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Influence of Pruning and Thinning on the Viticultural Parameters of Bobal Variety (Spain)

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Abstract: *Research on viticulturally techniques has gained attention for the impact they have in the composition and quality of grapes and wines. This work evaluate the effect of pruning thinning on the viticulturally parameters of Bobal red variety. Four pruning treatments which included winter pruning and green pruning activities were studied. Viticulturally parameters such as vigor, vine balance, cluster characteristics and yield were evaluated.*

The treatments showed different results in viticulturally and physicochemical parameters. Vigor and berry size decreased with a larger pruning. Vine balance was best for the control. The control also had better phenolic maturity when compared with the rest of the treatments, and thinning showed to improve maturity parameters. Yield was higher for the larger pruning.

Keywords: *pruning, thinning, viticulturally parameters, Bobal variety*.

1. INTRODUCTION

Viticulturally practices can have a major influence in the development of the vine as well as in the physicochemical characteristics of the grape [2]. The growth and the fructification of grapevines in the vineyard are of utmost importance to wine quality [5].

It has long been known that high-quality wines are usually produced from vineyards having low to moderate yields based on variety and cultural practices [16]. Among these practices used to improve quality of the must and wines is the control of vigor through the vine pruning [14]. In viticulture, according to the varietal, place and year, different techniques are adjusted such as pruning to limit the production, which allows improving the characteristics of the fruit and, by consequence the quality of its wines [21].

Pruning is considered as the viticulture practice most decisive over the production and quality of the harvest [7]. It is also considered as one of the practices that tend to improve the organoleptic quality of the musts and of the wines [21]. One of the most important potential benefits of pruning is the ability to regulate yield. Pruning each year can help the vine achieve a more stable production [11]. Pruning can be done at different times of the year and of the vine's growing cycle to reach different objectives [9].

Techniques for vigor control or the physiological behavior of the vine include pruning and green operations such as thinning, shoot trimming, and leaf thinning. The result of these activities depends on soil fertility, climatic conditions among other factors such as variety and canopy placement [17].

The level of vigor in a vine can have an effect in the composition of the berries. Of all the things that can negatively affect the phenolic accumulation in grapes and the subsequent wine quality, excessive vigor is the most damaging [10]. On the contrary, having vines with too little vigor can result in lack of productivity and struggling to maintain proper size canopy and fully ripe fruit [4].

Balance is achieved when vegetative vigor and fruit load are in equilibrium and consistent with high fruit quality [13, 20]. To measure vine balance, crop load is calculated using different equations. The

most commonly used is the Ravaz index [19] where the yield from the current harvest is divided by the pruning weight of the following dormant season.

When having smaller clusters with smaller grape size and greater leaf surface per volume unit, more aromatic wines and with more extract can be produced [11]. A reduction in compactness of the clusters and lighter berries increases the skin mass, providing more phenolic compounds found in the skin [15]. Having lighter berries can also increase the concentration of sugars and other compounds in the berry, helping have a better maturity. More mature grapes have shown togive wines with more polymerized tannins, lower gelatin indexes and more intense aromas [18].

Severe pruning has showed to increase brix, pH, tannins, anthocyanins, phenolic, color density, among other parameters [10], while minimal pruning has in effect shown reduction in color, pH, although sensory parameters show a better expression of fruitiness in wines coming from minimal pruned vines [2].

Another type of pruning is done during the active vegetative period of the vine and is generally known as green pruning or green operations. They contribute, along with the normal pruning to favor the production and quality of the fruit [7]. In most cases, cluster thinning induces faster grape ripening [3]. Furthermore, cluster thinning improves canopy sanitary conditions as it allows more enlightenment and fresh air penetration in the clusters and vegetation [1, 6].

The aim of this work was study the influence of pruning and thinning on viticulturally parameters of Bobal red variety from DO Utiel-Requena (Valencia, Spain).

2. MATERIALS AND METHODS

The study site is a parcel of 0.49 hectares of Bobal variety located at Requena (Valencia, Spain) at 700 m.a.s.l. with latitude 39° 31’ and longitude 1° 7’. The type of soil that is found in this parcel is mainly limestone and the rootstock used is 110R.

The pruning was the double Cordon Royat with four spurs on each branch and 16 buds in total. The height of the vines is of 0.75 m and they are planted at 2850 vines per hectare (1.4 x 2.5 m). Treatments done to the soil include farming and application of 10,000 kilograms of manure per hectare every three years. The vines are also under a drip fed irrigation system. The climate is a Mediterranean-continental type with annual precipitations of 450 mm.

For the objectives of this project lighter pruning treatments were made, increasing the number of buds. In one treatment, one shoot with four extra buds was left during pruning on each branch giving atotal of 24 buds, and in another treatment two shoots were left on each of the branches (32 buds). The green pruning activity of thinning was also made in a repetition of the pruning treatments previously described and included as another treatment. Thinning was made at a 30% level. A total of five type of pruning treatments were made and evaluated, including the control, which is the pruning normally made for these variety.

2.1. Experimental Design

Three blocks of 10 rows each were destined for this experiment. The rows were put together into sets of two rows where a type of pruning was done. Each row was composed of 28 to 33 vines. The five different types of pruning treatments were done with two repetitions, one on each block. Figure 1 shows the experimental design of the parcel.

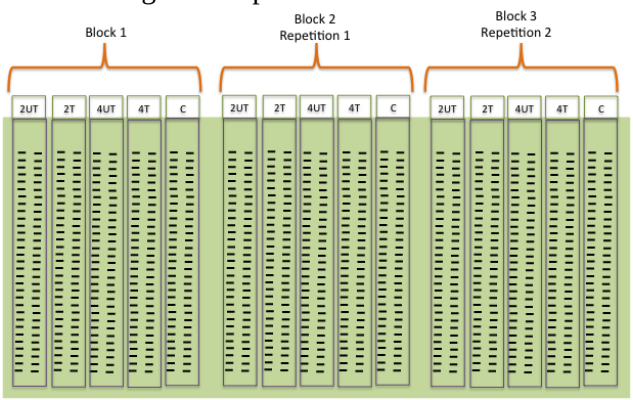

Figure1. *Experimental design on the parcel. 2UT: Two shoots left (24 buds) with no thinning. 2T: Two shoots left (24 buds) + thinning. 4UT: Four shoots left (32 buds) with no thinning. 4T: Four shoots left (32 buds) + thinning.*

2.2. Viticulture Parameters

For the viticulturally parameters that were measured in this study such as shoot measurements, pruning weight and dormant cane weight, three vines from each treatment were chosen according to observations of the similarity in vigor that they showed. A wine was obtained from each treatment and its replicates, giving a total of 15 wines.

2.2.1. Vigor

After pruning in 2014, vine vigor was measured by weighting the pruned wood of the shoots from the vines chosen from each of the experimental sets. A ten-kilogram commercial scale was used to weight the wood. Also included to determine vigor was the dormant cane weight. The ranges used to determine optimum pruning weights and vigor levels by cane weight are according with Skinkis [19]. Measurement of the dormant shoot diameters as well as the dormant shoot lengths and total number of shoots were also measured.

2.2.2. Cluster and Berry

In order to know how fruitful the vines according to their pruning system were, the shoots that presented clusters were counted per vine and a percentage of fruitful shoots was obtained.The number of clusters per vine was counted for the year 2014 and compared with the data obtained in the year 2013. Cluster compactness was obtained by observations for the harvest of 2013 and 2014.Bunch weight and the kilograms of berry weight were also obtained. Baume degree and acidity was obtained for grapes of 2014, before harvest.

2.2.3. Yield

For a proper calculation of yield in hectoliters per hectare, the formula used by the winery was applied: Yield = 0.74 x (Kg of grapes x PD)

Where: PD: plantation density

0.74: yield percentage to obtain hectoliters from kg of grapes in the region

Vine balance. The vine balance was obtained by using the Ravaz index formula:

$$Ravaz\ Index = \frac{kg\ of\ grape}{pruning\ weight}$$

The kilograms of grape used were those obtained from the data of the yield of 2013 harvest, and the pruning weight was that of the pruning made during the dormant season in 2014.

2.3. Statistical Analysis

The results obtained for the viticulturally parameters, analytical procedures and sensory analysis were statistically analyzed by a variance analysis (ANOVA). The method used to discriminate among the means was Fisher's least significant difference (LSD) procedure. Pearson's product moment correlations where made between the variables to show the strength of the linear relationships between them. The software used was Statgraphics® Centurion XVI.

3. Results and Discussion

3.1. Viticulturally Parameters

The results for the impact of pruning in the vegetative characteristics of the vines are summarized in Table 1. Results were grouped into three groups (Control, 2-shoot and 4-shoot) since thinning at veraison does not have any effect in the vegetative characteristics.

Table1. *Effect of pruning on the vegetative characteristics*

Parameter		Control	2 shoot	4 shoot
Shoot length (cm)	2013	87.15±25.33a*	85.50±18.44a	83.23±17.67a
Shoot diameter (mm)	2013	0.98±0.22b	0.91±0.33b	0.76±0.23a
Dormant cane weight (g)	2013	45.79±4.68b	21.69±1.71a	20.88±1.67a
Pruning weight (kg/vine)	2013	0.73±0.07c	0.52±0.04a	0.67±0.05b

Pruning weight (kg/m of row)	2013	0.52±0.05c	0.37± 0.03a	0.48±0.04b
Shoots/vine	2013	16.00±3.00a	24.00±4.00b	32.00±5.00c
	2014	16.00±3.00a	20.00±5.00b	20.00±5.00b
Fruitful shoots (%)	2014	55.00±18.07a	52.00±11.89a	45.00±15.42a

[*] *Numbers followed by the same letter in the row do not differ significantly at p≤0.05.*

3.1.1. Vigor

The vigor that the vine presents for a certain harvest is normally expressed in the shoot length of dormant canes and pruning weight and cane weights of the following dormant season.

The shoot lengths presented no significant differences between treatments. Generally, a reduction in cane length occurs when there is a reducing vigor effect due to an increased crop load. In a similar study where different pruning levels were experimented, the shoot lengths for certain varieties like Chardonnay were not affected [2]. A possible explanation to this result is that the plant had just suffered the change of pruning for the first year, and used its reserves from last year to keep up with this change.

According to the pruning weight measured in kg/m of row, the control vines had the highest value (0.52 kg/m), followed by the four-shoot treatment (0.48 kg/m) and by the two-shoot treatment (0.37 kg/m). The number of shoots and the shoot diameter, which measures thickness, explain these results. All of the treatments are under the optimum range of pruning weight (0.3-0.6 kg/m of row)[19]. The results are in part consistent with other studies that have shown higher pruning weight for larger number of buds [14].

For the dormant cane weights, the results are consistent with those of Archer and Schalkwyk [2] were the highest weight was obtained for the more severe pruning treatment. The two-shoot and four-shoot treatments were classified as vines with moderate vigor level. The level of the control treatment was higher than the moderate vigor range, but still low to classify it as a highly vigorous vine.

Summarizing the results obtained in the viticulturally parameters above mentioned, the control treatment had the highest vigor for this experiment. Having a larger pruning allowed the vines to lower their vigor and, except for the control, the treatments were under the classification of moderate vigor vines.

Regarding the number of shoots, a vintage effect was observed. In 2013, significant differences were found between all the treatments but in 2014 the two-shoot and four-shoot treatment presented no significant differences between them. For the second year of pruning, the two-shoot and four shoot treatments presented a decrease in the number of shoots when compared to the first year. The control treatment, on the other hand presented no differences between years.

Regarding the fruitful shoots, there was no significant differences between the treatments. In general, a single cluster per shoot was obtained for every treatment.

It was observed that the four-shoot treatment might be expressing the symptoms of acrotony and inhibition that are usually observed in an abandoned vine, where the number of buds left for the vine is higher than what it can manage. The results also suggest that the control vine is better adapted to its pruning than the other two treatments, which could also be presenting alternate bearing[7], especially the four-shoot treatment.

3.1.2. Cluster and Berry Characteristics

Cluster and berry measurements for 2014 were done in August, when thinning was done. A larger pruning increased the number of clusters per vine. In 2013 significant differences were found in the number of clusters in all treatments, the two-shoot treatment and for the four-shoot treatment represented a 100% and 175% increase in number of clusters respectively when compared to the control. In 2014, the number of clusters for the two-shoot and for the four-shoot treatments presented no significant differences between them (Table 2).

Table2. *Effect of pruning in cluster and berry parameters*

Parameter		Control	2 shoots UT	2 shoots T	4 shoots UT	4 shoots T
Clusters/vine	2013	12.0±3.0a*	24.0±3.0c	17.0±3.0b	33.0±5.0d	23.0±5.0c
	2014	9.0±3.0a	12.0±4.0b	-	14.0±6.0b	-
Cluster compactness	2013	Well filled	Loose	Loose	Loose	Loose
	2014	Well filled	Loose	Loose	Loose	Loose
Cluster weight (kg)	2013	0.56±0.06c	0.46±0.10b	0.40±0.08a	0.4±0.06 1a	0.42±0.08a
	2014	0.28±0.04b	0.22±0.07a	-	0.18±0.09 a	-
Berry weight (g)	2014	2.90±0.02b	1.80±0.05a	-	1.30±0.05a	-

* *Numbers followed by the same letter in the row do not differ significantly at p≤0.05.*

In general, all the treatments presented a lower number of clusters when compared with the year before. In 2014, the control treatment had a 25% decrease, while the two-shoot treatment presented a 50% decrease, and the four-shoot treatment a 57% when compared to 2013.

The vintage effect observed over the number of clusters might be due to the climate. 2013 was a particular year that had more rainfall than usual and a cooler summer. The large differences found between 2013 and 2014 also suggests that the vines were over cropped in 2013, causing a decrease in the fruitfulness of the retained buds for the following year.

Observations in both years showed that berry size was reduced by the larger pruning treatments when compared to those of the control. This was reflected in the lower compactness of the clusters for the larger pruning treatments.

The control treatment showed the highest cluster weight for both years, and the highest berry weight in 2014. The results are consistent with a study made in Cabernet Sauvignon where a larger number of buds left at winter pruning presented lower berry weights [8]. The quantity of clusters produced has a fundamental effect on the weight of the berries, an increase in number of clusters results in decrease in berry weight [21].

Thinning had a decreasing effect in cluster weight for the two-shoot thinned treatment. Thinning can cause heavier clusters and larger berries through yield compensation mechanisms [15]. This inconsistency could be due to a vintage effect. There was no significant effect for the four-shoot treatment.

Sugar content and acidity measured in grapes of 2014 did not show any significant difference between them, although the larger pruning systems showed lower acidity and higher Baume degrees (Table3).

Table3. *Effect of pruning in berry composition*

Parameter		Control	2 shoots	4 shoots
ºBaumé	2014	10.0±0.82a*	11±0.75a	11.0±0.9a
Acidity (g tart.a./L)	2014	6.0±0.33a	5.8±0.20a	5.9± 0.57a

* *Numbers followed by the same letter in the row do not differ significantly at p≤0.05*

3.1.3. Yield

The kilograms obtained per vine were significantly different from one another except between the control and the two-shoot thinned treatments (Table 4). The control showed to have the lowest grape yield per vine, and there was an increase for the two-shoot and four-shoot untinned treatments. Yield increased linearly with the number of buds that were left on each vine. This result is consistent with thosefound by Ortega-Farías et al. [14]. Thinning decreased by 38% the yield of the two-shoot treatment and by 28% the yield of the four-shoot treatment.

Table4. *Effect of pruning in yield*

Parameter		Control	2 shoots UT	2 shoots T	4 shoots UT	4 shoots T
Production/vine (kg)	2013	6.72±1.09a*	11.04±1.62c	6.8±1.45a	13.53±1.93d	9.66±1.9b
Yield (hl/ha)	2013	141.72a	232.83c	143.41a	285.35d	203.73b

* *Numbers followed by the same letter in the row do not differ significantly at p≤0.05*

The lower weight of the individual bunches was compensated by the higher number of clusters in the larger pruning treatments. It is noteworthy to observe that at the same level of cluster thinning (30%), the reduction in yield was different for the two-shoot and for the four- shoot treatments. Thinning at a more severe pruning caused the yield to decrease 10% more than at a lighter pruning. For 2013, the different pruning levels changed the yield of the vines, but did not compromise the yield requirements of the winery, since all of the experimental treatments had higher yields than the control.

3.1.4. Vine Balance

The vines with a larger number of buds presented a significant larger number of clusters, which were lighter in weight; and higher yields when compared to the control treatment, explaining the higher RI results obtained for the 2-shoot and 4-shoot treatments (Figure 2). Thinning proved to be a good practice for decreasing the Ravaz Index in the treatments.

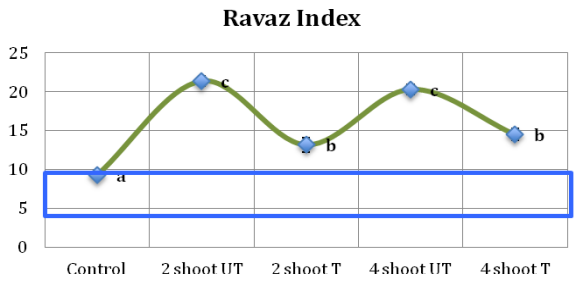

Figure2. *Effect of pruning on the Ravaz index. Results are in mean values ± standard error*

Results showed that the only vine that was under the balanced range was the control vine. The rest of the treatments were classified as over cropped. Ravaz indexes higher than 10 have resulted in an over cropped situation, while better quality parameters were found in vines with indexes ranging between 3 and 10 [14]. The untinned treatments had the highest values and presented no significant difference between them.

4. CONCLUSION

Significant differences were found in the viticulturally parameters of the different pruning levels. The higher number of clusters, the lower dormant cane weight or vigor and the higher yield were ascribed to leaving a larger pruning. Lighter pruning also decreased cluster weight and berry size. Vine balance was not improved with the treatments made. The control showed to have better maturity parameters, followed by the two-shoot thinned treatment. The four-shoot treatments resulted in being over cropped and showing symptoms of acrotony and inhibition.

Results observed in the vineyard suggest that a change of pruning to an increased number of buds to 24 could give favorable results in quality parameters, as long as thinning is included. An increase to the largest number of buds to 32 is not favorable for the Bobal variety in this vineyard.

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