Journal of Agricultural Sciences (Belgrade) https://doi.org/10.2298/JAS2502159K
Vol. 70, No. 2, 2025 UDC: 634.8(497.2)
Pages 159-172 Original scientific paper

AGROBIOLOGICAL AND ECONOMIC POTENTIAL OF WINE GRAPEVINE CULTIVARS GROWN IN THE KYUSTENDIL REGION, BULGARIA

Simeon D. Krumov[1*], Iliyana S. Krishkova[1] and Iliyan N. Simeonov[2]

[1]Institute of Agriculture – Kyustendil, Agricultural Academy – Sofia, Bulgaria
[2]Institute of Viticulture and Enology - Pleven, Agricultural Academy – Sofia, Bulgaria

Abstract: A comparative analysis of the agrobiological and economic potential of 2 white ('Slava' and 'Droujba') and 3 red ('Kaylashki rubin', 'Trapezitsa' and 'Rubin') wine grapevine cultivars under the soil and climatic conditions of the Kyustendil region in Bulgaria was carried out. Comparative variants (standards) for red cultivars were 'Pamid', and for white cultivars – 'Tamyanka'. The study was conducted during the period 2021–2024 in a collection vineyard of the Institute of Agriculture – Kyustendil, Bulgaria. In terms of quality, fertility and size of the bunches and berries, the studied cultivars reached and even exceeded the values characteristic for each of them. The percentage of berries in the bunch was "high" in all variants – from 95.0% for 'Trapezitsa' to 97.2% for 'Kaylashki rubin' and 'Droujba'. The grapes of the 'Pamid' and 'Tamyanka' standards, as well as the interspecific cultivars 'Droujba' and 'Kaylashki rubin', were characterized by a "very high" theoretical yield. In economic terms, the best results, under the experimental conditions, were achieved with the red cultivars 'Trapezitsa' and 'Kaylashki rubin'. The high level of net income and profitability show that the white cultivar 'Droujba' also has considerable economic potential.

Key words: wine grape cultivars, yield, economic evaluation.

Introduction

The grapevine (*Vitis)* exhibits great ecological plasticity and adaptability. However, despite this characteristic, the introduction of grapevine cultivars must be carried out precisely and on a scientific basis. The agrobiological properties and technological qualities of a cultivar are only fully developed when the natural conditions are most favorable for its development. Therefore, the adaptive capabilities of each cultivar to the environment must be studied to determine its economic potential and specific requirements (Katerov et al., 1990; Pappalardo et

*Corresponding author: e-mail: simeon.krumov@gmail.com

al., 2013; Borisenko et al., 2015; Milić et al., 2016; Filipovic et al., 2017; Krumov et al., 2020; Jelocnik et al., 2024).

Against the backdrop of changing climatic conditions, the development and introduction of grape cultivars with complex resistance to stressful biotic and abiotic factors represent an extremely important and contemporary scientific direction with significant economic implications. Both Bulgarian and global grape breeding efforts address these new challenges by developing and introducing cultivars with increased resistance to low winter temperatures and diseases while maintaining valuable biological and economic qualities (Fengmei et al., 1990; Pernesz, 2004; Hajdu, 2004; He et al., 2007; Xiang et al., 2008; Slavtcheva, 2008; Zhao et al., 2009; Jiang et al., 2009; Ivanov et al., 2011a; Ivanov et al., 2011b; Ivanov et al., 2012; Ivanov, 2013; Eibach and Töpfer, 2015; Ivanov et al., 2015; Dyakova et al., 2015; Mincheva et al., 2015; Ivanov, 2016; Simeonov et al., 2017; Delrot et al., 2020; Vannozzi et al., 2021).

In recent years, the Kyustendil region of Bulgaria has experienced record-low winter temperatures, reaching -29.5ºC, as well as late spring frosts that have destroyed grape yields. Prolonged periods of drought accompanied by extremely high temperatures have also become increasingly common. Each of these stress factors negatively affects the vitality of the vines, the quantity and quality of the harvest, and, consequently, the economic profitability of grape cultivation. Therefore, the objective of this study was to conduct an economic assessment of the potential for cultivating seven wine grape cultivars in the Kyustendil region (the second sub-region of the southwestern wine-growing region of Bulgaria).

Material and Methods

The study was conducted in a collection vineyard at the Institute of Agriculture – Kyustendil, Bulgaria, during the period 2021–2024. The experimental site is located in the eastern part of the Kyustendil Valley. The soil is a highly leached, medium sandy-clayey, slightly to moderately stony cinnamon forest soil (*Chromic Luvisols*) with a neutral reaction.

The subject of the study was wine grape cultivars developed at the Institute of Viticulture and Enology – Pleven, Bulgaria (IVE-Pleven): White cultivars: 'Slava' ('Dunavska Gamza' × 'Tsvetochnyi'), 'Droujba' ('Misket Kaylashki' × Hybrid II-51/23 × 'Zarya Severa' × 'Muscat Hamburg'), red cultivars: 'Trapezitsa' ('Dunavska Gamza' × 'Noir Hatif de Marseille'), 'Kaylashki rubin' ('Pamid' × Hybrid VI 2/15 × 'Gamay Noir' × *Vitis amurensis*), and 'Rubin' ('Nebbiolo' × 'Syrah'). For comparative purposes, the study included widely distributed standard cultivars – red cultivars: 'Pamid' (an old cultivar from the Black Sea ecological-geographical group) and white cultivars: 'Tamyanka' (an old cultivar from the Oriental ecological-geographical group).

The vines were planted in the spring of 2015. They were grafted onto the Berlandieri × Riparia SO4 rootstock and trained using the Guyot system (stemmed). The planting distances were 2.50 m between rows and 1.30 m within the row. During the study period, the vine load was set at 18 buds per vine (3 × 2 + 1 × 12). Each variant was arranged in three replicates, with 10 vines per replicate, aligned in terms of vegetative development.

During the grape growing period, the main economic indicators were calculated annually: gross output, euro/ha; production costs, euro/ha; net income, euro/ha; rate of profitability, %, prime cost, euro/ha and euro/kg. The necessary funds for obtaining grape production were established on the basis of the actual costs incurred in accordance with the standardized norms and tariffs for labor and mechanized works used in the Institute of Agriculture – Kyustendil as well as taking into account the market prices of the raw materials and other materials utilized. The valuation of production was determined using the actual realization prices in the individual years.

The yield elements were determined according to the methodology approved in Bulgarian Ampelography, Volume 1 (Katerov et al., 1990). The experimental data were analyzed using the analysis of variance (ANOVA) method, applying the least significant difference (LSD) criterion to assess the statistical significance of the differences between the control and the variants (Maneva, 2007).

Results and Discussion

The timing of the individual phenological phases of the studied cultivars under the soil and climatic conditions of the Kyustendil region was established. Cultivars of interspecific origin begin their development relatively earlier than those belonging to the *V. vinifera* group. The earliest budburst was observed in ‘Kaylashki rubin’ (April 9), which occurred six days earlier than in the standard red cultivar ‘Pamid’ (April 23). The budburst of ‘Trapezitsa’ (April 22) occurred one day earlier, while that of ‘Rubin’ (April 24) occurred one day later than that of ‘Pamid’.

Among the white cultivars, ‘Droujba’ (April 22) and ‘Slava’ (April 21) began to develop, on average, two days earlier than the standard ‘Tamyanka’ (April 24). Flowering began in the first half of June, with the differences mainly attributed to the specific characteristics of each cultivar. The *V. vinifera* cultivars ‘Pamid’, ‘Tamyanka’, and ‘Rubin’ initiated flowering later (June 10–11) compared to the interspecific cultivars ‘Kaylashki rubin’, ‘Trapezitsa’, ‘Slava’, and ‘Droujba’ (June 4–10).

Based on the timing of technological maturity in the Kyustendil region, the studied cultivars were classified into two groups: mid-ripening cultivars – ‘Rubin’ (September 15), and late-ripening cultivars – ‘Tamyanka’ (September 16),

'Droujba' (September 20), 'Trapezitsa' (September 23), 'Slava' (September 23), 'Pamid' (September 25), and 'Kaylashki rubin' (September 29).

Table 1. Phenological observations for the period 2021–2024.

Cultivar	Year	Development of buds (start), date	(+) or (-) days in comparison to standard	Flowering, date			Technological ripeness, date	(+) or (-) days in comparison to standard	Vegetation period, number of days
				Beginning	Massive	Finish			
Cultivars for red wines									
'Kaylashki rubin'	2021	26/IV	-4	02/VI	06/VI	10/VI	08/X	+2	166
	2022	26/IV	-4	05/VI	09/VI	14/VI	26/IX	+12	154
	2023	12/IV	-9	08/VI	11/VI	15/VI	12/X	-	173
	2024	09/IV	-8	30/V	02/VI	05/VI	20/IX	+4	164
	x*	17/IV	-6	04/VI	07/VI	09/VI	29/IX	+6	164
'Trapezitsa'	2021	30/IV	0	14/VI	18/VI	21/VI	03/X	-3	157
	2022	29/IV	-1	15/VI	19/VI	22/VI	14/IX	0	139
	2023	20/IV	-1	13/VI	16/VI	19/VI	18/IX	-	151
	2024	15/IV	-2	05/VI	09/VI	11/VI	13/IX	-3	151
	x	22/IV	-1	10/VI	14/VI	16/VI	23/IX	-2	150
**'Rubin'	2021	01/V	+1	15/VI	19/VI	23/VI	26/IX	-10	149
	2022	01/V	+1	14/VI	18/VI	21/VI	07/IX	-7	130
	2023	22/IV	+1	14/VI	18/VI	21/VI	-	-	-
	2024	18/IV	+1	06/VI	10/VI	13/VI	05/IX	-11	140
	x	24/IV	+1	11/VI	14/VI	18/VI	15/IX	-9	140
**Pamid' (standard)	2021	30/IV	-	15/VI	19/VI	23/VI	06/X	-	160
	2022	30/IV	-	16/VI	18/VI	22/VI	14/IX	-	138
	2023	21/IV	-	14/VI	17/VI	20/VI	-	-	-
	2024	17/IV	-	07/VI	10/VI	14/VI	16/IX	-	152
	x	23/IV	-	11/VI	14/VI	18/VI	25/IX	-	150
Cultivars for white wines									
'Slava'	2021	28/IV	-3	09/VI	14/VI	17/VI	29/IX	+4	154
	2022	29/IV	-1	12/VI	15/VI	18/VI	19/IX	+12	144
	2023	18/IV	-3	12/VI	16/VI	18/VI	18/IX	-	153
	2024	15/IV	-3	03/VI	06/VI	09/VI	16/IX	+8	154
	x	21/IV	-2	07/VI	10/VI	13/VI	23/IX	+8	151
'Droujba'	2021	29/IV	-2	08/VI	13/VI	17/VI	06/X	+11	160
	2022	29/IV	-1	11/VI	15/VI	18/VI	09/IX	-7	133
	2023	18/IV	-3	12/VI	16/VI	19/VI	10/IX	-	140
	2024	15/IV	-3	03/VI	06/VI	09/VI	05/IX	-3	143
	x	22/IV	-2	07/VI	11/VI	14/VI	20/IX	-1	144
**Tamyanka' (standard)	2021	01/V	-	14/VI	18/VI	21/VI	25/IX	-	148
	2022	30/IV	-	15/VI	20/VI	22/VI	16/IX	-	140
	2023	21/IV	-	14/VI	18/VI	21/VI	-	-	-
	2024	18/IV	-	06/VI	10/VI	14/VI	08/IX	-	143
	x	24/IV	-	10/VI	14/VI	18/VI	16/IX	-	144

*Average for the period 2021–2024; **Due to the impact of downy mildew (*P. viticola*) on the harvest in 2023, no phenological observations were carried out in the cultivars of the *V. vinifera* group.

The duration of the period from budburst to technological maturity (average for the study period) was as follows: 'Rubin' – 140 days, 'Droujba' and 'Tamyanka' – 144 days, 'Trapezitsa' and 'Pamid' – 150 days, 'Slava' – 151 days and 'Kaylashki rubin' – 164 days (Table 1).

Phenological observations conducted under the specific agro-climatic conditions of the Kyustendil region revealed distinct differences between *Vitis vinifera* and interspecific cultivars in terms of both the onset and duration of their vegetative cycles. Interspecific varieties such as 'Kaylashki rubin', 'Trapezitsa', 'Slava', and 'Droujba' demonstrated earlier budburst and more rapid initial development compared to traditional wine cultivars like 'Pamid', 'Tamyanka', and 'Rubin'. This trend likely reflects their enhanced adaptability to shortened and fluctuating growing seasons – an increasingly valuable trait under current climate dynamics. Of particular interest is the fact that 'Kaylashki rubin', despite its early budburst, reached technological maturity only by late September, indicating an extended vegetative period and slower progression during later phenological stages. These findings highlight the importance of selecting cultivars suited to regional agroecological conditions. Interspecific varieties are promising for climate-resilient viticulture, but breeding programs must carefully consider the entire vegetative season and the associated risks, such as early autumn frosts. An integrated selection approach—balancing precocity and environmental adaptability is essential for promoting sustainable viticulture under both present and anticipated climate scenarios.

At technological maturity, a mechanical analysis was performed to determine the structure of the bunches and berries, as well as the sugar and acid content in the grape juice (Table 2).

Among the red cultivars, 'Trapezitsa' had the largest average bunch weight (304.0 g), followed by 'Rubin' (280.3 g), the standard 'Pamid' (269.4 g) and 'Kaylashki rubin' (242.7 g).

Among the white cultivars, 'Droujba' had the largest average bunch weight (256.3 g), followed by the standard 'Tamyanka' (186.3 g). 'Slava' had the smallest bunches (159.4 g).

Regarding bunch dimensions, the red cultivar 'Trapezitsa' had the largest linear length and width (16.7 × 12.2 cm), while among the white cultivars, 'Droujba' stood out (16.5 × 11.4 cm). The other cultivars exhibited bunch dimensions ranging from 14.4 × 8.7 cm ('Tamyanka') to 16.2 × 11.1 cm ('Pamid') (Table 3, Figure 1).

According to the accepted classification, the studied wine grape cultivars had bunches ranging from small to medium-large, reaching or even exceeding the characteristic values for each cultivar. The mechanical analysis of the red cultivars showed that the average mass of 100 berries was the highest in the standard 'Pamid' (214.7 g), which, according to ampelographic descriptions, has a dual-

purpose use. The smallest berries were recorded in ‘Rubin’ (141.6 g). ‘Kaylashki rubin’ and ‘Trapezitsa’ had almost identical berry sizes, at 165.0 g and 168.0 g, respectively.

Table 2. Mechanical analysis of grapes of red wine grapevine cultivars, 2021–2024.

Cultivar	Year	Weight per bunch	Bunch sizes		Weight per 100 berries	Berry sizes		Structure of bunch		Theoretical yield
			Length	Width		Length	Width	Rachis	Berries	
		g	cm	cm	g	mm	mm	%	%	%
‘Kaylashki rubin’	2021	208.5	14.9	9.8	158.0	13.2	13.0	3.1	96.9	82.4
	2022	262.3	15.8	11.4	166.0	13.5	13.1	2.6	97.4	85.1
	2023	264.0	15.9	11.2	169.0	13.6	13.2	2.7	97.3	85.9
	2024	236.0	16.0	10.6	167.0	13.5	13.2	2.7	97.3	84.9
	x*	242.7	15.7 n.s.	10.8 n.s.	165.0	13.5	13.1	2.8	97.2	84.6
		n.s.			-	--	-	-	+	n.s.
‘Trapezitsa’	2021	244.7	15.6	11.3	120.0	12.2	11.9	5.7	94.3	72.1
	2022	400.4	16.9	12.6	224.0	15.3	14.8	3.7	96.3	82.5
	2023	265.0	16.0	11.7	198.0	14.4	14.0	5.5	94.5	78.9
	2024	305.8	18.2	13.0	130.0	12.7	12.1	5.1	94.9	74.4
	x*	304.0	16.7	12.2	168.0	13.7	13.2	5.0	95.0	77.0
		n.s.	n.s.	+	-	--	-	+++	---	---
‘Rubin’	2021	222.8	14.7	10.9	122.8	12.5	12.0	4.2	95.8	78.7
	2022	331.8	16.5	12.0	165.0	13.5	13.0	3.6	96.4	84.7
	2023**	-	-	-	-	-		-	-	-
	2024	286.3	16.1	12.8	137.0	13.2	12.1	3.3	96.7	82.1
	x*	280.3	15.8	11.9	141.6	13.0	12.4	3.7	96.3	81.8
		n.s.	n.s.	n.s.	--	---	--	n.s.	n.s.	--
‘Pamid’ (standard)	2021	245.1	16.0	11.3	180.0	14.0	12.8	4.1	95.9	85.2
	2022	300.8	16.3	11.2	254.0	16.3	15.7	2.8	97.2	89.1
	2023**	-	-	-	-	-	-	-	-	-
	2024	262.3	16.3	10.9	210.0	15.5	14.9	3.9	96.1	86.4
	x*	269.4	16.2	11.1	214.7	15.3	14.5	3.6	96.4	86.9
F		3.7	3.1	5.7	7.4	10.2	5.7	20.0	20.1	23.6
SD		18.8	0.4	0.4	15.9	0.4	0.5	0.3	0.3	1.2
LSD 0.05		42.4	0.8	0.9	35.9	1.0	1.2	0.7	0.7	2.8

*Average for the period 2021–2024 **Due to the impairment of the harvest by downy mildew (*P. viticola*) in the cultivars of the *V. vinifera* group, in 2023 no mechanical analysis of the yield was carried out – ns (non-significant differences); +/- (P<0.05); ++/-- (P<0.01); +++/--- (P<0.001).

Among the white cultivars, ‘Droujba’ had the largest berries (354.0 g) in all years of the study. According to the ampelographic descriptions, ‘Droujba’ is a dual-purpose cultivar. The standard ‘Tamyanka’ ranked second (188.0 g), while ‘Slava’ had the smallest berries (165.5 g).

A similar trend was observed regarding berry dimensions. ‘Droujba’ had the highest average length-to-width ratio (18.3 × 17.5 mm), while ‘Slava’ had the lowest (13.1 × 12.7 mm). Among the red cultivars, the standard cultivar ‘Pamid’

had the largest berries (15.3 × 14.5 mm), while the other cultivars had nearly identical sizes.

The comparative analysis showed that the differences between the red cultivars and the standard were insignificant, whereas in 'Droujba', the differences in berry size were statistically significant.

The data on bunch and berry structure indicate that the percentage of berries within the bunch was consistently high across all variants, ranging from 95.0% in 'Trapezitsa' to 97.2% in 'Kaylashki rubin' and 'Droujba'. Under the specific regional conditions, the theoretical yield was high for all cultivars and ranged from 77.0% to 86.9% (Tables 2 and 3).

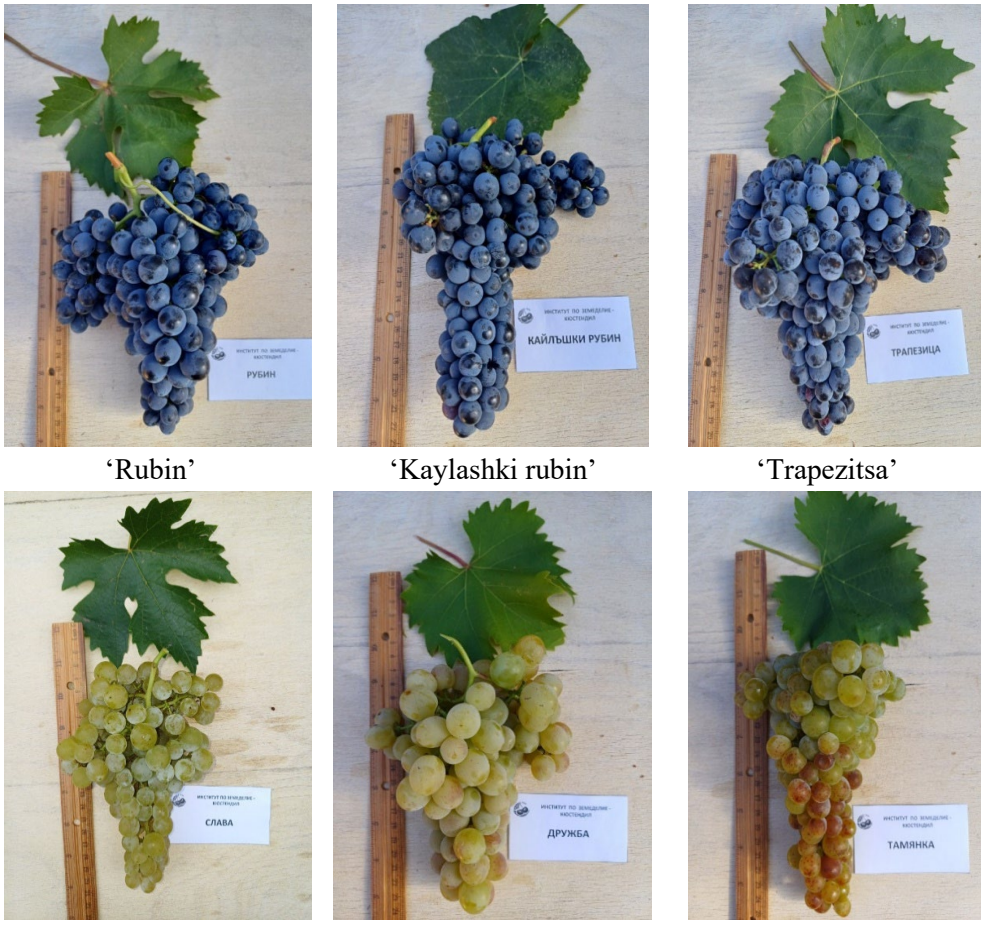
Table 3. Mechanical analysis of grapes of white wine grapevine cultivars, 2021–2024.

Cultivar	Year	Weight per bunch	Bunch sizes		Weight per 100 berries	Berry sizes		Structure of bunch		Theoretical yield
			Length	Width		Length	Width	Rachis	Berries	
		g	*cm*	*cm*	*g*	*mm*	*mm*	*%*	*%*	*%*
'Slava'	2021	125.5	12.8	8.6	154.0	12.6	12.4	4.0	96.0	79.9
	2022	209.2	14.8	10.8	175.0	13.5	13.2	3.0	97.0	82.0
	2023	154.1	13.3	8.8	174.0	13.2	12.7	3.9	96.1	80.4
	2024	148.6	14.3	9.2	159.0	13.0	12.7	4.3	95.7	80.2
	x*	159.4	13.8	9.4	165.5	13.1	12.7	3.8	96.2	80.6
		n.s.	n.s.	n.s.	n.s.	-	--	n.s.	n.s.	---
'Droujba'	2021	234.8	15.2	11.4	305.0	16.8	16.7	3.4	96.6	84.5
	2022	311.2	18.4	11.5	404.0	19.7	18.6	2.2	97.8	87.1
	2023	239.0	16.3	11.2	377.0	18.7	17.5	3.0	97.0	86.1
	2024	240.3	16.0	11.5	330.0	18.0	17.0	2.5	97.5	86.3
	x*	256.3	16.5	11.4	354.0	18.3	17.5	2.8	97.2	86.0
		+	n.s.	+	+++	+++	+++	-	+	n.s.
'Tamyanka' (standard)	2021	177.3	14.5	8.1	161.0	12.9	12.8	3.8	96.2	86.2
	2022	165.5	12.6	7.7	213.0	15.2	14.9	5.6	94.4	85.6
	2023**	-	-	-	-	-	-	-	-	-
	2024	216.0	16.0	10.4	190.0	13.9	13.8	4.2	95.8	86.3
	x*	186.3	14.4	8.7	188.0	14.0	13.8	4.5	95.5	86.0
F		11.5	4.1	7.4	122.0	150.7	225.8	5.3	5.2	63.0
SD		20.8	1.0	0.7	13.2	0.3	0.2	0.5	0.54	0.6
LSD 0.05		51.1	2.4	1.8	32.3	0.8	0.6	1.3	1.3	1.4

*Average for the period 2021–2024 **Due to the impairment of the harvest by downy mildew (*P. viticola*) in the cultivars of the *V. vinifera* group, in 2023 no mechanical analysis of the yield was carried out – ns (non-significant differences); +/- (P<0.05); ++/-- (P<0.01); +++/--- (P<0.001).

The results of this study demonstrate clear trends in the selection and adaptation of the evaluated wine grape varieties to the current climatic conditions. Among the red varieties, 'Trapezitsa' and 'Kaylashki rubin' stood out due to their excellent technological qualities. 'Trapezitsa' is characterized by the highest average bunch weight and size, combined with a high percentage of berries and an optimal bunch and berry structure, resulting in the greatest theoretical yield.

Despite the smaller berry size, ‘Kaylashki rubin’ achieved a comparable yield efficiency. Both varieties significantly outperformed the standard cultivar ‘Pamid’, thereby confirming the effectiveness of the breeding efforts aimed at enhancing resilience and productivity (Ivanov et al., 2011b; Ivanov et al., 2012; Roychev, 2012; Ivanov, 2016).



‘Rubin’ ‘Kaylashki rubin’ ‘Trapezitsa’

‘Slava’ ‘Droujba’ ‘Tamyanka’

Figure 1. Grapevine cultivars.

Among the white cultivars, ‘Droujba’ is characterized by its large bunches and berries, high yield potential, and favorable technological characteristics, supporting its classification as a dual-purpose variety (Simeonov et al., 2009; Roychev, 2012). The mechanical analysis further substantiated the superiority of ‘Droujba’ over ‘Tamyanka’ and ‘Slava’.

In conclusion, the cultivars ‘Trapezitsa’, ‘Kaylashki rubin’, and ‘Droujba’ demonstrated strong potential for integration into contemporary viticultural systems. Their high productivity and desirable technological traits position them as valuable assets for sustainable viticulture under evolving climatic conditions.

The grape yield is a function of the number of bunches per vine and their average weight. Among the red cultivars, ‘Trapezitsa’ (21252 kg/ha) and ‘Kaylashki rubin’ (20328 kg/ha) stood out with the highest and almost equal average grape yield per hectare (2021–2024). The differences compared to the ‘Pamid’ standard (17248 kg/ha) were statistically significant. ‘Rubin’ had the lowest yield, at 14168 kg/ha. Among the white cultivars, ‘Droujba’ had the highest recorded yield per hectare (15092 kg/ha), due to its larger bunches, followed by ‘Slava’ (10780 kg/ha). The lowest average yield per vine was recorded for the ‘Tamyanka’ standard (8932 kg/ha) (Figure 2). The price of the grapes is determined by the actual prices realized over the years and is given as an average value for the period. Its value was 0.61 euro/kg. The profitability rate ranged from 82% to 175%.

The highest gross output was achieved by the red cultivars ‘Trapezitsa’ (13039 euros/ha) and ‘Kaylashki rubin’ (12472 euros/ha), while the lowest was recorded for the white standard ‘Tamyanka’ (5480 euros/ha). The red cultivars demonstrated higher economic value compared to the white ones.

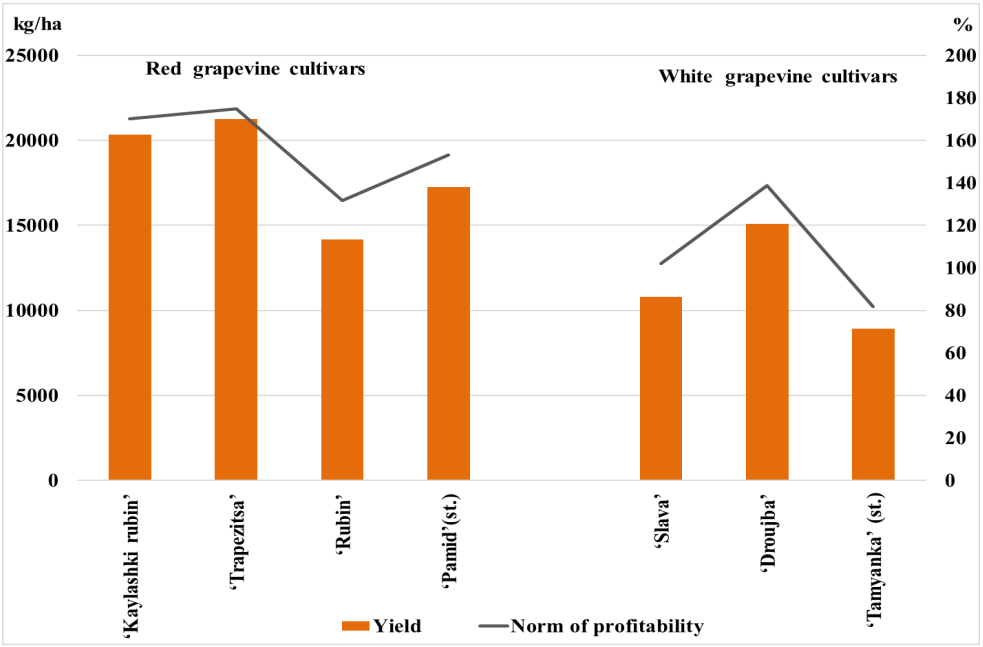


Figure 2. Yield (kg/ha) and profitability rate (%).

Production costs for red cultivars ranged from 3749 euros/ha (‘Rubin’) to 4745 euros/ha (‘Trapezitsa’). White cultivars had lower production costs, making them more attractive from this point of view. ‘Tamyanka’ had the lowest costs (3013 euro/ha), which is due to its lower yield.

The net income followed the trend observed for the gross output, with the highest values recorded for ‘Trapezitsa’ (8294 euro/ha), followed by ‘Kaylashki rubin’ (7857 euro/ha). Compared to the standard, these cultivars generated higher net incomes of 1893 euros/ha and 1456 euros/ha, respectively (Figure 3). The gained research results are generally in line with some previous researches providing the evidence that grape cultivation could be profitable (Pappalardo et al., 2013; Milić et al., 2016; Filipovic et al., 2017; Jelocnik et al., 2024).

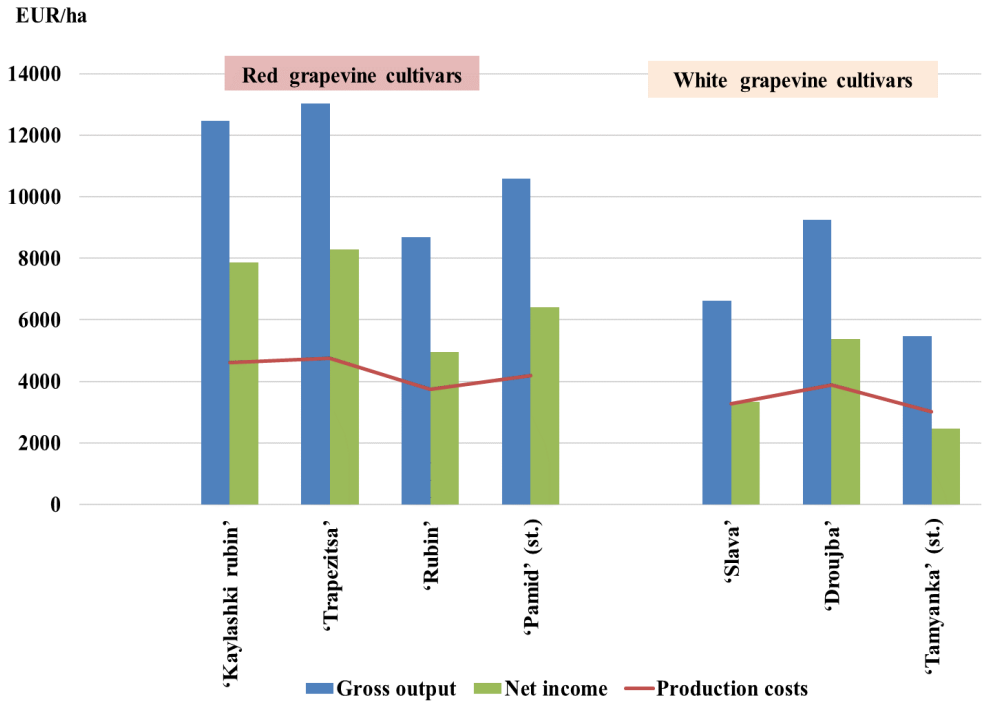


Figure 3. Gross output, net income and production costs, euro/ha.

The red cultivars were more cost-effective to produce, with lower production costs. The lowest prime cost was recorded for ‘Trapezitsa’ (0.22 euro/kg), while ‘Rubin’ had the highest value (0.26 euro/kg). Among the white cultivars, the lowest prime cost was observed for ‘Droujba’ (0.26 euro/kg), whereas ‘Tamyanka’

had the highest cost (0.34 euro/kg). The prime costs per hectare were highest for ‘Trapezitsa’ and lowest for ‘Tamyanka’ (Figure 4).

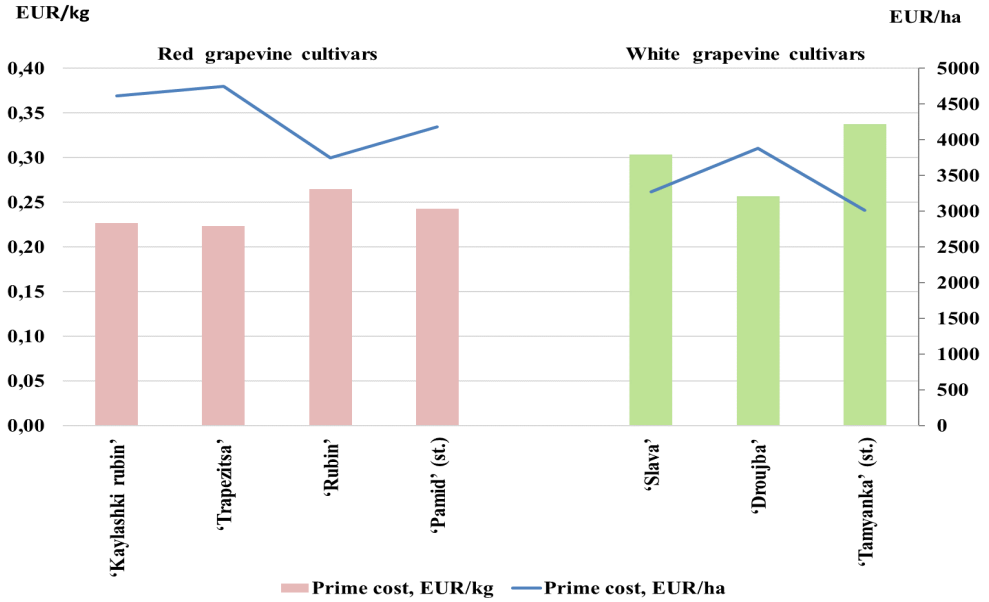


Figure 4. Prime costs, euro/ha and euro/kg.

Conclusion

The timing of the individual phenophases of the studied cultivars under the soil and climatic conditions of the Kyustendil region, Bulgaria, has been determined. Cultivars of interspecific origin began their development relatively earlier than those belonging to the *V. vinifera* group. Based on the onset of technological maturity, the studied cultivars can be classified into two groups: mid-ripening – ‘Rubin’ (15/IX) and late-ripening – ‘Tamyanka’ (16/IX), ‘Droujba’ (20/IX), ‘Trapezitsa’ (23/IX), ‘Slava’ (23/IX), ‘Pamid’ (25/IX), and ‘Kaylashki rubin’ (29/IX).

The bunches of the studied wine cultivars ranged from small to medium-large and reached the characteristic values. The percentage of berries within the bunch was high across all variants, ranging from 95.0% in ‘Trapezitsa’ to 97.2% in ‘Kaylashki rubin’ and ‘Droujba’. The grapes of the ‘Pamid’ and ‘Tamyanka’ standards, as well as ‘Droujba’ and ‘Kaylashki rubin’, had a very high theoretical yield.

Among the red cultivars, ‘Trapezitsa’ and ‘Kaylashki rubin’ outperformed the others in almost all indicators, including yield, net income, and profitability. Their cultivation under the soil and climatic conditions of the Kyustendil region provides opportunities for achieving high economic returns. Although white cultivars such as ‘Droujba’ have lower production costs, they cannot compete with the high economic efficiency of the red ones.

References

Borisenko, M., Likhovskoi, V., Studennikova, N., Troshin, L., & Saliev, T. (2015). Agro-economical evaluation of Crimean indigenous grape varieties, *Scientific journal of KubSAU. Agricultural sciences*, *113* (09), 1-14.

Delrot, S., Grimplet, J., Carbonell-Bejerano, P., Schwandner, A., Bert, P.F., Bavaresco L., Dalla Costa, L., Di Gaspero, G., Duchêne, E., Hausmann, L., Malnoy, M., Morgante, M., Ollat, N., Pecile, M., & Vezzulli, S. (2020). Genetic and genomic approaches for adaptation of grapevine to climate change. In Kole C. (Ed.), *Genomic designing of climate-smart fruit crops.* (pp. 157-270). Springer: Cham. doi:10.1007/978-3-319-97946-5_7.

Dyakova, G., Mincheva, R., Yoncheva, T., & Hajgarov, V. (2015). Performance of a new wine candidate-variety Muscat Viking selected in IASS „Obraztsov chiflik – Ruse”. *Proceedings of the Union of Scientists – Ruse, Book 3, Agrarian and veterinary sciences, 7*, 96-99.

Eibach, R., & Töpfer, R. (2015). Traditional Grapevine Breeding Techniques. In A. Reynolds (Ed.), *Grapevine Breeding Programs for the Wine Industry.* (pp. 3-21). Woodhead Publishing, Cambridge.

Fengmei, L., & Fengqin, Zh. (1990). Grape breeding in China. *Vitis*, *29,* 212-216.

Filipovic, J., Stankovic, S., Rahovic, D., Tomic, V., Ljiljanic, N., Radisic, R., & Maslovaric, M. (2017). Gross margin and economic parameters of grapeproduction in Pomoravlje region, Serbia. In Kovačević, D. (Ed.) *Proceedings from VIII International Scientific Agriculture Symposium “Agrosym 2017”,* (pp. 2575-2578). Jahorina, BiH.

Hajdu, E. (2007). Bud survival of vine varieties and hybrids after cold stress, *Horticulture*, *39* (3), 20-28.

He, K., Ning, C.G., Cai, L. G., Zhao, Q., & Wang, L.H. (2007). The table grape cultivar "Yongyou 1" and its cultural techniques. *South China Fruits*, *4*, 59-63.

Ivanov, M., Simeonov, I., & Nakov, Z. (2011a). Study on the resistance of interspecific table grape cultivars to low winter temperatures under field conditions, *Proceedings of the International scientific and practical conference,* (pp. 60-67). Novocherkassk.

Ivanov, M., Nakov, Z., Simeonov, I., & Iliev, A. (2011b). Kaylashki rubin – a new red wine grapevine variety. *Agricultural Science*, *44,* (4), 60-65.

Ivanov, M., Simeonov, I., & Nakov, Z. (2012). Trapezitsa - new red wine grapevine variety. *Agricultural science*, *45,* (1), 57-62.

Ivanov, M. (2013). Selection for resistance to stress factors in grapevines within the vineyards of the Institute of Viticulture and Enology – Pleven (review). *Viticulture and Enology*, 4, 22-28.

Ivanov, M. (2016). *The hybridization in breeding in grapevine.* Academic Publishing House of the Agricultural University, Plovdiv.

Ivanov, M., Simeonov, I., & Nakov, Z. (2015). Agrobiological characteristic of interspecies table grapevine varieties suitable for growing in hilly and mountain regions of Bulgaria. *Journal of Mountain Agriculture on Balkans*, *18* (4), 714-726.

Jelocnik, M., Jaksic, D., & Petrovic, M. (2024). Economic competitiveness of autochthonous (local) grapevine varieties for the production of white wines. *Ekonomika*, *70* (2), 13-26.

Jiang, A.L., Li, S.C., Yiang, T.Y., Jin, P.F., & Zhang, C.X. (2009). Shenbao, a new table grape cultivar. *Journal of Fruit Science*, *26* (6), 922-923.

Katerov, K., Donchev, A., Kondarev, M., Kurtev, P., Tsankov, B, Zankov, Z., Getov, G., & Tsakov, D. (1990). *Bulgarian ampelography, I*. Publishing House of the Bulgarian Academy of Sciences.

Krumov, S., Simeonov I., & Dimitrova D. (2020). Comparative agrobiological and economical analysis of grape yield and quality indicators of new introduced table grapevines varieties for Kyustendil region. *Bulgarian Journal of Crop Science*, *57*, (3), 37-44.

Maneva, S. (2007). *Mathematical methods in plant protection*. Dissertation, Plant Protection Institute Sofia.

Milić, D., Glavaš Trbić, D., Tomaš Simin, M., Janković, D., & Zekić, V. (2016). Economic characteristics of grape production in south Banat. *Economics of Agriculture*, *63* (4), 1187-1203.

Mincheva, R., Dyakova, G., Yoncheva, T., & Hajgarov, V. (2015). Performance of a new wine candidate-variety Kristalen selected in IASS „Obraztsov chiflik – Ruse", *Agrarian and veterinary sciences, 7*, 57-60.

Pappalardo, G., Scienza, A., Vindigni, G., & D'Amico, M. (2013). Profitability ofwine grape growing in the EU member states. *Journal of Wine Research*, *24* (1), 59-76.

Pernesz, G. (2004). New resistant table grape cultivars bred in Hungary. ISHS *Acta Horticulturae, 652,* 321-327.

Roychev, V. (2012). *Ampelography*. Academic Publishing House of the Agriculture University – Plovdiv.

Simeonov, I., Ivanov, M., Nakov, Z., & Iliev, A. (2017). Results of grapevine intra-species and interspecific hybridization at IVE-Pleven (overview). *Journal of Mountain Agriculture on the Balkans*, *20* (3), 211-220.

Slavtcheva, T. (2008). On the grapevine cold hardiness again. *Viticulture and Enology*, *2*, 11-19.

Simeonov, I., Ivanov, M., & Nakov, Z. (2009). Agrobiological characteristics of recommended and permitted wine grapevine varieties suitable for growing in semi-mountain and mountain regions of the Republic of Bulgaria, *Journal of Mountain Agriculture on the Balkans*, *12* (5), 1115-1125.

Vannozzi, A., Palumbo, F., Magon, G., Lucchin, M., & Barcaccia, G. (2021). The grapevine (*Vitis vinifera* L.) floral transcriptome in Pinot noir variety: identification of tissue-related gene networks and whorl-specific markers in pre-and post-anthesis phases. *Horticulture Research*, *8,* 200. doi:10.1038/s41438-021-00635-7.

Xiang, D.F., Li, S.X., Zhang, M.H., Liu, J., Wang, N., Wang, X.D., Luo, S.X., Qi, H.X., & Geng, X.G. (2008). A New Grape Cultivar 'Jingtianmeigui'[J]. *Acta Horticulturae Sinica*, *35* (6), 926-926.

Zhao, S.J., Zhang, X.Z., Guo, Z. J., & Ma, A.H. (2009). Characteristics of new triploid seedless table grape cultivar 'Champion Seedless' released in China. *ISHS Acta Horticulturae, 827,* 451-456.

Received: March 11, 2025
Accepted: June 6, 2025

AGROBIOLOŠKI I EKONOMSKI POTENCIJAL VINSKIH SORTI VINOVE LOZE GAJENIH U REGIONU ĆUSTENDILA, BUGARSKA

Simeon D. Krumov[1*], Iliyana S. Krishkova[1] i Iliyan N. Simeonov[2]

[1]Institute of Agriculture - Kyustendil, 2500, Agricultural Academy – Sofia, Bulgaria
[2]Institute of Viticulture and Enology - Pleven, 5800, Agricultural Academy – Sofia, Bulgaria

R e z i m e

Sprovedena je uporedna analiza agrobiološkog i ekonomskog potencijala dve bele sorte vinove loze (‘slava’ i ‘družba’) i tri crvene sorte (‘kajlaški rubin’, ‘trapezica’ i ‘rubin’) u zemljišnim i klimatskim uslovima regiona Ćustendila u Bugarskoj. Kao uporedne varijante (standardi) korišćene su sorte ‘pamid’ za crvene i ‘tamjanika’ za bele sorte. Istraživanje je sprovedeno u periodu od 2021. do 2024. godine u kolekcionom vinogradu Instituta za poljoprivredu – Ćustendil, Bugarska. Kada je reč o kvalitetu, plodnosti i veličini grozdova i bobica, ispitivane sorte su dostigle, pa čak i premašile vrednosti karakteristične za svaku od njih. Udeo bobica u grozdu bio je „visok” kod svih varijanti – od 95,0% kod sorte ‘trapezica’ do 97,2% kod sorti ‘kajlaški rubin’ i ‘družba’. Grožđe standardnih sorti ‘pamid’ i ‘tamjanika’, kao i međuvrsnih sorti ‘družba’ i ‘kajlaški rubin’, odlikovalo se „veoma visokim” teorijskim prinosom. Sa ekonomske tačke gledišta, najbolji rezultati u eksperimentalnim uslovima postignuti su kod crvenih sorti ‘trapezica’ i ‘kajlaški rubin’. Visok nivo neto prihoda i profitabilnosti pokazuje da i bela sorta ‘družba’ ima značajan ekonomski potencijal.

Ključne reči: vinske sorte vinove loze, prinos, ekonomska evaluacija.

Primljeno: 11. marta 2025.
Odobreno: 6. juna 2025.

[*]Autor za kontakt: e-mail: simeon.krumov@gmail.com