistance, Grapevine variety.

INTRODUCTION

Structural improvement of the assortment of table grapes' genotypes is constantly a concern of researchers. Over time a large number of genotypes for grape production were created in almost all wine-growing areas favourable for vine cultivation. The expansion of their culture was possible only after studies on the adaptability of the grape varieties to the climatic conditions of the ecosystem in which they were introduced and in conjunction with this have been highlighted a result of research concerning the agro-biological and technological features, establishing the most valuable for multiplication and cultivation.

The theme of the study falls within the general context of the research and technological agro-biological of two new varieties for table grapes Paula and Gelu, created at the Research Station for Viticulture and Wine making Iasi versus Aromat de Iasi variety, for demonstration of production potential and the quality of their degree of adaptation to the climatic conditions that are in constant change.

Table grape varieties from the point of view of the eco-climatic conditions are located in the wine-producing ecosystems that exhibit a high degree of favourability, where large, qualitative productions are obtained, with a small percentage of rejects, and eliminate the special technical interventions.

Studies conducted by Oprea [1] on limitative biotope factors for vine culture, show that the level of climatic and eco-pedological factors are favourable for the cultivation of the vine in Romania, regarding both varieties for table grapes and wine, in clearly defined areas of the crop.

Large quantities of precipitation during flowering, pollination, fecundation and setting of the berries, adversely affect physiological processes mentioned, leading to phenomena of partial destruction of inflorescences, default on grape production and its quality.

Research about the influence of temperature on budburst showed that the *Vitis vinifera* genotypes exhibit different requirements compared with useful thermal balance namely: genotypes with early budburst (Perla de Csaba, Muscat de Hamburg) require 120-140 °C useful temperature; those with middle budburst (most varieties) require 140-150 °C useful temperature-; genotypes with late budburst (Afuz Ali, Cinsaut)

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require 150-160 °C useful temperature. This constitutes a constant requirement that is not modified from one year to another [2].

The blooming phenophase requires, on average, a balance of useful heat of 120 °C, with values ranging from 100 °C for genotypes with early flowering and 130-150°C for those with late-flowering [2]. A broader study conducted over a period of 11 years (1986-1996) in the Centre of Iasi, Copou Hill Vineyard, on a number of 7 genotypes for table grapes and wine revealed that from budburst up to full bloom, the useful heat balance sheet ranged between 255 °C and 340 °C, with an average multiannual of 293 °C, and the sum of active temperatures from the same range was, on average, of 716 °C, with an amplitude of 191 °C [3].

From this study it appears that prediction of flowering using the useful thermal balance value in the long run is uncertain and that the variability of the heat requirement for triggering the blooming of vine is strongly determined by adjusting and regulating metabolic processes of each variety.

Maturation of the grapes on Romanian territory begins in the first decade of July, ending towards the end of October, having a length of 20-25 days for early varieties (Perla de Csaba), 40-45 days for the medium (Chasselas d'oré), up to 50-60 days for late and very late ones. The sum of the degrees of global temperature required from budburst up to full maturity is between 1900 °C to 2500 °C for early varieties, 2500 °C -2900 °C for medium maturation genotypes, 3000 °C -3500 °C for late varieties and over 3,700 °C for very late (major general, 2004).

Starting and conducting phenophases of vegetation are conditioned by reaching or surpassing certain thresholds of temperature, the most important being the biological threshold of 10 °C between the period length of bioactive, optimum level of daily average temperature in order to achieve budburst of 20 °C -25 °C [2].

MATERIALS AND METHODS

For the analysis of climatic data were used maps and SCDVV Iasi Agro Expert system (air temperature-average value, maximum and minimum temperature at the ground surface-mean value, minimum, and maximum rainfall, hygroscopicity and brightness), as well as those of the Regional Meteorological Centre in Moldova.

The climatic conditions of the years 2017, 2018 and 2019 have been successful in conducting research on the behavior of new varieties for table grapes, Paula and Gelu (Figure **1**), the cumulative effect of environmental factors on the stressor, but also technological properties under them, compared to another new variety created from SCDVV-aromatic, with similar maturation age and with mixed functions.

Highlighting the resistance of the varieties studied at low temperatures was performed by determining the percentage of viable buds through longitudinal section by visualization at binocular magnifier and biological method of forcing start-up buds vegetation in climate rooms.

Phenological stages of the studied varieties were determined by ratings and observations in the field concerning the budburst, flowering, *véraison*,

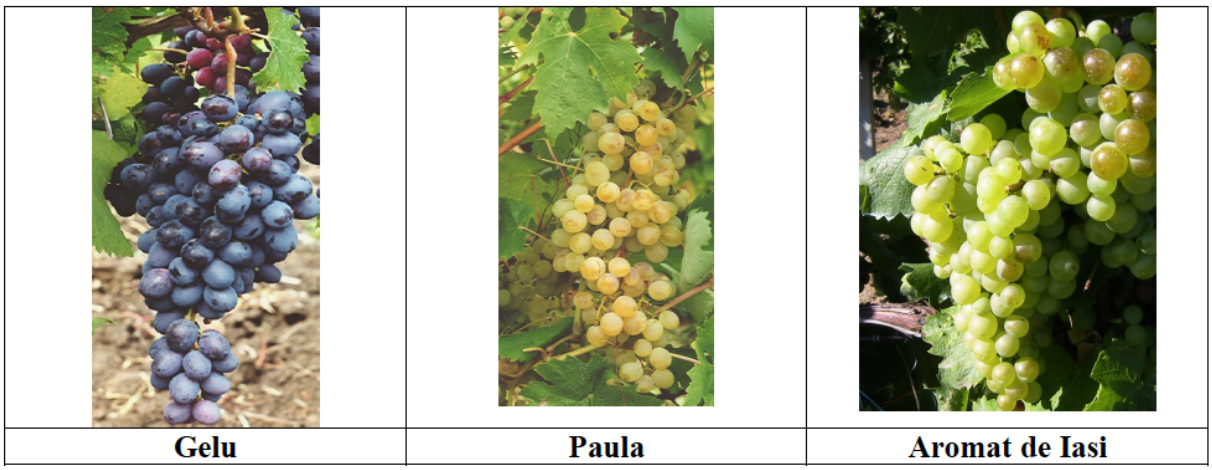

Figure 1: New vinifera creations for table grapes cultivated in the restrictive conditions in the north-eastern area of Romania.

maturation for fresh grape consumption and falling leaves.

In order to highlight the fructification capacity taken into study over the period 2017-2019 within each genotype five repetitions were established: bud-load vine, the total number of shoots/vine, the number of fertile shoots/vine, the number of sterile shoots/vine, number of inflorescences/vine, expressed in percentage of fertility shoots, fertility, fertility coefficients and their relative absolutes.

In order to determine the production elements within each variety, five repetitions of ten hubs for each year of study were performed and the results have been statistically and mathematically interpreted, which demonstrated that the production of grapes of each studied varieties is strongly connected to the fact that new genotypes have lower genetic stability. The results obtained have been compared to the control variety, Aromat de Iasi (Figure **1**).

RESULTS

Temperature along with humidity are restrictive factors determining the cultivation area as well as the economic culture of the vine around the globe, the starting and completion of phenophases, the quantity and quality of production. From a thermal point of view it was found average of 2017-2019 was warmer than normal, the average air temperature 10.3°C and respectively 10.4°C, being higher by 0.5°C - 0.6°C than the multi-annual average (1981-2010).

Absolute maximum temperature in the air had the value of 40.10°C (august 2017), and the absolute minimum temperature recorded was in February 2017 – 26.7°C in air and -33°C at the surface of the soil (Table **1**). Amounts of global temperature, active and useful of all years taken into study were higher than the multi-annual averages.

Several authors [4-6] mention that, in the temperate zone, the culture of the vine is possible in areas where annual rainfall ranges between 400 and 700 mm, out of which 250 to 300 mm during the vegetation season. From measurements made in the viticultural centre Copou, the multiannual average rainfall (1981-2010) is 579.6 mm, of which during vegetation period 398.1 mm.

In the period under review, 2017-2019, the driest year was 2017, when quantities of recorded precipitations have been distributed very unevenly in a total of only 287.1 mm, compared to the normal value 398.1 mm for the viticultural center Copou, of Iasi vineyard.

The quantity of precipitations recorded in 2018 was close to normal values, higher during the months of May, June and September when there have been 113.8 mm, 174.3 mm, mm, respectively 82.0 mm, almost double compared to multi-annual averages. These have led to the restoration of soil moisture as a result of the deficit recorded in the previous year (2017). During the growing season rainfall amounted to 501.1 mm versus multiannual average 398.1 mm in the Centre of Copou Hill, Iasi Vineyard.

In 2019 the quantities of precipitation recorded were unevenly distributed, in some months there have been very small amounts, far below the normal value, as well as periods in which there have been more than those amounts. Precipitation fell during the growing season (April-September) amounted to 377.1 millimetres, a little below the normal value of 398.1 mm and the annual data were 618.0 mm over a multiannual average of 579.6 mm.

The light in a vineyard was assessed after the amount of hours of sunlight (sunstroke) during the vegetation period. In the period under review, the maximum annual glow of the Sun was 2169.5 hours in 2017, and in the years 2018 and 2019, the glow of the Sun presented value close to but slightly lower than the average multi-annual which is 2044.4 hours (Table **1**). The amount of hours of sunstroke from vegetation period was between 1405.2 hours in 2019 and 1499.1 hours in 2017.

The combined effect of the climatic factors was expressed using synthetic indicators that integrates the action of two or three climatic factors and climate, being thus able to characterize the potential of a vineyard or viticultural centre, as well as the requirements of vine varieties studied.

The most representative heliothermic real index (IHr) had values between 2,0-2,8, larger than the multiannual limits described in literature (1.75-2.25) which shows an increase of heliothermic resources and of the optimum conditions for ripening for late varieties in the North-East of the country.

Hydro-thermic coefficient (CH) had values between 0.8 and 1.6, remaining within the limits described in literature (0.7-1.8), indicating that the humidity was sufficient, correlating with the favourable temperature.

Table 1: Synthesis of the Main Climatic Elements in the Period under Review Compared to Multi-Annual Averages

Climatic elements studied	Average 1981-2010	2017	2018	2019	Average 2017-2019
Global heat balance, ∑tºg	3168,4	3652,8	3253,9	3219,0	3375,2
Active heat balance, ∑tºa	3048,9	3596,3	3147,1	3076,7	3273,4
Useful heat balance, ∑tºu	1386,0	1856,3	1467,1	1426,7	1583,4
Average temperature in July, °C	21,0	25,4	20,5	21,5	22,5
Average temperature in August,°C	20,3	22,6	21,2	21,6	21,8
Average temperature in September,°C	15,6	18,6	14,2	16,9	16,6
The average year temperature, ºC	9,8	10,4	10,3	10,3	10,3
The average temperature/vegetation period, ºC	17,5	19,9	17,8	17,7	18,5
Absolute minimum temperature, ºC	-27,2/ 28.12.1996	-26,7/ 12.02.	-14,3/ 09.01.	-20,6/ 31.01	-26,7/ 12.02.2017
Absolute maximum temperature, ºC	42,3/ 20.07.2007	40,1/ 07.08.	33,7/ 30.07.	34,2/ 14.08	40,1/ 07.08.2017
Number of days with temperatures higher than 30 ° C	17,3	55	14	22	30,3
∑ annual real insolation, (hours)	2044,4	2169,5	1987,5	1971,1	2042,7
∑real insolation from vegetation period, (hours)	1448,2	1499,1	1426,1	1405,2	1443,5
∑ annual rainfall, (mm)	579,6	535,9	656,2	618,0	603,4
∑ rainfall from vegetation period, (mm)	398,1	287,1	501,1	377,1	388,4
Duration of period of vegetation, (days)	169	175	167	189	177,0
Coefficient hydro-thermic, (CH)	1,3	0,8	1,6	1,2	1,2
Real heliothermic index, (IHr)	2,0	2,8	2,1	2,0	2,3
Bioclimatic viticulture index , (Ibcv)	7,1	10,7	5,4	7,0	7,7
Index assessing oeno-climatic potential (IAOe)	4106,1	5058,2	4322,1	4354,8	4578,4
Annual drying index Martonne ($I_{ar\text{-}DM}$)	30,3	26,50	36,05	28,05	30,2
Index heliothermic Huglin (IH)	-	2541	2059	2103	2234
Nights cooling index (IF)	-	13,2	10,2	10,9	11,4

The values of the bio-climatic index in the vineyard (Ibcv), were 5.4 in 2018, which indicates low heliothermic resources, amid higher water resources and thereby reduces the quality and quantity of grapes and production values, The index is 10.7 in 2017 indicating high heliothermic resources and lower water resources.

Oeno-climatic proficiency index (IAOe) was in the range of 4322.1 (2018) and 5058.2 (2017), which indicates an area mainly for the production of white wines and with middle level of favourability for producing red wines, but specifically are more conducive to table grapes culture varieties maturing in ages I-IV.

Aridity index Martonne had values between 26.5 and 36.05, with an average of 30.2, indicating a semi-wet forest, in the Centre of Copou Hill, Iasi Vineyard.

The most representative heliothermic index, Huglin index provides information in connection with the thermic potential for the culture of table grapes and wine varieties, with different periods of ripening. The rationale for choosing this index rests on the fact that, compared to other heliothermic indices, the current presents close links with sugars from grape must. Depending on the values of the index, J. Tonietto and A. Carbonneau (2004) have established climatic classes.

In the case of wine-growing center Copou, Iasi, sum of the values of Huglin index was 2440 in 2017, 2059 in 2018 and 2103 in 2019. Depending on the value of the index, a warm climate class has been established for 2017, with the IH5-limit values higher than 2400 and less than or equal to 3000, and for the years 2018 and 2019, a IH3 climate class, specific to areas with

temperate climate that limit values higher than 1800, and less than or equal to 2100.

The index of cooling during the nights (IF) is involved mainly in the period of grape ripening. IF index was calculated only for the month of September, the value obtained being 13.2 in 2017, 10.2 in 2018 and 10.9 in 2019. These values fall within class < 12, corresponding to the class climate with very cool nights in the years 2018 and 2019 and the climate with cool nights in the year 2017.

DISCUSSION

Resistance to Frost of the Studied Varieties

The literature shows that the limit of resistance to frost of vineyards ranges from -15°C...-18° C for the fruiting buds of table grapes varieties, -18°C...-21°C for fruiting buds of grapes for wine-making, the shoots are affected yearly at temperatures of -20°C...-21°C and multiannual wood at -22 °C...-24 °C [7-9]. The degree of resistance depends on a number of factors such as the intensity and duration of frost, the period in which these occur in relation to the degree of preparation of the vine trunks (tempering), the level of maturation of different wooden elements, alternation of low temperatures with high ones, the quantity of the grape yield and cultural technologies practiced in the previous year [10-12].

The results showed significant losses in 2017 for both Gelu and Paula varieties as well as the control variety Aromat de Iasi. Thus, under the terms of the absolute minimum temperatures -26.7 °C in the air and -33.0°C at the ground surface, the main buds have been affected in proportion of 68-81% (Table **2**). When vegetation starts, these varieties have rebuilt the vegetative apparatus from buds protected by snow on the safety canes from the bottom of the trunk and from secondary buds on the canes. In the winter of 2018, the absolute minimum temperature in the air was of -14.3°C which does not exceed the limit of resistance of varieties for table grapes. In these circumstances the loss of shoots was between normal physiological limits. Noticeable is the variety Gelu' s greater sensibility, where main shoots have been affected at the rate of 36%.

The absolute minimum recorded temperatures in 2019 (-20.6 °C and -22.5 °C at the soil surface in 31.01.2019), as well as the phenomenon of glazed frost that persisted for two weeks have led to loss of the main buds ranging from 13 to 55%. The results obtained give a proper background of the vulnerability of the varieties studied to extreme low temperatures, emphasizing that resistance to frost is genetic in nature, but heavily influenced by the level of climatic factors.

The Behaviour of the Studied Varieties to Drought Stress

Fruiting vine plantations presents a good resistant to drought due to its deep root system that explores in depth to ensure the soil with water, especially if the

Table 2: Reaction to Frost of the Varieties Studied in the Period of 2017-2019

Genotype	Absolute Minimum Temperatures, °C		% Viable Buds		
	Air	Soil	Principals	Secondary	Total
year 2017					
Vitis vinifera L. Gelu	-26,7°C	-33,0°C	19	94	94
Vitis vinifera L Paula			32	88	88
Vitis vinifera L Aromat de Iaşi (control)			24	70	70
year 2018					
Vitis vinifera L Gelu	-14,3°C	-20,5°C	64	100	100
Vitis vinifera L Paula			97	100	100
Vitis vinifera L Aromat de Iaşi (control)			95	100	100
year 2019					
Vitis vinifera L Gelu	-20,6°C	-22,5°C	45	85	85
Vitis vinifera L Paula			68	97	97
Vitis vinifera L Aromat de Iaşi (control)			87	98	98

ground has been gained during the autumn and winter of sufficient moisture from rain and snow [13]. In the viticultural centre of Iasi, Copou vineyard, in recent years a decrease is observed in the quantities of precipitation and an uneven distribution throughout the year. Also, it was found that after a rainy couple years, 1-2 years with drought or excessive drought appear [14].

Climatic conditions, different by way of manifestation (intensity, persistence) in 2017, have allowed for studies to be useful in practice relating to wine-growing reaction to drought of new varieties for table grapes, Paula and Gelu, in terms of vegetative spectrum evolution, vegetative growths, fertility and productivity, and also the grape yield and its quality.

Drought period began during the months of August and September 2011 and continued with the winter months of November, December and January 2017 when there was shortage of rainfall (-33.2 mm in November, -19.3 mm in December and -16.6 mm in January) as well as during the summer months of June, July and August, where the deficit was of – 48.9 mm, -39.7 mm, respectively -23.8 mm compared to the multiannual values (Figure **2**). The amount of rainfall during the period of vegetation of 2017 was only 287.2 mm in comparison to 398.1 mm, the multiannual average in viticultural center, Copou Iaşi. Amid these conditions, the soil deficit increased from month to month, arriving in late August 2017 up to 80% on a depth of 0-100 cm.

Values of humidity accessible between 15-20% refer to very difficult to access water on soil profile 0-100 cm, making it known that the range for readily available water for vines is between 50-80% of the water capacity output [15, 16].

Also, the average temperatures of the period analysis of vegetation of 2017 shows us that during this period there have been average temperatures whose

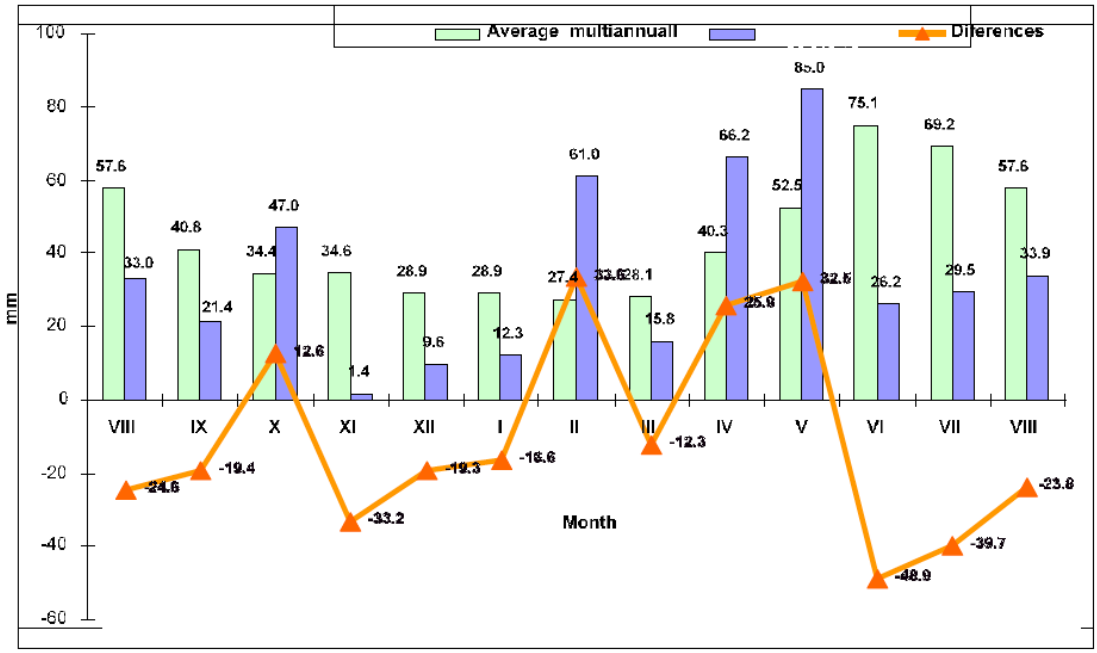

Figure 2: Precipitation recorded in the Centre of Iasi - Copou during the period August 2017-august 2019.

Table 3: Temperature Values during the Period of Vegetation of 2017

Thermic Values	Month					
	IV	V	VI	VII	VIII	IX
Average temperature, multiannual values, °C	10,1	16,1	19,4	21,0	20,3	15,6
Average temperature, °C, 2017	12,9	17,7	22,3	25,4	22,6	18,6
Average max. temperature , multiannual values, °C	15,9	22,4	25,0	27,2	26,9	21,5
Average max. temperatures °C, 2017	18,1	23,6	28,3	32,8	29,3	25,3

values were mostly higher than the multiannual values, rising from 12.9°C in April up to 25.4°C in June. The months of June, July and August were the warmest. Maximum air temperature averages were 28.3°C in June, 32.8°C in July and 29.3°C in August. Multi-annual averages of maximum temperatures recorded in the same months during 1981-2010 were 25.0°C in June, 27.2°C in July and 26.9°C in August (Table **3**).

High values of temperatures combined with soil water deficit led to a rise in atmospheric and soil drought with adverse effects on the state of the vegetation of vines by moving the growth and fructification pheno-phases.

The high temperatures in the air at the end of April and from the first decade of May, which were between 27°C and 31°C have force-started the vegetation growth and the appearance of shoots, inflorescences, in a shorter time, virtually offsetting these pheno-phases by about two weeks. Growth of shoots was slowed down (reduced), the phenomenon of fading and premature yellowing of the leaves appeared frequently, especially those surrounding the grapes, taking the appearance of natural de-leafing, the grapes remained small, with small and withered grains compared to normal years in terms of climate.

Research regarding the succession and the perfecting of physiological pheno-phases of varieties studied, in relation to ecological factors of the studied years, highlighting the fact that the vegetation pheno-phases were conditioned by complex and cumulative actions of climatic factors and hereditary specifics of variety (Table **4**).

Budburst

The pheno-phase that starts the vegetation period of a variety, took place in all the studied years in the last decade of April (21st-25th April for Paula grape variety, 23rd-26th April for Gelu grape variety, about 3 - 4 days after the control variety, Aromat de Iasi).

For this pheno-phase, varieties have received a variable useful thermal balance (Σ °tu), the lowest values being registered in 2019 (14.0°C - 31.3°C), while in 2017, he following values have been registered (42.2 - 63.2°C) (Table **4**). As a result of increased air temperatures and values at ground level, trends of

Table 4: Development of Vegetation Phenopases at Varieties Studied

Phenological Stage	Genotype	2017		2018		2019	
		Date	Σ °t utile	Data	Σ °t utile	Date	Σ °t utile
Budburst	*Vitis vinifera L* Gelu	26 IV	63,2	26 IV	46,5	23 IV	31,3
	Vitis vinifera L Paula	25 IV	54,7	25 IV	36,9	21 IV	22,5
	Vitis vinifera L Aromat de Iaşi (control)	23 IV	42,2	22 IV	22,3	18 IV	14,0
Flowering	*Vitis vinifera L* Gelu	02 VI	302,9	24 V	272,5	08 VI	277,4
	Vitis vinifera L Paula	30 V	344,1	24 V	282,1	08 VI	290,1
	Vitis vinifera L Aromat de Iaşi (control)	26 V	278,6	23 V	291,2	05 VI	264,4
Beginning of ripening	*Vitis vinifera L* Gelu	15 VII	595,1	09 VII	426,4	28 VII	506,6
	Vitis vinifera L Paula	09 VII	522,8	07 VII	403,2	21 VII	427,5
	Vitis vinifera L Aromat de Iaşi (control)	11 VII	582,6	08 VII	420,0	24 VII	422,5
Veraison	*Vitis vinifera L* Gelu	15 VIII	433,7	16 VIII	445,0	23 VIII	310,4
	Vitis vinifera L Paula	08 VIII	551,1	09 VIII	375,2	18 VIII	337,4
	Vitis vinifera L Aromat de Iaşi (control)	25 VIII	611,3	29 VIII	589,4	30 VIII	410,1
Leaves fall	*Vitis vinifera L* Gelu	03 XI	569,5	10 X	336,2	23 X	343,8
	Vitis vinifera L Paula	03 XI	555,2	10 X	429,2	23 X	390,7
	Vitis vinifera L Aromat de Iaşi (control)	03 XI	429,7	09 X	197,3	21 X	287,4
Duration of vegetation period	*Vitis vinifera L* Gelu	194 days		168 days		171 days	
	Vitis vinifera L Paula	193 days		169 days		186 days	
	Vitis vinifera L Aromat de Iaşi (control)	195 days		171 days		187 days	

shifting the timing of budburst and a shortening of the its specific period have been noted.

Flowering

Defines the fruiting process and influences the yield and its quality, began at the end of May or the beginning of June, all its stages being affected by the cumulative action of climatic factors with genetic and agro-technical ones. The influence of climatic changes can pinpoint of the exact moment of this pheno-phase. The increase of sum of useful average temperature, trend registered in recent years, has shortened the duration of flowering, and hastening the onset of this pheno-phase, a good example being the year 2018 when flowering was registered on May 23rd for Aromat de Iasi and May 24th for Gelu and Paula varieties. Useful heat balance that has conditioned this pheno-phase had values between 264.4^{o}C (2019) and 344.1°C (2017).

Véraison

Occurred during 7thof July – 28th of July, depending on climatic conditions and hereditary characteristics of the variety. This pheno-phase also had the tendency to overtake the normal time period, influenced by the high values of air temperature, the high number of days with maximum temperatures over 30°C in July (for example: 13 days in 2017) and high hydric deficit.

The Maturation of Grapes

Coincided with the date of the harvest and was carried out during the month of August with average temperatures of 21.2°C - 22.6°C, which led to the completion of the physiological processes of the plant and the grapes from this pheno-phase. In all three years of the study, the first grapes reaching maturation of consumption have been those of Paula variety, starting on the 9th of August in 2017 and 18th of August in 2019, followed at a week difference by Gelu grape variety. The useful heat balance which caused harvesting had values between 310.4°C and 611.3°C.

The results obtained with regard to the behaviour of véraison and the maturation of the grapes highlight the two newly created varieties which retain these qualities of precocity, important for expanding and diversifying the varietal conveyer of varieties for table grapes, in the North East of the country, area which lacks in terms of a possibilities that ensures fresh consumption of grapes over a long period of time.

Fall of the Leaves

Is marked by the end of the growing season, appearing either normally, or being caused by early frosts the earliest being registered on the 9th of October 2018 and the lateest on the 3rd of November 2017.

The active vegetation period summed up an average of 178 days at Gelu variety, 182 days at Paula and 184 days at Aromat de Iasi variety.

Fertility of Studied Genotypes

Fertility represents the capacity of forming, year after year, organs of fructification as initial basis for the grape harvest; it can be considered from the point of view of two aspects: potential and actual fertility; for the assessment of the degree of fertility of a variety the index of absolute fertility and the index of relative fertility are calculated.

The proportion of the total number of fertile shoots from the total of shoots /vine is one of the most important indicators in order to assess the actual fertility of a genotype. During the period studied, it fluctuated from year to year, with pronounced variability even within the same genotype (Table **5**). This feature is attributed to fluctuating climatic conditions that are reflected best in the year 2017, when, under very low

Table 5: Statistics on the Vine Elements Relating to fruit load and Fertility of Fruit Shoots

Parameters determined	*Vitis vinifera L* Gelu				*Vitis vinifera L* Paula				*Vitis vinifera L* Aromat de Iasi (control)			
	2017	2018	2019	Media	2017	2018	2019	Media	2017	2018	2019	Media
Total buds	38,8	41,0	43,8	41,2	38,0	40,0	44,0	40,7	47,2	51,8	51,0	50,0
Total shoots	32,9	33,8	36,2	34,3	28,3	31,4	40,0	33,2	41,8	51,0	48,4	47,1
Fertile shoots	15,2	22,6	28,8	22,2	9,3	25,2	23,0	19,2	21,8	42,4	36,6	33,6
Sterile shoots	17,2	11,2	7,4	11,9	19,3	6,2	16,8	14,1	21,0	8,6	11,8	13,8
Inflorescences	17,4	26,0	35,2	26,2	9,6	31,2	25,0	21,9	27,2	53,0	56,2	45,5
Fertility, %	46,4	66,4	79,4	64,1	32,4	80,4	57,2	56,7	51,8	83,2	74,6	69,9

winter temperatures and prolonged drought, under similar conditions, fruit load, the proportion of fertile shoots was located below the biological potential of the known varieties which have achieved 32.4 % in Paula, 46.4% in Gelu genotype, both much under the values of the witness Aromat de Iasi (51.8%). The fertility was specific to the studied varieties, in 2018 the variety Paula having 80.4% fertile shoots, and in 2019 the genotype Gelu having an average percentage of fertile shoots of 79.4%.

The number of inflorescences that are formed on the vine is a genetic character of genotype, being influenced by climatic conditions, of the fruit load left during pruning etc. Different research shows that the average number of inflorescences on the vine differed from one genotype to another, within each genotype where different fruit loads were applied, the number of inflorescences was variable, with smaller values in 2017 and normal in other years of study.

In this respect, the newly created varieties Paula and Gelu, with large berries, specific for table grapes, have registered an average number of inflorescences/vine of 21.9, respectively 26.2, both values under those of the control genotype Aromat de Iasi, with an average density of 45.5 inflorescences/vine, with mixed qualities in terms of the direction of production (table grapes or wine).

The fertility coefficient values were also variable, from one genotype to another, and from one year to another, being conditioned to a large extent by the eco-climatic conditions and by the quality of applied agro-technical works. In general, the fertility coefficient values, during the three years of study, have been higher to all varieties, ranging between 1.10 for Paula grape variety and 1.24 for Gelu, both smaller than the values observed by the control variety - Aromat de Iaşi, 1.49 respectively. The fertility coefficient was subunitary at the varieties Gelu (0.77 - 0.99) and Paula (0.93 - 0.96), the highest being the values of Aromat de Iaşi (1.04 - 1.11), which has reacted better to the culture and agro-technical measures applied (Tables **6** and **7**).

Production Potential

Research on the studied varieties regarding production characteristics revealed that there are specific genetic features of each genotype as well as subject to the existing level of climatic factors in the

Table 6: Elements of Fertility and Productivity

Genotype	Absolute Fertility Coefficient			Relative Fertility Coefficient			Absolute Productivity Index			Relative Productivity Index		
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
Vitis vinifera L Gelu	1,15	1,15	1,24	0,55	0,77	0,99	230	287	387	110	188	308
Vitis vinifera L Paula	1,00	1,24	1,10	0,45	0,99	0,63	213	361	302	92	324	172
Vitis vinifera L Aromat de Iaşi (control)	1,25	1,25	1,49	0,65	1,04	1,11	200	202	212	104	168	173

Table 7: The Average Values of the Elements of Fertility and Productivity

Genotype	Absolute Fertility Coefficient		Relative Fertility Coefficient		Absolute Productivity Index		Relative Productivity Index	
	2017 - 2019	The significance	2017 - 2019	The significance	2017 - 2019	The significance	2017 - 2019	The significance
Vitis vinifera L Gelu	1,18	o	0,77	oo	301,33	xxx	202,00	xxx
Vitis vinifera L Paula	1,11	oo	0,69	ooo	292,00	xxx	196,00	xxx
Vitis vinifera L Aromat de Iaşi (control)	1,33	-	0,93	-	204,67	-	148,33	-
	DL 5%= 0,13 DL 1%= 0,18 DL 0,1%= 0,28		DL 5%= 0,11 DL 1%= 0,15 DL 0,1%= 0,23		DL 5%= 23,17 DL 1%= 33,70 DL 0,1%= 50,56		DL 5%= 18,81 DL 1%= 27,36 DL 0,1%= 41,04	

ecosystem. These are reflected in the values of the elements that define the productive potential: average number of grapes/vine, the mean weight of one grape, yield/vine, ones, total production and proportion of the useful production (Tables **8** and **9**).

With respect to the average number of grapes on the vine, it was approximately equal in the years 2018 and 2019, registering 19-20 grapes/vine for the grape variety Gelu, 18-21 grapes/vine at Paula grape variety, both lower values compared to Aromat de Iasi grape variety with 32-33 grape/vines, differences being statistically very significant.

In the year 2017, atypical in terms of climatic conditions, the average number of grapes/vine was located under the biological potential of the known varieties and had values between 9 grapes/vine for Paula grape variety and 12 grapes/vine for Gelu variety, both below the control variety Aromat de Iasi, with 25.6 grapes/vine.

The size of grapes, expressed by the average mass of a grape ranks Paula first with 304,5 g (315,0 g in 2019), followed by Gelu with 280 g/grape, both values much larger in relation to the variety of Aromat de Iasi (154 g/grape). The differences between the varieties studied and control variety, regarding the size of grapes, were deemed very significant statistically.

The unfavourable climatic factors from the year 2017 led to obtaining grapes with 50-100 grams

Table 8: The Components of the Production of the Varieties Studied in 2018 -2019

Genotype	Repeti-tion	Number Grapes/vine			The average mass of a Grape, g			Production, kg/vine			Production, to/Ha			Sales Production, %		
		2018	2019	Average	2018	2019	Average	2018	2019	Average	2018	2019	Average	2018	2019	Average
Vitis vinifera L Gelu	1	18	22	20.0	230	298	264.0	3.78	6.56	5.17	14.31	24.83	19.57	82	89	86
	2	23	23	23.0	213	290	251.5	4.20	6.67	5.44	15.90	25.26	20.58	84	86	85
	3	15	18	16.5	271	319	295.0	4.07	5.74	4.91	15.41	21.74	18.58	81	90	86
	4	17	22	19.5	244	317	280.5	4.15	6.97	5.56	15.72	26.41	21.07	85	86	86
	5	23	16	19.5	290	330	310.0	6.65	5.28	5.97	25.18	20.00	22.59	79	89	84
	Average	19.2	20.2	19.7°	249.6	310.8xxx	280.2	4.57	6.24	5.41x	17.30	23.65	20.48xx	82	88	85xxx
Vitis vinifera L Paula	1	22	23	22.5	295	298	296.5	6.64	6.85	6.75	25.14	25.96	25.55	78	79	79
	2	18	19	18.5	310	303	306.5	6.40	5.76	6.08	24.23	21.80	23.02	80	80	80
	3	24	17	20.5	295	316	305.5	7.05	5.37	6.21	26.69	20.34	23.52	76	82	79
	4	23	17	20.0	270	330	300.0	6.25	5.61	5.93	23.66	21.25	22.46	79	81	80
	5	22	16	19.0	300	328	314.0	6.50	5.25	5.88	24.61	19.87	22.24	77	83	80
	Average	21.8	18.4	20.1°	294	315xxx	304.5	6.57	5.77	6.17xx	24.87	21.84	23.36xxx	78	81	80xxx
Vitis vinifera L Aromat de Iaşi (control)	1	41	12	26.5	162	167	164.5	6.70	2.00	4.35	25.37	7.57	16.47	68	56	62
	2	45	63	54.0	172	108	140.0	5.70	5.80	5.75	20.39	21.96	21.17	70	54	62
	3	24	27	25.5	139	163	151.0	3.30	4.40	3.85	12.49	16.66	14.58	69	52	61
	4	30	27	28.5	174	141	157.5	5.30	3.80	4.55	20.07	14.39	17.23	70	54	62
	5	22	36	29.0	164	150	157.0	3.60	5.40	4.50	13.63	20.45	17.04	71	50	61
	Average	32.4	33	32.7	162.2	145.8	154.0	4.92	4.28	4.60	18.39	16.21	17.30	70	53	61
		DL 5%=10,03 DL 1%=14,59 DL 0,1%=21,89			DL 5%=19,62 DL 1%=28,54 DL 0,1%=42,81			DL 5%=0,76 DL 1%=1,11 DL 0,1%=1,67			DL 5%=2,74 DL 1%=3,98 DL 0,1%=5,97			DL 5%=1,02 DL 1%=1,48 DL 0,1%=2,22		

Table 9: Production Items of Studied Varieties

Genotype	Repetition	Number Grapes/vine	The Average Mass of a Grape, g	Effective Production, kg/vine	Calculated Production, to/Ha	Sales Production, %
Vitis vinifera L Gelu	1	13	210	2,5	9,47	80
	2	11	205	2,4	9,09	81
	3	10	190	2,2	8,33	83
	4	14	200	2,4	9,05	80
	5	13	195	2,5	9,47	76
	Average	12,0	200,0	2,4	9,10	80
Vitis vinifera L Paula	1	9	200	0,74	2,80	75
	2	10	195	0,77	2,92	77
	3	8	210	0,73	2,76	76
	4	8	205	0,74	2,80	75
	5	10	215	0,77	2,92	77
	Average	9,0	205,0	0,75	2,82	76
Vitis vinifera L Aromat de Iaşi (control)	1	28	158	1,83	6,93	64
	2	24	167	1,70	6,44	66
	3	30	160	1,90	7,20	65
	4	25	158	1,59	6,02	68
	5	21	160	1,54	5,83	62
	Average	25,6	160,0	1,71	6,47	65

smaller in relation to normal years, where grapes weighed 200-205 g, reality seen in the quantitative production, as well.

The production of grapes. The varieties studied, with similar fruit loads, have confirmed their good productive potential from early stages, the most effective being Paula variety with an average yield during 2018-2019 of 6.17 kg/vine effective yield, respectively, 23.6 t/ha production, with 80% commercial production. A harvest increase of over 6 tons was considered statistically significant distinct. Also, Gelu variety ranged with its normal production parameters, having an effective yield of 5,41 kg/vine and 20,48 t/ha, with an average value of commercial production of 85%, values superior by over 20% to the variety of comparison (61%). Production rises compared to the witness were analysed from a statical point of view as well, showing that both varieties can be harvested for fresh consumption.

The small productions of 2017 were set far below the potential of the studied genotypes, which included values between 0.74kg/ vine (2.80 t/ha) for Paula and 2.40 kg/vine (9,1 t/ha) for Gelu, superior to the control variety, Aromat de Iasi with 1.71 kg/vine (6,47 t/ha). In these circumstances, the commercial yield was also lower, respectively 76% for Paula grape variety and 80% for Gelu variety. These results demonstrate that grape production was significantly influenced by climatic factors in direct correlation with the specific genetical characteristics of each genotype.

Taking into consideration the yield potential in two years with normal weather conditions, the results confirm the productive capacity of the varieties and that they can be cultivated in the viticultural center Copou Iasi and can be well commercialised in the ecosystem in the northeast of the country.

The qualitative characteristics of the studied varieties were appreciated by the content in sugars and total acidity of musts (Table **10**) that complete their technological value and contribute to their taking in culture.

The chemical composition of the must highlights differences between varieties. At harvest, which took

Table 10: Chemical Composition of Must at Varieties Studied

Determined Elements	*Vitis vinifera L* Gelu	*Vitis vinifera L* Paula	*Vitis vinifera L* Aromat de Iași (control)
Date of harvest	15.08	8.08	25.08
Sugars, g/L	164	175	165
Total acidity g/L C4H6O6	3,5	4,9	4.9
pH	3,7	3,60	3.41
Index gluco-acidimetric	52	39	36
Soluble dry matter (°Brix)	19,4	21,0	17.2
Total dry matter %	20,2	24,15	18.74
Humidity %	79,78	75,85	81.25
Anthocyanins mg/L	192,7	-	-
Total anthocyanin potential	558,3	-	-
Polyphenols total, g/L acid Gallic	0,31	0,21	0.23
Index polyphenolic total (IPT)	5,6	1,9	1.6

place for all grape varieties in the month of August, analyses have highlighted a potential accumulation of sugars in the must specific for table grapes for fresh consumption. Superior values were recorded at Paula variety, a whopping 175 g/L sugars, having an earlier ripening, 7-17 days prior to Gelu variety and 7-21 days sooner than the control variety, which is also the paternal genitor of Paula variety. A normal accumulation of sugars was recorded for Gelu variety: 164 g/L.

The acidity of the must ranged between normal values in the years 2018 and 2019 (4.1 - 4.4 g/L $C_4H_6O_6$ for Gelu and 5.8 - 6.0 g/L $C_4H_6O_6$ for Paula grape variety, values close to the control sample). In 2017, the acidity was very low (2.1 - 2.9 g/L $C_4H_6O_6$) due to lack of rainfall and high temperatures during *véraison* and grape ripening.

Harmonious balance and pleasant taste of grapes is shown by the gluco-acidimetric index value, which in normal climatic years had values between 37 - 39 at Gelu and 29-31 at Paula, lower than control and very large superior 58-80 in 2017, given the very low acidity of the grape must. pH of the must had values close to the two varieties 3.68 - 3,79, slightly lower in 2017.

The dry soluble residue content of Paula variety recorded higher values in all the years of study, ranging from 20.6-21.4 ^{o}Brix, slightly lower at Gelu variety, 18.9-19.8 °Brix, superior to the control (16.3-17.7 °Brix).

The same trend has been recorded in the case of the total dry matter of the grape must, with higher values, between 21.27 % – 26.36 % (Paula) and between 19.8 % - 21.7 % (Gelu), both exceeding the control variety Aromat de Iasi (17.68 % – 20 18 %). Noting that in the year 2017, with drought conditions, total dry matter content was higher, indicating a degree of dehydration, expressed by the contents of humidity as well (73.64 %- 78.30 %).

The quantity of anthocyanins, organic substances specific for red grape varieties, like Gelu that has a bluish-violet epidermis, recorded the highest values in 2019, mainly 211.4 mg/L, 30 mg/L less in 2017. With regard to the potential maximum anthocyanic total was achieved also in 2019, 608.4 mg/L, respectively.

The total polyphenolic content expressed in grams per litre galic acid in Gelu ranged between 0.26-0.35 g/L galic acid, lower in Paula variety (0.19-0.24 g/L galic acid), both values higher than the control variety. Regarding the total polyphenolic content, it had the same distribution per variety and per vintage, with higher values for Gelu (5.1 - 5.9) and 3-4 times lower at Paula and Aromat de Iasi, both yellow in colour.

From the analysis of the values obtained during the determination of chemical composition of grapes and must, it can be demonstrated that the climatic factors (temperature, precipitations, etc.) visibly affect their development and quality characteristics.

CONCLUSIONS

Analysis of the main elements from the overall climate during 2017-2019 compared to the multi-annual averages (1981-2010) highlights the following issues: the increase in annual average temperatures from 9.8°C (multiannual value) to 10.4°C (2017) and, by default, the values of the thermal balance sheets; the increase of the average temperatures during the months of July, August and September; the reduction of the quantities of precipitation from the period of vegetation and a very uneven distribution; the increase of the number of days with temperatures above 30°C in 2017 and 2019, compared with the multiannual amount.

Reaction to abiotic factors (frost and drought) of the varieties studied was that specific to the *Vinifera* species, the loss of main buds being higher in 2017, ranging between 68% (Paula) and 81% (Gelu), while the vegetative growths and the production of grapes as well as its quality was affected by the prolonged drought.

In terms of conducting of pheno-phases, it was held in a logical sequence, the beginning of vegetation being marked in sprays against pests of budburst range 21-25 April, according to a balance sheet useful heat (∑ °C tu) between 14 and 63.2°C flowering between May 23rd (2018) and June 5th (2019), in which the totals of useful heat (∑ °C tu) was between 264.4° C and 344.1°C grapes, *véraison* has occurred from 7th to 28th of July, the maturation of grapes consumption was marked, in each year of the study, by *Vitis vinifera* L. Paula, with effect from 9th of August, followed by *Vitis vinifera* L. Gelu, after 15th of August, both outpacing the control, Aromat de Iasi by 15-20 days.

The fertility and productivity of varieties studied was within the normal biological potential specific, known for each variety - in the normal climate (2018, 2019) and below potential in 2017.

The production potential through a determined level elements, *i.e*. the average number of grapes/vine, the average mass of a bunch of grapes, the actual production and calculated per hectare ranked first in the case of *Vitis vinifera* L. Paula variety 23.36 t/ha, followed by Gelu with over 20 t/ha, last achieving a big commercial production (85%), Paula (80%) and the while the control sample, genotype with mixed functions produced just 61%.

Analysis of chemical composition of grape varieties studied shows a potential for accumulation of sugars in the must between 170-184 g/L for *Vitis vinifera* L. Paula and 160-170 g/L for *Vitis vinifera* L. Gelu, accompanied by a normal acidity of 5,6 - 6,0 g/L tartaric acid, respectively 4.1 - 4.4 g/L tartaric acid specific varieties, ensuring a pleasant and harmonious balance shown by the values of gluco-acidimetric index. Determinations made regarding content in anthocyanins and polyphenols highlights the potential for accumulation of *Vitis vinifera* L. Gelu genotype, higher than the other two.

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