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Studies on growth and yield components in Merlot, Pinot noir and Syrah varieties

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Abstract Growth and yield components of three red wine varieties were evaluated in Recas vineyards during three growing seasons (2016-2018). Yield per vine, vegetative growth and berry composition were measured. Final data were used to compare Merlot, Pinot Noir and Syrah performance, under same cultural practices and climate variability. Differences in yield/ vine among varieties were mostly due to different berry weight and number of clusters/vine. The field trial for all three varieties was developed in Recas vineyards. The vines were trained as unilateral cordon and pruned each year. Each growing season data for yield components and berry composition was collected. Pinot Noir variety show the best results for berry quality (sugar concentration and titratable acidity), while Merlot and Syrah recorded the highest vegetative growth and grape yield. Appropriate canopy management correlated with temperature and rainfall from each growing season and grape variety increase the grape yield and berry quality.

Key words

Merlot, Pinot Noir, Syrah, cluster, berry, sugar, vine

The Merlot variety originally from France, Bordeaux vineyards, is moderate to strong vigour, has medium-sized grapes, with pyramids shape, winged, and more or less dispersed, with the green or pink peduncle [8]. Berries are medium size, round, blue-purple, with epicuticular wax. The skin has a medium density; the pulp/flesh is juicy, sweet, and tasteful [12]. Merlot variety is resistant to low temperatures and drought; in low-temperature years it ripens better than Cabernet Sauvignon, and in the high-temperature years it accumulates more sugar [16]. Grapes of the Merlot variety offer a very delicate, soft finish, red-ruby wine, with a characteristic taste and fruit flavour [3]. Normally, the wine has low acidity. Merlot is sensitive to spring frost and drought conditions [2].

Pinot Noir originally from Burgundy (France), is very well adapted to temperate zones, but in hot climate, grapes maturation is fast [19]. Both, clusters and berries are quite small, but in favourable conditions, can produce high quality wine, with strong flavour, long-term colour and moderate acidity [11].

Result from the crossbreeding of two French varieties (Dureza and Mondeuse blanche) Syrah, have long shoots, fragile to spring winds. Grapes are small or moderate size, with small berries which ripens quickly after short veraison [18]. Syrah can produce high quality wine with bluish colour, fine, intense aroma, and low acidity [10].

The objective of the research was to compare the viticultural parameters of three red wine varieties (Merlot, Pinot Noir and Syrah), grown in similar conditions in the Recas Vineyards, from Timis County, Romania.

Materials and Methods

All three varieties evaluated during three growing seasons have long history in wine production. Varieties were planted in 1999 (Merlot on 117 ha, Syrah 14 ha) and 2000 (Pinot Noir 54 ha) in Recas vineyards. The vines were spaced at 1.8 m between rows and 1.2 m between vines, on north – south oriented rows. The vines were trained as unilateral cordon at 100 cm above the soil. Cordons were pruned each year; shoots were trained upright onto trellis.

Recaş vineyards are located in the south-western of the country, has moderate temperate continental climate with shorter and milder winters, and frequently there are influences of cyclones and hot air masses from the Mediterranean and Adriatic. Average annual rainfall in Recas area is 609 mm of which 49% are falling during grapevine growing season. Average annual temperature is 11.0 ^{o}C. The hottest month of the year is July, with an average of 21.1 ^{o}C, while the coldest is January with -1.1^{o}C in average (Fig. 1).

The grapevines are grown on predominantly acidic soils (average value 6.09 pH). Phosphorus supply is medium value - 27.2 ppm, while potassium supply is good - around 141.1 ppm K. Soil provision in humus is medium, with an average of 2.35%. The nitrogen supply

expressed by the Nitrogen Index (NI) is low, with value around 1.85 %.

Six vines with three field replications, from each variety, were selected for the field trial. Each growing season was collected data for main phenological stages, yield components, grape berries composition and weight of cane pruning. Clusters per vine were collected and numbered at harvest and yield was calculated. Berry weight was calculated on 100 berries sampled from ten clusters.

The three year averages for yield and berries components (sugar, pH, TA) were calculated for each variety, using GraphPad Prism 7.Ink. (Version 7.04).

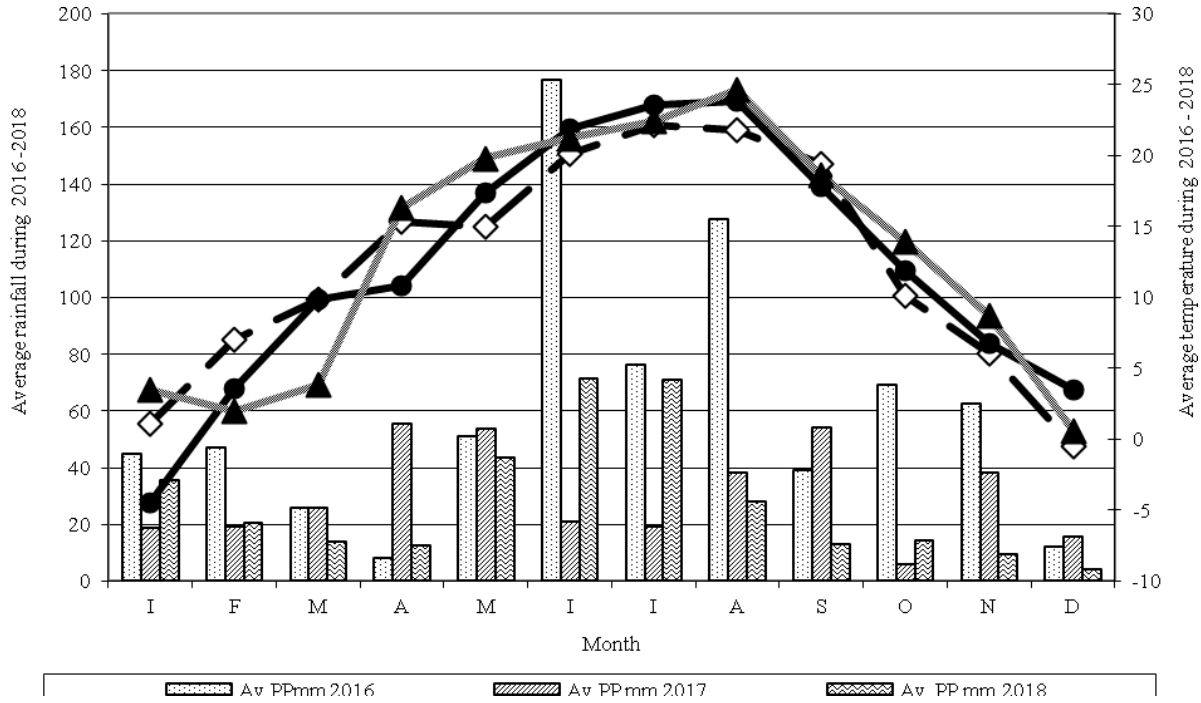

Fig.1 Average temperature and rainfall during trial (2016-2018)

Results and Discussions

The vegetative growth and floral development, yield components (Table 1) and berry composition at harvest was variable among Merlot, Pinot Noir and Syrah varieties during the growing seasons (2016 -2018).

Syrah variety (2.63 kg/vine) recorded above average yield on vine regardless of the growing season, yield which is significantly higher than Pinot Noir. The lower yield was due to smaller cluster weight and number of clusters/vine. Lower level of rainfall in April and May from 2016 at flowering stage favoured the pollination and flowers fertility.

Table 1

Yield components for Merlot, Pinot Noir and Syrah variety during 2016-2018

Variety	Yield kg/vine					Clusters/vine				
	2016	2017	2018	CV%	3 years avg.	2016	2017	2018	CV%	3 years avg.
Merlot	2.2	2.9	2.5	13.86	2.53	13.1	18.7	15.9	17.61	15.90
Pinot Noir	0.9	1.4	1.1	22.21	1.13	8.6	11.3	9.10	14.86	9.67
Syrah	2.3	3.0	2.6	13.34	2.63	12.2	17.5	14.8	17.87	14.83

Variability of yield/ vine was low during growing seasons for both Merlot and Syrah varieties. Pinot Noir variety display a medium variability for yield/vine. Grape yield/ vine in Merlot clones from Serbia ranged among 1.15 and 1.73 kg/vine, and clusters/vine between 9.73 and 19.13 [17]. Castagnoli and Vasconcelor (2006) [4] reported for Pinot Noir grown in Oregon (USA), five – years means yield among 1.21 and 2.93 kg /vine.

The highest number of clusters/vine, was recorded in Merlot variety (18.7 clusters /vine) followed by Syrah. The fewest grapes were recorded in the Pinot Noir variety (8.6 in 2016). Contrary to the yield /vine, Pinot Noir had the lowest variability among varieties, with small amplitude from one growing season to another. Merlot and Syrah varieties show little variability of clusters /vine. Higher average number of clusters/ vine

(38 and 61) was found in Pinot Noir clones (California) by Anderson et al. (2008) [1]. During three growing seasons, Gil-Muñoz et al. (2009) [9] evaluated Syrah variety for yield components, and found 1.9 – 3.1 kg grape yield/ vine, and 108.9 – 129.4 g for cluster weight. Significant variety and year climatic conditions interactions were observed for cluster weight. In 2017 lower cluster weight was the response to wet weather from bloom season. Each growing season, the larger berries were collected from Merlot variety. Lower cluster weight in Pinot Noir was due to the response to the wet and cooler weather during blooming stage in 2017 which cause poor fruit set (Table 2). Dry summer of the same growing season reduce berry weight in Syrah variety. Sivcev et al. (2018) [17] evaluate the basic production parameters in several Merlot clones and found out that cluster weight ranged between 95.33 g and 111.33 g, berry weight among 0.91 g and 1.24 g. Different berry weight was reported by Fidelibus et al. (2007) [8], in Merlot clones from California, between 1.54 and 1.73 g.

Table 2

Yield components for Merlot, Pinot Noir and Syrah variety during 2016-2018

Variety	Cluster weight (g)					Berry weight (g)				
	2016	2017	2018	CV%	3 years avg.	2016	2017	2018	CV%	3 years avg.
Merlot	143	139	150	3.87	144.00	1.53	1.46	1.50	2.35	1.49
Pinot Noir	84	77	98	12.39	86.33	1.47	1.38	1.43	3.16	1.43
Syrah	164	149	171	6.97	161.33	1.22	1.11	1.32	8.63	1.22

Both cluster and berry weight was quite uniform in all three grape varieties. Variability was very low during growing seasons (2016 -2018). Even the cluster weight was different between Merlot and Syrah varieties; the range was small with only 17.33 g difference. Yearly the berry weight was different among varieties; the heaviest were in Merlot 1.53 g and the smallest in Syrah 1.11 g (Table 2). Beery weight found in Californian Pinot Noir clones ranged among 1.3 -1.5 g, and cluster weight between large limits, from 111 to 190 g [1]. Bettiga (2003) [3] found in Merlot clones grown in California yields among 5.5 and 18.8 kg/ vine with 81 to 104 clusters/ vine. Berry weight found in Syrah variety grown in Brazil, by Favero et al. (2010) [7], ranged between 1.35 and 1.46 g. Shiraz variety show similar juice sugar concentration and pH in small (0.3 -0.7 g) and larger berries (1.4 - 2.0 g) according to Walker et al. (2005) [20].

In South Africa, Shiraz variety recorded berry weight among 0.83 and 1.75 g, according to berry position on the rachis [15]. Shoot number per vine was uniform during growing seasons with very low variability in Merlot, Pinot Noir and Syrah varieties (Table 3). The mean of shoot number/vine is very significant for this yield component.

Pruning weight decrease over years in Merlot variety but was uniform in Pinot Noir and Syrah. The pruning weight was the lowest in Syrah variety, intermediate for Merlot and the highest for Pinot Noir variety. However, in Pinot Noir variety pruning weight ratio variability during growing seasons was very low. Smallest number of shoots in 2017 resulted in lower pruning weight from the same growing season.

Table 3

Shoot number and pruning weight in Merlot, Pinot Noir and Syrah variety during 2016-2018

Variety	Shoot number/ vine					Pruning weight (kg/vine)				
	2016	2017	2018	CV%	3 years avg.	2016	2017	2018	CV%	3 years avg.
Merlot	13.2	12.7	13.0	1.94	12.97	1.45	1.01	1.18	18.29	1.21
Pinot Noir	12.6	11.9	12.2	2.87	12.23	1.24	1.27	1.25	1.22	1.25
Syrah	13.4	12.9	13.1	1.92	13.13	1.10	1.05	1.12	3.31	1.09

Higher shoot number / vine was found by Bettiga (2003) [3] in Merlot variety, with limits between 37 and 52, while pruning weight ranged among 1.57 and 3.15 kg/ vine. In Pinot Noir clones, pruning weight reported by Anderson et al. (2008) [1], was 0.6 to 1.4 kg /vine. Each variety was harvest at full maturity. Fruit composition in sugar, pH and titratable acidity was different among varieties but quite uniform in the grape variety during growing seasons, excepting the medium variability for titratable acidity in Merlot variety. Pinot Noir had higher sugar concentration while Merlot and Syrah were almost the same average. The highest pH was reported in Merlot variety, and the higher titratable acidity in Pinot Noir.

Table 4

Sugar, pH and titratable acidity in Merlot, Pinot Noir and Syrah variety during 2016-2018

Variety	Sugar (g l^{-1})					pH					Titratable acidity (g l^{-1})				
	2016	2017	2018	CV%	3 years av.	2016	2017	2018	CV%	3 years av.	2016	2017	2018	CV%	3 years av.
Merlot	219	208	224	3.77	217	3.43	3.34	3.63	4.28	3.47	4.30	3.60	5.60	22.55	4.50
Pinot Noir	221	219	229	2.37	223	3.21	3.15	3.33	2.84	3.23	7.59	7.73	7.28	3.06	7.53
Syrah	218	215	220	1.16	218	3.34	3.23	3.41	2.73	3.33	5.90	5.20	6.70	12.65	5.93

Merlot and Syrah varieties were closed average values for sugar (table 4). Ranges in pH were significant but small, while the titratable acidity different widely between varieties.

Anderson et al. (2008) [1] reported for Pinot Noir clones sugar concentration among 198 and 209 g l^{-1}, an average pH between 3.16 - 3.24 and titratable acidity ranging from 9.1 to 10.6 g l^{-1}. According with Dobrei et al. (2016) [6] sugar concentration in Pinot Noir grown in Romania (Timis County), was influenced by crop load and ranged among 180 -197 g l^{-1}; in Merlot variety the lowest value was 182 g l^{-1} and the highest 190 g l^{-1}.

Sugar concentration in Merlot variety found by Bettiga (2003) [3] ranged between the lowest 209 to the highest value of 239 g l^{-1}, pH among 3.32 and 3.64, while titratable acidity average values ranged from 4.8 to 7.3 g l^{-1}. Dobrei et al. (2015) [5], reported for Merlot variety, an average between 5.2 g l^{-1} total acidity. Titratable acidity in Syrah variety (Spain) ranged during three growing seasons, from 246 to 253 g l^{-1} and pH between 3.9 -4.18, according to Gil-Muñoz et al. (2009) [9]. In Merlot and Syrah varieties during growing seasons 2016-2018, grape yield and cluster number /vine are highly significant correlated (r = 0.9966). All other yield components have negative relationship with grape yield and cluster number/vine in both varieties (Table 5).

In Merlot variety high significant correlation was observed between berry weight, shoot number/vine (r=0.9995), pruning weight (r=0.9775) and sugar concentration (r =0.7305). Similar relationship was recorded between shoot number/vine, pruning weight (r=0.9700) and sugar concentration (r=0.7525). Cluster weight has very strong relationship with sugar concentration (r=0.9325) and titratable acidity (r=0.9999).

For certain, between sugar concentration, pH (r=0.9095) and titratable acidity (r=0.9269) can't be only a very strong and significant correlation. Obviously there are not only positive correlations among yield components; between cluster number/vine, berry weight (r= -0.9966), shoot number/vine (r= -0.9934) and pruning weight (r= -0.9915) relationship is highly significant negative.

Table 5

Correlation matrix (Pearson (n)) among yield components in Merlot variety (2016-2018)

Variables	Yield kg/vine	Cluster number /vine	Cluster weight (g)	Berry weight (g)	Shoot number /vine	Pruning weight (g)	Sugar (g/l)	pH	TA (g/l)
Yield kg/vine	**1**	0.9966	-0.4347	-1.0000	-0.9995	-0.9775	-0.7305	-0.3805	-0.4209
Cluster number /vine	0.9966	**1**	-0.3592	-0.9966	-0.9934	-0.9915	-0.6719	-0.3032	-0.3449
Cluster weight (g)	-0.4347	-0.3592	**1**	0.4347	0.4639	0.2347	0.9325	0.9982	0.9999
Berry weight (g)	-1.0000	-0.9966	0.4347	**1**	0.9995	0.9775	0.7305	0.3805	0.4209
Shoot number /vine	-0.9995	-0.9934	0.4639	0.9995	**1**	0.9700	0.7525	0.4105	0.4503
Pruning weight (g)	-0.9775	-0.9915	0.2347	0.9775	0.9700	**1**	0.5699	0.1766	0.2198
Sugar (g/l)	-0.7305	-0.6719	0.9325	0.7305	0.7525	0.5699	**1**	0.9095	0.9269
pH	-0.3805	-0.3032	0.9982	0.3805	0.4105	0.1766	0.9095	**1**	0.9990
TA (g/l)	-0.4209	-0.3449	0.9999	0.4209	0.4503	0.2198	0.9269	0.9990	**1**

In Pinot Noir variety, grape yield recorded high significant relationship with cluster number/vine (r=0.9728) and pruning weight (r= 0.9972; Table 6)). Once again, cluster weight has very strong relationship with sugar concentration (r= 0.9897) but is negatively correlated with titratable acidity (r= -0.9997).

Table 6

Correlation matrix (Pearson (n)) among yield components in Pinot Noir variety (2016-2018)

Variables	Yield kg/vine	Cluster number /vine	Cluster weight (g)	Berry weight (g)	Shoot number /vine	Pruning weight (g)	Sugar (g/l)	pH	TA (g/l)
Yield kg/vine	**1**	0.9728	-0.4336	-0.9987	-0.9806	0.9972	-0.3004	-0.4336	0.4112
Cluster number /vine	0.9728	**1**	-0.6305	-0.9598	-0.9086	0.9875	-0.5131	-0.6305	0.6112
Cluster weight (g)	-0.4336	-0.6305	**1**	0.3871	0.2485	-0.5000	0.9897	1.0000	-0.9997
Berry weight (g)	-0.9987	-0.9598	0.3871	**1**	0.9893	-0.9921	0.2515	0.3871	-0.3643
Shoot number /vine	-0.9806	-0.9086	0.2485	0.9893	**1**	-0.9631	0.1076	0.2485	-0.2246
Pruning weight (g)	0.9972	0.9875	-0.5000	-0.9921	-0.9631	**1**	-0.3712	-0.5000	0.4785
Sugar (g/l)	-0.3004	-0.5131	0.9897	0.2515	0.1076	-0.3712	**1**	0.9897	-0.9930
pH	-0.4336	-0.6305	1.0000	0.3871	0.2485	-0.5000	0.9897	**1**	-0.9997
TA (g/l)	0.4112	0.6112	-0.9997	-0.3643	-0.2246	0.4785	-0.9930	-0.9997	**1**

The perfect correlation was recorded between cluster weight and pH (r = 1.000). Undoubtedly, the higher the sugar concentration is, the lowest the titratable acidity (r= -0.9997).

Liu et al. (2018) [13] found significant negative correlation in Pinot Meunier between sugar concentration and titratable acidity (r = -0.959) while the relationship with pH was very significant positive (r= 0.942).

Except their very strong mutual relationship, both yield and cluster number (r = 0.9975) in Syrah variety have a negative relationship with all the other yield components (Table 6). Significant positive correlation was recorded between sugar concentration, pH (r= 0.9999), titratable acidity (r=0.9883) and berry weight (r=0.992).

The present data are confirmed by highly positive correlation reported in Grenache variety (Italy), between sugar concentration and pH (r = 0.97), while the relationship with titratable acidity was highly significant negative (r = -0.95) Mercenaro et al. (2016) [14].

Table 6

Correlation matrix (Pearson (n)) among yield components in Syrah variety (2016-2018)

Variables	Yield kg/vine	Cluster number /vine	Cluster weight (g)	Berry weight (g)	Shoot number /vine	Pruning weight	Sugar (g/l)	pH	TA (g/l)
Yield kg/vine	**1**	0.9975	-0.7262	-0.5919	-0.9806	-0.7503	-0.6600	-0.6695	-0.5375
Cluster number /vine	0.9975	**1**	-0.6753	-0.5329	-0.9921	-0.7012	-0.6048	-0.6148	-0.4759
Cluster weight (g)	-0.7262	-0.6753	**1**	0.9839	0.5774	0.9994	0.9958	0.9969	0.9700
Berry weight (g)	-0.5919	-0.5329	0.9839	**1**	0.4224	0.9770	0.9962	0.9950	0.9978
Shoot number /vine	-0.9806	-0.9921	0.5774	0.4224	**1**	0.6061	0.5000	0.5109	0.3618
Pruning weight	-0.7503	-0.7012	0.9994	0.9770	0.6061	**1**	0.9919	0.9934	0.9608
Sugar (g/l)	-0.6600	-0.6048	0.9958	0.9962	0.5000	0.9919	**1**	0.9999	0.9883
pH	-0.6695	-0.6148	0.9969	0.9950	0.5109	0.9934	0.9999	**1**	0.9862
TA (g/l)	-0.5375	-0.4759	0.9700	0.9978	0.3618	0.9608	0.9883	0.9862	**1**

During the growing seasons, Merlot variety was characterized by high value of pH, cluster number/vine and berry weight and by the lowest sugar concentration and titratable acidity (Figure 2).

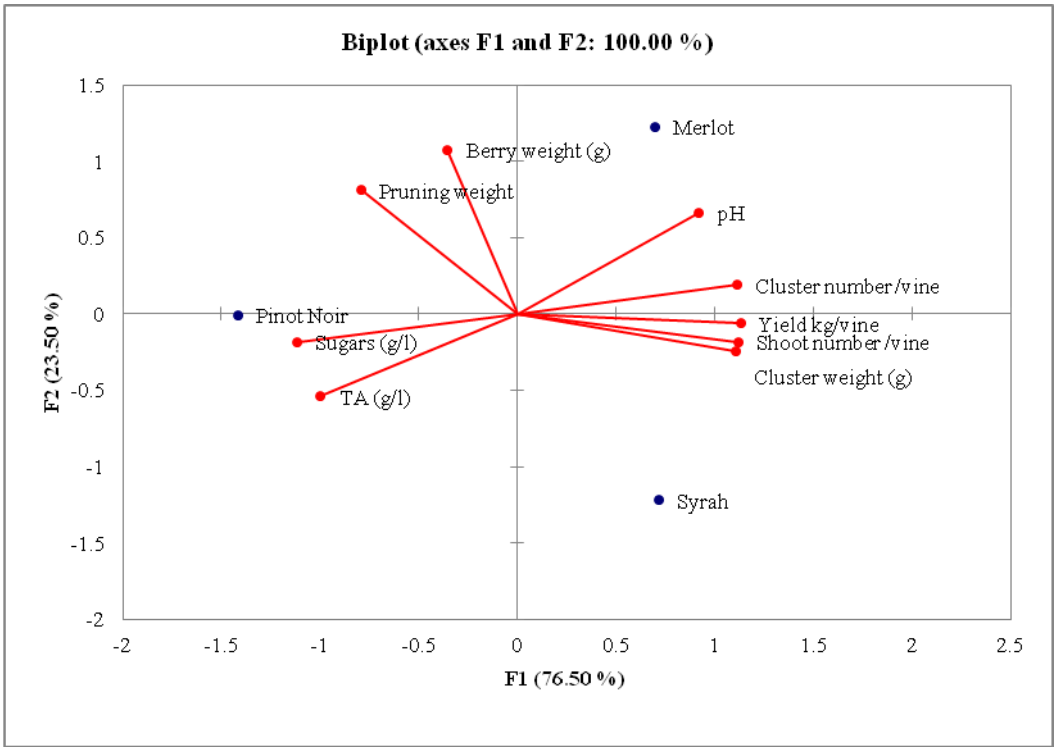

Figure 2. PCA of yield component, vine vigour and berry composition in Merlot, Pinot Noir and Syrah varieties

Otherwise, Pinot Noir sugar concentration and titratable acidity were higher than in other two grape varieties. As regards, Syrah variety recorded the lowest pruning weight, but the highest cluster weight, shoot number/vine and yield/vine.

Conclusions

Viticultural performance of Merlot, Pinot Noir and Syrah red grape varieties was different from each other and growing season. Pinot Noir surpass the other two varieties for pruning weight, sugar concentration and titratable acidity, but have the lowest vegetative growth and grape yield; alternative pruning method can be chose to increase the vigour, the cluster number and yield. The highest number of cluster/vine and pH were found in Merlot variety. In Syrah vigour and grape yield were not influenced by the pruning method, resulting in heaviest cluster and cluster number/vine that prevented the yield decrease. Canopy management has to be correlated with temperature and rainfall from each growing season, and growers need to adopt strategies to increase grape yield quality in dryer climate. The results of the study show that Merlot, Pinot Noir and Syrah perform very well in the Western region of Romania in Recas Vineyards.

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