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BUNCH THINNING AND ITS EFFECT ON WINE QUALITY IN SYRAH VARIETY CLONES

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Abstract

The experiment was conducted during the period 2020-2022 at the Agricultural University-Plovdiv. A unified technological scheme for the production of red dry wines was used. The object of the study was clones from the Syrah variety numbered 100, 174, 470 and 524 grafted onto SO4 rootstock. After flowering, at a berry size of 4 to 6 mm (BBCH - 75), bunch thinning was applied; the number of clusters was reduced to 60% (8 clusters per vine). The following physicochemical indicators determining wine quality and differences were found in the analysis of relative density (g/dm^3); alcohol (%); sugars (g/dm^3); total extract (g/dm^3); sugar-free extract (g/dm^3); titratable acids (g/dm^3); volatile acids (g/dm^3); free sulfur dioxide (mg/dm^3); total sulfur dioxide (mg/dm^3); total phenols (mg/dm^3). Bunch thinning had a positive impact, expressed in the higher average content of total extract (30.00 g/dm^3), sugar-free extract (28.53 g/dm^3) and total phenols (1884.42 mg/dm^3). Selective bunch thinning during vine vegetative growth is a technological practice that positively affects the wine quality obtained from vines with reduced yield.

Key words*: clones, green pruning, Syrah variety, red wine, wine analysis.*

INTRODUCTION

Clonal selection allows the control of viral diseases and the selection of genotypes according to agronomic, viticultural, or oenological criteria (Roby et al., 2014).

The clone selection of renowned varieties, more adapted to the predicted climatic conditions, can help maintain the typicality of the wine (Arrizabalaga-Arriazu et al., 2020).

Bunch thinning is a common technique in viticulture to modulate the balance between foliage and yield in order to improve fruit quality and increase the level of secondary metabolites (Alem et al., 2019).

According to Meillon et al. (2010) it affects the reduction of yield, the advancement of grape maturity, the improvement of the phenolic content of the grapes and therefore of the wine.

Reducing the number of clusters in the "pea-sized" phase has a beneficial effect on the components determining the technological maturity of grapes - the dynamics of sugar content and titratable acids (Popova, & Angelov, 2024).

Other studies on fruit and wine composition have shown that bunch thinning increases anthocyanin and phenolic content (Guidoni et al., 2002; Keller et al., 2005; Nuzzo & Matthews, 2006), while pH and titratable acidity results vary (Nuzzo & Matthews, 2006; Intrigliolo & Castel, 2011; Preszler et al., 2013). Various authors have observed an advance in fruit ripeness and increased sugar accumulation (Nuzzo & Matthews, 2006; Reynolds et al., 1994; Bowen et al., 2011). In 1980, Freeman et al. found no consistent effects on wine sensory scores due to yield reduction, while Chapman et al. (2004) reported improvements in wine aromas as a consequence of thinning.

Piernas et al. (2022), cites authors who have studied the impact of reducing the number of bunches on wine grape ripening, as well as on wine composition and quality (Gil-Muñoz et al., 2009; Gatti et al., 2012; Keller et al., 2005; Diago et al., 2010). In addition to improving the phenolic content of wine grapes, thinning of bunches has the ability to reduce total acidity and increase total soluble solids and pH (Nuzzo & Matthews, 2006).

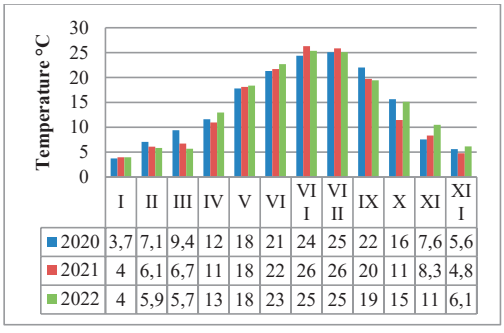
Nevertheless, Diago et al. (2010) reported that this agronomic method showed a positive effect on wine quality, associated with an increase in berry size, which reduced the skin-to-mesocarp ratio.

The physicochemical analysis of wine is the basis for controlling and monitoring the technological flow of wine production (Răducu et al., 2019).

Syrah can produce high-quality wine with a bluish color, a fine, intense aroma, and low acidity (Hanlin et al., 2011).
The main objective of this study was to evaluate the impact of grape thinning on wine quality in clones 100, 174, 470 and 524 of the Syrah variety, grown in the Brestnik village area.

MATERIALS AND METHODS

The subject of the study was Syrah variety clones numbered 100, 174, 470 and 524, distinguished by valuable economic and technological qualities. Clone 100 is for producing wines with lower sugar content, neutral and plain; clone 174 is for high-quality wines; clone 470 is well-coloured, with excellent sugars and good tannin-structure wines; and clone 524 is balanced with medium to high sugar content (ENTAV-INRA-ENSA-M- ONIVINS, 1995). Vines were grafted onto Berlandieri x Riparia SO4 rootstock, planted in April 2011 in the experimental field of Viticulture at the Agricultural University - Plovdiv.
The vineyard is in full fruiting. The planting distance is 3.0 m between rows and 1.00 m between vines in the row - 3330 pcs per ha. The vines are trained with a high stem on a double sided cordon with the corresponding support trellis. The bud loading in all variants was carried out by spur pruning two buds, a total of 6 spurs/12 buds/ per vine. The rows are grassed, and the soil surface between the vines is kept clean by applying herbicides. The vines are grown under non-irrigated conditions.
The rows' direction in the vineyard is northwest - southeast, with a slope of the terrain to the east of 3.2% /1.8º/ and an average altitude of -194 m.
The following 8 variants were included in the scheme of the experimental work:
V1 - clone 100 - non-controlled yield;
V2 - clone 174 - non- controlled yield;
V3 - clone 470 - non- controlled yield;
V4 - clone 524 - non- controlled yield;
V5 - clone 100 - with controlled yield in the "pea size" phase (8 clusters per vine);
V6 - clone 174 - with controlled yield in the "pea size" phase (8 bunches per vine);
V7 - clone 470 - with controlled yield in the "pea size" phase (8 bunches per vine);
V8 - clone 524 - with controlled yield in the "pea size" phase (8 bunches per vine).
Each variant included 60 vines (4 replicates x 15 vines).
The yield rationing was carried out during the vegetation in the "pea size" phase, leaving 8 bunches per vine.
The grapes were harvested when they reached technological ripeness, and for the controlled variants (V5, V6, V7 and V8), it was carried out one week earlier than for the variants with non-controlled yield (V1, V2, V3 and V4). Wines were produced from each harvest according to the same technological scheme for the production of red quality wines - crushing, sulfitisation (50 mg/kg SO_2), two hours after sulfitisation, seeding with yeast Excellence XR - 20 g/hl and yeast food Vitaferment - 30 g, fermentation temperature 24-26°C, separation from solids, dosulfitisation, storage.
At the winery lab, a physicochemical analysis of the experimental wines was carried out according to the methodology described in the Manual for Exercises in Winemaking (Bambalov, 2009). The following were studied: relative density (g/dm^3); alcohol (%); sugars (g/dm^3); total extract (g/dm^3); sugar-free extract (g/dm^3); titratable acids (g/dm^3); volatile acids (g/dm^3); free sulfur dioxide (mg/dm^3); total sulfur dioxide (mg/dm^3); total phenols (mg/dm^3).
The climatic data for the experimental period were taken from the meteorological station located in the vineyard. The indicators are average monthly air temperature (ºC) and the amount of precipitation (mm), which characterize the climatic features of the studied area. The graphs show their changes during the experimental years (Figures 1 and 2).



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2020	3,7	7,1	9,4	12	18	21	24	25	22	16	7,6	5,6
2021	4	6,1	6,7	11	18	22	26	26	20	11	8,3	4,8
2022	4	5,9	5,7	13	18	23	25	25	19	15	11	6,1

Figure 1. Average monthly air temperature, 2020-2022

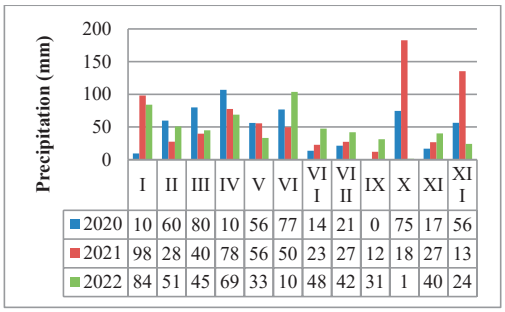


Figure 2. Precipitation, 2020-2022

The correlation analysis was performed using MS Excel.

RESULTS AND DISCUSSIONS

Physicochemical analysis show significant differences in their analytical composition, depending on both the agricultural cultivation technique (standardized and non-standardized variants) and the grape variety clone. The alcohol and titratable acid content are within optimal limits (Figure 3), with the differences between the variants with controlled and non-controlled yield being minimal, since all experimental variants were harvested at approximately the same level of ripeness, which was reached earlier in the variants with standardized yield.

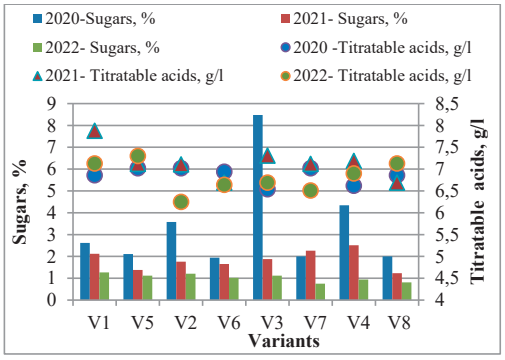


Figure 3. Sugars and titratable acids in wine, 2020-2022

The wines from the 2020 harvest have the highest alcohol content and the lowest titratable acidity, which is due to the very high initial sugar content in the berries.

A higher content of total and sugar-free extract was found in the wines from the 2020 and 2022 harvests (Table 1), compared to 2021, especially in the variants with controlled yield.

Table 1. Relative density, alcohol, total and sugar-free extract, 2020-2022

Variants / Clone	Period (Year)	Relative density	Alcohol %	Total extract, g/dm^3	Sugar-free extract, g/dm^3
V_1 100	2020	0.9917	15.10	28.70	26.08
	2021	0.9928	14.30	29.20	27.08
	2022	0.9927	14.30	28.90	27.63
	Average	0.9924	14.56	28.93	26.93
V_2 174	2020	0.9931	14.30	30.00	26.42
	2021	0.9930	14.12	29.20	27.44
	2022	0.9939	13.15	28.70	27.49
	Average	0.9933	13.85	29.30	27.11
V_3 470	2020	0.9937	15.91	36.20	27.72
	2021	0.9932	14.12	29.70	27.82
	2022	0.9936	13.41	28.70	27.58
	Average	0.9935	14.48	31.53	27.71
V_4 524	2020	0.9927	15.91	33.60	29.26
	2021	0.9932	14.12	29.70	27.19
	2022	0.9933	13.67	28.70	27.76
	Average	0.9931	14.56	30.66	28.07
V_5 100	2020	0.9924	15.28	31.00	28.89
	2021	0.9932	13.85	28.90	27.52
	2022	0.9931	14.56	30.70	29.58
	Average	0.9929	14.56	3020	28.66
V_6 174	2020	0.9920	14.92	28.90	26.96
	2021	0.9936	13.59	29.20	27.55
	2022	0.9946	13.24	30.70	29.68
	Average	0.9934	13.92	29.60	28.06
V_7 470	2020	0.9920	15.37	30.20	28.20
	2021	0.9933	13.67	28.70	26.44
	2022	0.9943	13.50	30.70	29.95
	Average	0.9932	14.18	29.86	28.19
V_8 524	2020	0.9926	15.19	31.30	29.86
	2021	0.9935	13.32	28.10	26.87
	2022	0.9946	13.59	31.80	30.99
	Average	0.9935	14.03	30.40	29.24

This result is due to the significant rainfall during the grape ripening period in 2021, which led to waterlogging of grape juice and are the reason for the lower content of total and sugar-free extract in the wines from the 2021 harvest.

Wines from clone 174 V2 (13.85%) and V6 (13.92%) have the lowest alcohol content. Wines from clone 524 in variants V4 and V8 from the 2020 and 2022 harvests have a higher content of total extract and sugar-free extract.

Wines from clone 100 (V1 and V5) report a higher alcohol content (14.56%), which correlates with a higher sugar content of the grapes, both for the controlled and non-controlled variants. This is most valid for wines from the 2022 harvest and allows us to make the assumption that grapes from this clone have the highest sugar accumulation energy.

The wines from clone 100 had the highest content of total phenolic substances in V1 (1903.76 g/dm^3) and V5 (2107.08 g/dm^3), compared to wines from all other clones, which makes these wines better structured (Table 2).

Table 2. Content of volatile acids, free sulfur dioxide, total sulfur dioxide and total phenols, 2020-2022

Variants / Clone	Period (Year)	Volatile acids, g/dm^3	Free sulfur dioxide, g/dm^3	Total sulfur dioxide, g/dm^3	Total phenols, g/dm^3
V_1 100	2020	0.73	34.24	127.19	2514.40
	2021	0.42	8.11	35.13	1580.48
	2022	0.49	17.96	53.38	1616.40
	Average	0.54	20.10	71.90	1903.76
V_2 174	2020	0.77	30.58	133.92	2083.36
	2021	0.36	13.51	41.88	1495.17
	2022	0.37	16.47	53.14	1477.21
	Average	0.50	20.18	76.31	1685.24
V_3 470	2020	0.64	30.58	126.58	2370.72
	2021	0.44	16.21	59.44	1558.03
	2022	0.37	14.97	59.88	1373.94
	Average	0.48	20.58	81.96	1767.56
V_4 524	2020	0.43	39.14	128.42	2375.21
	2021	0.38	14.86	41.21	1454.76
	2022	0.42	13.47	57.63	1257.20
	Average	0.41	22.49	75.75	1695.72
V_5 100	2020	0.61	11.07	42.19	2765.84
	2021	0.31	13.51	43.23	1840.90
	2022	0.35	20.96	68.86	1714.50
	Average	0.42	15.18	51.43	2107.08
V_6 174	2020	0.51	8.56	38.52	2330.31
	2021	0.32	13.51	40.53	1516.20
	2022	0.35	19.46	59.13	1562.22
	Average	0.39	13.84	46.06	1802.91
V_7 470	2020	0.32	12.25	47.70	2440.80
	2021	0.47	14.86	42.56	1620.80
	2022	0.35	19.46	60.63	1484.30
	Average	0.38	15.52	66.20	1848.63
V_8 524	2020	0.48	10.40	46.11	2406.64
	2021	0.34	8.11	40.53	1544.20
	2022	0.36	17.96	59.88	1386.40
	Average	0.39	12.16	48.84	1779.08

The content of volatile acids for all wines was in the normal range, which is an indication of the conduct of pure alcoholic fermentation and their proper storage.

Summarized results from all years report differences in the physicochemical indicators of the wines from the studied clones in each harvest.

The interrelationships between chemical indicators that determine wine quality are important for optimizing the technological processes and for predicting the organoleptic wine properties.

Correlation analysis allows assessing the strength and direction of the dependencies between the different indicators.

A negative correlation was established between the alcohol content and the relative density in both variants (Table 3). The relationships vary from very strong to weak. Changes in relative density are due to variations in the alcohol content in which the accumulation of ethanol leads to a decrease in relative density.

Table 3. Correlations between wine indicators

Indicators	Variants	
	Non-controlled	Controlled
Clone 100		
alcohol ↔ relative density	r = - 0.90	r = - 0.59
alcohol ↔ residual sugar	r = + 0.77	r = + 0.72
alcohol↔ sugar-free extract	r = - 0.59	r = + 0.81
phenols ↔ total extract	r = - 0.71	r = + 0.43
alcohol ↔ phenols	r = + 0.97	r = + 0.80
Clone 174		
alcohol ↔ relative density	r = - 0.25	r = - 0.20
alcohol ↔ residual sugar	r = + 0.76	r = + 0.90
alcohol↔ sugar-free extract	r = + 0.47	r = - 0.56
phenols ↔ total extract	r = + 0.34	r = - 0.53
alcohol ↔ phenols	r = + 0.62	r = + 0.94
Clone 470		
alcohol ↔ relative density	r = - 0.27	r = - 0.32
alcohol ↔ residual sugar	r = + 0.98	r = + 0.47
alcohol↔ sugar-free extract	r = + 0.98	r = + 0.08
phenols ↔ total extract	r = + 0.99	r = + 0.11
alcohol ↔ phenols	r = + 0.99	r = + 0.97
Clone 524		
alcohol ↔ relative density	r = - 0.61	r = - 0.35
alcohol ↔ residual sugar	r = + 0.92	r = + 0.87
alcohol ↔ sugar-free extract	r = + 0.97	r = + 0.56
phenols ↔ total extract	r = + 0.97	r = + 0.29
alcohol ↔ phenols	r = + 0.99	r = + 0.95

The results obtained are in accordance with the technological laws of alcoholic fermentation, in which an increase in alcohol content leads to a decrease in the relative density of the medium. The low value of the coefficients suggests that the relationship is not very pronounced and is probably influenced by additional factors.

A moderate to strong positive correlation was established between the alcohol content and residual sugar. The changes in residual sugar are due to variations in the alcohol content. The differences between the two variants suggest the presence of different biochemical factors affecting the fermentation process.

A different nature of the correlation between the alcohol content and sugar-free extract was established between the two variants in the wines from clones 100 and 174. A moderate to strong negative and very strong positive correlation was observed.

In clones 470 and 524, different results were observed. From a very strong positive correlation to no significant relationship between the indicators (r = 0.06). The variation of the sugar-free extract is due to the changes in alcohol.

Results show different dynamics of extractive substances between the variants, which is due to variations in the primary must.

The correlation analysis between phenols and the total extract in clones 100 and 174 shows a different relationship in the two variants. From a strong negative relationship (r = - 0.71) to a moderate and positive one (r = + 0.43). Phenols have an impact on the total extract. In clones 470 and 524 is very strong positive relationship (r = + 0.99) in the non-controlled variant, compared a non-existent one (r = + 0.11) in the controlled one.

The must composition and the concentration of phenols have a significant impact on the extractive substances.

The analysis between the alcohol content and phenols shows a strong positive relationship in both variants. Alcohol is the strongest factor determining the concentration of phenols and highlights the importance of alcohol levels for the organoleptic and antioxidant wine properties.

Alcohol content shows the strongest positive correlation with phenols, $r \geq 0.62$, as in all variants; and in the non-controlled variants, the relationship with phenols reaches a value of r = 0.99. That is why the alcohol is the best predictor of phenolic concentration and extractives, which is important for the taste and antioxidant potential of the wine.

Residual sugar has a moderate to strong relationship with alcohol, which shows that other factors affect the density, including alcohol content and total extract.

Phenols have a strong relationship with total extract in the non-controlled variant, but in the controlled one this relationship is weak. The grape composition significantly affects the extractive and phenolic components.

CONCLUSIONS

Yield regulation is one of the most important tools in the production of quality wines with a controlled designation of origin, and the results of the study clearly illustrate this.

During the experiment, was found that the variants with controlled yield (V5, V6, V7 and V8), have a higher content of total and sugar-free extract, and total phenolic substances, compared to the variants with non-controlled yield (V1, V2, V3 and V4).

The reduction of bunch numbers has an impact on extremely important indicators like the dynamics of sugar content and titratable acids in the grapes.

Within the experimental period, all variants reach the technological ripeness phase relatively early (first part of September) for the studied region. The grape harvest from vines with controlled yield precedes those with non-controlled yield by approximately one week. Correlation analysis shows that alcohol and phenols are major indicators of wine quality, while total extract and residual sugar have a more moderate influence on wine density.

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