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THE BIOLOGY OF THE DEVELOPMENT PROCESS IN SOME GRAPE CULTIVARS FOR RED WINES STUDIED ON THE SANDY SOILS OF SOUTHERN OLTENIA

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Abstract

The research carried out in the period 2020-2022 looked at the biological, productive and quality potential of four grape cultivars for red wines (Băbească neagră, Haiduc, Novac, Arcaș), studied in the ampelographic collection of the Research-Development Station for Plant Culture on Sands Dăbuleni. The obtained results showed that the beginning of bud burst phenophase of these cultivars with grapes for red wines started at temperatures between 11.5-18.2°C, the earliest being the Novac cultivar, which beginning of bud burst between April 16 and May 10. The vegetation period for red wine grape cultivars was between 159-164 days, under the conditions of recording an active heat balance between 3429.4-3491°C. From the point of view of productivity, the Novac cultivar stood out with a grape production of 20479 kg/ha, registering a difference of 6579 kg/ha compared to the control, statistically assured as distinctly significant. The quality recorded at harvest maturity of the grapes revealed values of the content in total sugars between 180 g/l for the Arcaș cultivar and 200 g/l for the Novac cultivar.

Key words*: grapes for wine, grape production, quality.*

INTRODUCTION

The grapevine is a traditional culture for the area of sandy soils in the south of Oltenia, being used since ancient times as a fixing plant for shifting sands. The ecopedological conditions on the unimproved sands were and are quite harsh, being unfavorable for most crops (Baniță, 1983). In this sense, in conditions of low precipitation, with very high temperatures during the summer, low hygroscopicity and the high frequency of days with strong wind exceeding 5-6 m/s, having the effect of increasing the degree of wind deflation and the intensity of evapotranspiration, grapevine was and is one of the species that economically exploit sands and sandy soils (Rățoi et al., 2014). The vine at a certain age, depending on the cultivar, forms its reproductive organs, flowers and fruits. This qualitative jump corresponds to physiological maturity and is the result of a whole series of physiological and biochemical transformations that take place at the level of cells. Starting with the first fruiting and until death, the vine bears fruit every year, being a polycarpic plant, with multiple and repeated fruiting (Popa, 2019). During the vegetation period, the vine goes through several phenophases/vegetation phases, which mark the processes of growth, development and reproduction. In the chronological order of their succession, the vine phenophases are: weeping, beginning of bud burst, beginning of ripening, shoot growth, flowering, berries ripe for harvest, and leaf fall. Weeping, beginning of bud burst, shoot growth and leaf fall are phenophases of vegetative organs, and flowering, berries ripe for harvest and grape ripening are phenophases of fruit organs. The phenophases of the fruit organs take place simultaneously with those of the vegetative organs and are passed by the vine in all types of climate (Irimia, 2012; Manzoor et al., 2023).

Buds exposed to low temperatures (0-10°C), flower faster at 10°C, compared to 20-25°C (Pouget, 1965). According to Carboneanu (1990), the cold requirement for coming out of dormancy is achieved after 7 days of exposure

of the buds to positive temperatures lower than 10°C.

The main factor that determines the initiation of the flowering process is temperature. Thus, the initiation of flowering takes place at a temperature of 15-17°C, at 20-25°C the opening of flowers is fast, at 24-27°C the optimal limits are achieved, because at temperatures above 30°C the rate of opening of flowers to decrease (Burzo et al., 2020; Cortázar-Atauri et al., 2017).

Harvesting wine grapes at their optimal level of maturity is the first step in producing high quality wines (Jahnke et al., 2023). Determining the best time to harvest requires both experience and careful assessment of the ripeness of wine grapes. Typical chemical analyzes for determining grape ripeness for wine include monitoring sugar content, titratable acidity and pH (Watson, 2003). Grape ripening is associated with changes in the walls of the pulp cells, due to the action of pectolytic enzymes that hydrolyze the pectins in the cell wall, making them permeable to the changes that occur during winemaking (Amrani and Glories, 1995a; Amrani and Glories, 1995b; Lecas and Brillouet, 1994).

MATERIALS AND METHODS

The study was carried out on four grape cultivars for red wines (Băbească neagră, Haiduc, Novac, Arcaș), from the ampelographic collection of the Research - Development Station for Plant Culture on Sands Dăbuleni. The ampelographic collection was established in 2010. The form of driving the stumps was the classic (low), the planting density was 3787 stumps/ha and the planting distances were 2.2/1.2 m. The experiment was located on a sandy soil with low natural fertility, with an organic carbon content within the limits of 0.24-0.74%, poorly supplied with nitrogen (N_{total}= 0.02-0.03%), well supplied in phosphorus ($P_{extractable}$=74.42-85.56 ppm) and with a low potassium content ($K_{exchangeable}$=36.26-46.93 ppm), according to the supply range established by Davidescu (1981).

The viticultural climate parameters analyzed were: air temperature, thermal balances and precipitation, recorded at the Weather Station of Research - Development Station for Plant Culture on Sands Dăbuleni. The global thermal balance represents the sum of the average daily degrees during the vegetation period; The active thermal balance represents the sum of average daily temperatures higher than 10°C during the vegetation period; The useful thermal balance represents the sum of the differences between the average daily temperature higher than 10°C, and 10, which represents the biological threshold (Georgescu et al., 1986).

Observations and determinations were made regarding the phenological stages: beginning of bud burst, flowering, beginning of ripening, berries ripe for harvest, shoot fertility, grape production and quality. The phenological determinations consisted in the visual observation and noting the initiation of the vegetation phenophases, when they were recorded in at least 30% of the stumps studied within the cultivar.

Production determinations were carried out by weighing the grapes in 4 repetitions, for each cultivar at technological maturity. For quality determinations, samples were taken from the harvested grapes parameters were analyzed in the laboratory: the weight of 100 grapes, by the gravimetric method, the sugar content using the KRUSS digital portable refractometer 0-32% brix and titratable acidity, by the titrimetric method. The obtained results were analyzed statistically using analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

Climatic data are necessary for the correct zoning of grape cultivars. Each cultivar requires a certain amount of temperatures for its grapes to reach full ripening. The need for thermal resources cultivar considerably from one cultivar to another and is closely related to the length of the vegetation period of the cultivars (Huglin & Schneider, 1998).

In the vineyards of our country, a global thermal balance is recorded between 2700-4000°C, the active one between 2500-3800°C, and the useful one between 1000-1800°C (Georgescu et al., 1986).

From the analysis of the main climatic elements carried out in the period 2020-2022, it is found

that the temperature values, expressed through the heat balances, fell within the limited range presented in the specialized literature, so that the global heat balance recorded 3682°C, the active heat balance of recorded 3601°C and the useful heat balance recorded 1888°C (Figure 1).

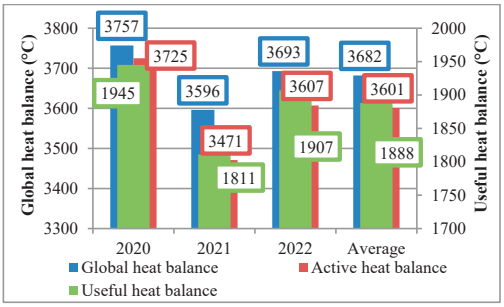

Figure 1. The heat balance recorded in the period 2020-2022

The average temperature during the analyzed period was 12.9°C, higher by 1.42°C compared to the multiannual average from 1956-2022 (11.48°C). The maximum temperature has been increasing since 2020, when 37.3°C were recorded, reaching the maximum of 41.6°C during this period in 2022 (Table 1).

Table 1. The main climatic elements recorded at the weather station* of RDSPCS Dăbuleni during 2020-2022

Climatic elements	Agricultural year		
	October 2019-September 2020	October 2020-September 2021	October 2021-September 2022
Average temperature (°C)	13.6	12.5	12.7
Minimum temperature (°C)	-9.4	-10.6	-10.2
Maximum temperature (°C)	37.3	41.2	41.6
Multiannual mean temperature (1956-2022) °C	11.46	11.46	11.48
Multiannual average precipitation (1956-2022) mm	560.98	562.08	560.06
Annual precipitation (mm)	550.4	547.2	547.2
Precipitation during the vegetation period April-September (mm)	310.4	173.6	300.2
Number of days with rain	102	114	111
Number of days with maximum temperatures > 30°C	79	68	79

*AgroExpert from Adcon Telemetry SRL Romania.

Precipitation during the vegetation period had values between 173.6 mm in 2021 and 310.4 mm in 2020. The average annual precipitation in the period 2020-2022 was lower by 12.66 mm compared to the multiannual average in the period 1956-2022 (560.06 mm), and their correlation with increasing air temperature underlines the increasing drought.

During the analyzed period, beginning of bud burst in grape cultivars for red wines started at temperatures between 11.5-18.2°C. The useful temperature recorded from beginning of bud burst to flowering recorded values between 247.7-276.8°C. To reach maturity, the grapes needed useful temperatures between 734.8-783.6°C, different depending on the cultivar and climatic conditions. The useful thermal balance during the vegetation period recorded values between 1739.7-1765.0°C, and the active thermal balance recorded values between 3429.4-3491.4°C (Table 2).

The specialized literature mentions that during the period of berry growth, the optimum temperature varies between 25 and 26°C (Alleweldt, 1967). Kliewer and Lider (1968), found that temperature of 30°C day and 15°C night reduced berry volume in certain cultivars by 10-20% compared to temperature of 20°C day and 15°C night.

In the 2020-2022 period, the beginning of bud burst phenophase was triggered between April 16 and May 10, the Novac cultivar was the earliest. Flowering took place between May 20 and June 16, approximately 34-36 days after budding (Table 3).

Harvesting of grape cultivars for red wines at the beginning with the Băbeasca neagră cultivar during 13.09-22.10 and Arcaș during 14.09-19.10. The observations made by Constantinescu (1956), on 75 cultivars of vines, proved that the gap between beginning of bud burst of these cultivars varies between 4 and 7 days. However, climatic conditions can cause a delay of 17 to 23 days. The ripening occurs almost suddenly, in about 24 hours, and is marked by changes in the appearance and composition of the berry: the mesocarp loses its firmness, the skin thins, becomes elastic and translucent in white grape cultivars, or reddish in black grape cultivars, and the content of carbohydrates increases rapidly (Irimia, 2012).

In the analyzed period for the red wine grape cultivars, the beginning of destemming lasted

11-12 days, the flowering between 10-13 days, and from the beginning of ripening to the harvest they recorded 66-69 days (Figure 2).

Table 2. Useful heat balance for each phenophase (°C) in the period 2020-2022

Cultivar	Beginning of bud burst	Beginning of bud burst - Flowering	Flowering - Beginning of ripening	Beginning of ripening - Harvest	Useful thermal balance during the growing season	Active thermal balance during the vegetation period
	Limits °C	Σ °t useful	Σ °t useful	Σ °t useful	Σ °t useful	Σ °t active
Băbească neagră	13.9-18.0	272.9	754.8	783.6	1744.2	3445.0
Haiduc	13.9-18.0	276.8	747.3	747.2	1761.1	3472.6
Novac	11.5-14.6	248.5	789.5	734.8	1765.0	3491.4
Arcaș	13.9-18.2	247.7	724.5	767.0	1739.7	3429.4

Table 3. The main phenophases in the period 2020-2022

Cultivar	Beginning of bud burst	Flowering	Berry growth (beginning)	Beginning of ripening	Harvesting grapes
Băbească neagră	18.04-10.05	27.05-12.06	05-14.06	19.07-01.08	13.09-22.10
Haiduc	18.04-07.05	28.05-13.06	06-15.06	23-26.07	19.09-19.10
Novac	16.04-10.05	20.05-10.06	04-13.06	25-27.07	19.09-19.10
Arcaș	18.04-07.05	24.05-10.06	05-13.06	18-26.07	14.09-19.10

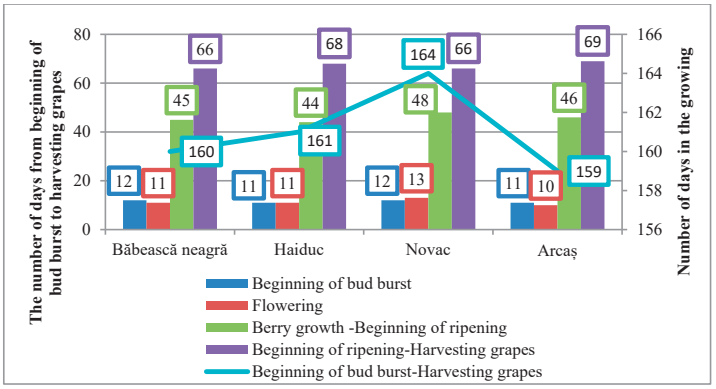

Figure 2. The duration of each phenophase in the period 2020-2022

The vegetation period for red wine grape cultivars was between 159-164 days. Dvornic et al. (1966) analyzing the duration of the flowering period for 5 cultivars of vine cultivated in the southern part of Romania found that this phase lasts 11-12 days and occurs between June 2-12.

The duration of the total growing period of the berries is on average 45 days. Rogiers et al. (2000) studied the process of berry growth in the Shiraz grape cultivar. It was found that the fresh mass of the berries increased for 85 days after flowering, stagnated until the 95th day after flowering, so that later the mass of these decrease.

Fertility and productivity of grapevine cultivars are traits that influence grape production (Table 4).

Table 4. Fertility of shoots in some cultivars of grapevine in the period 2020-2022

Cultivar	Total number of shoots per stump	Number of fertile shoots per stump	The percentage of fertile shoots (%)	Number of inflorescences per stump	Fertility coefficient	
					Relative ≥ 1	Absolute ≥ 1.5
Băbească neagră	27	20	74	23	0.87	1.16
Haiduc	23	19	83	26	1.12	1.62
Novac	28	19	67	27	0.99	1.40
Arcaș	24	20	83	30	1.23	1.50

Fertility is expressed in addition to the percentage of fertile shoots, the proportion of fertile shoots with one or two inflorescences and by the values of the two coefficients of relative and absolute fertility (Belea, 2008). Shoot fertility recorded different values depending on the variety and climatic conditions. The relative and absolute fertility coefficients recorded above-unit values for the Haiduc and Arcaș cultivars.

In the period 2020-2022 for cultivars with grapes for red wines, the average production had values between 13012 kg/ha, for the Arcaș cultivar and 20479 kg/ha, for the Novac cultivar, who recorded made the biggest difference (6579 kg/ha) compared to the Băbeasca neagră cultivar, taken as a control, difference statistically assured as distinctly significant (Table 5).

Table 5. Grape production of some vine cultivars in the period 2020-2022

Cultivar	Average production (kg/ha)	Difference from the witness (kg/ha)	Signification
Băbească neagră	13900	Mt.	
Haiduc	17662	3762	-
Novac	20479	6579	**
Arcaș	13012	-888	-
DL 5%=3816 DL 1%=5779 DL 0.1%=9283			

The useful heat balance and the active heat balance (°C) influenced grape production, the results obtained being represented by distinctly significant positive correlations (Figure 3 and Figure 4), which underline the increase in grape production with the accumulation in the air of as many thematic resources (r=991**; r=0.998**).

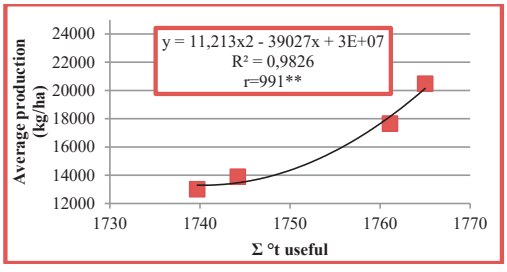

Figure 3. Correlation between average grape production (kg/ha) and useful heat balance °C in some red wine grape cultivars

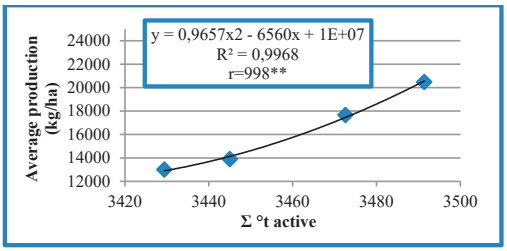

Figure 4. Correlation between average grape production (kg/ha) and active heat balance °C in some red wine grape cultivars

Quality analyzes consisted of determinations of 100 berry weight, total sugar content, and total titratable acidity at harvest. In the period 2020-2022, the weight of 100 berry recorded values between 180 g for the Arcaș cultivar and 263 g for the Novac cultivar, with a difference compared to the witness of 57 g, statistically assured as significant. The sugar content recorded values between 180 g/l for the Arcaș cultivar and 200 g/l for the Novac cultivar. Titratable acidity at harvest expressed in g/l H_2SO_4 recorded values between 3.76 g/l for the Arcaș cultivar and 4.10 g/l for the Novac cultivar (Table 6).

Table 6. Grape quality of some vine varieties in the period 2020-2022

Cultivar	Weight of 100 berries		Total sugar content		Total titratable acidity H_2SO_4	
	(g)	Difference from the witness (g)	(g/l)	Difference from the witness (g/l)	(g/l)	Difference from the witness (g/l)
Băbească neagră	206	Mt.	197	Mt.	3.98	Mt.
Haiduc	222	16	196	-1	3.94	-0.04
Novac	263	57*	200	3	4.10	0.12
Arcaș	180	-26	180	-16	3.76	-0.21
DL 5%=42			DL 5%=21		DL 5%=1.3	
DL 1%=63			DL 1%=32		DL 1%=2.0	
DL 0.1%=101			DL 0.1%=51		DL 0.1%=3.2	

CONCLUSIONS

The climatic conditions recorded in the area of sandy soils in the south of Oltenia were favorable for the metabolism of red wine grape cultivars, the active heat balance (3429.4-3491.4°C) and the useful heat balance (1739.7-1765°C) falling within the limits presented in the specialized literature.

The obtained results showed that the beginning of bud burst phenophase of these cultivars with

grapes for red wines started at temperatures between 11.5-18.2°C, the earliest being the Novac cultivar, which beginning of bud burst registered April 16 and May 10.
The vegetation period for red wine grape cultivars was between 159-164 days, under the conditions of recording an active thermal balance between 3429.4-3491°C.
From the cultivar of vines with grapes for red wines studied on sandy soils, the Novac cultivar stood out with the best production (20479 kg/ha) and quality (200 g/l sugars) characteristics.

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