Agronomic and qualitative behaviour of cv. Tempranillo according to three vine spacing on two different hydric-edaphic situations in the Duero river valley

Comportement agronomique et qualitatif du Tempranillo avec trois distances de plantation dans deux différentes situations hydrico-édaphiques dans la vallée du Duero

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Abstract

The knowledge of the influence of soil conditions on the effects that different plant densities provoke in the agronomic grapevine behaviour becomes very interesting since it allows to focus the vineyard management on the optimization of the natural, hydric and human resources.

This work is focused on the study of the vegetative, productive and qualitative behaviour of Tempranillo variety distributed with three different distances between vines (1.2, 1.5 and 1.8 m) and a common distance between rows (3.0 m) along the period 2005-2007, in two different growing conditions, moderated deficit irrigation and non irrigation. The final objective is to know the more adequate plant density under each particular growing conditions. The experimental trials have been located in the A.O. Rueda, along the Duero river valley, in the province of Valladolid (Spain).

The different vine spacing treatments have shown some differences in pruning weight, vigour of shoot, yield per hectare and cluster weight in both hydric-edaphic situations, being these differences more remarkable in the non irrigation conditions. The differences between treatments in fertility and berry weight have been fewer. The grape quality has hardly shown any difference between treatments in both growing situations.

These results suggest the convenience of different vineyard management depending on the particular growing conditions, being of doubtful effectiveness the increase of the number of plants if there is no any limiting factor that substantially alters these growing conditions.

Key words: development, distance, irrigation, quality, yield

Introduction

Vine spacing depends on two parameters: distance between rows and distance between vines within the row (Perez, 2002). For the election of the distance between rows it is mainly necessary to consider the mechanisation possibilities (Murisier & Zufferey, 2003, 2004), whereas for the election of the distance between vines within the row more aspects usually are taken into account, basically related to type of pruning (Murisier & Ferretti, 1996), permanent structure that will have the plant (Silvestroni *et al*., 2003), irrigation possibilities (Reynolds *et al*., 1995; Hunter, 1998a), production level, dynamics of maturation (Intrieri *et al*., 2003), etc. In this way, the election of the distance between vines directly affects most of the physiological processes and is crucial for the optimal use of the volume of ground available and the solar energy for vines, as several studies realised in irrigation conditions (Archer, 1991) as well as in non irrigation conditions (Hunter, 1998b) have shown. In any case, for the election of vine spacing, both spacing components have to be considered: width between rows and distance between vines within the row (Remoue y Lemaitre, 1985).

The interaction between vine spacing and hydric regime is shown in such a way that, for some defined atmospheric conditions and according to the water dose applied through irrigation, when modifying the vine spacing it is possible to orientate the vineyard towards the optimal balance of the vines to guarantee both harvest amount and desirable quality (Perez, 2002).

In this way, Planas (1998) observed that low vine spacings showed higher values of yield per hectare and lower values of yield per plant than those values of higher vine spacings. This increase of yield per hectare in a vineyard with low vine spacings was accompanied, in general, by an early and more complete maturation, and a higher quality of wines (red wines of more colour, more concentrate wines), what was explained by a better colonization of soil by vine roots, an effective interception of solar energy by vines and a competition between plants that reduced their individual vigour.

This work is focused on the study of the vegetative, productive and qualitative behaviour of Tempranillo variety distributed with three different distances between vines (1.2, 1.5 and 1.8 m) and a common distance between rows (3.0 m) along the period 2005-2007, in two different growing conditions, deficit moderated irrigation and non irrigation. The final objective is to know the more adequate plant density under each particular growing situation. The experimental trials have been located in the A.O. Rueda, along the Duero river valley, in Valladolid province (Spain).

Material and methods

Description of experimental trials

This work has been developed along 2005-07 and has been based on the modification of vine spacing. The vine spacings established have a common distance of 3.0 m between rows and three different distances on the row: 1.2 m, 1.5 m and 1.8 m. The soil area that corresponds to each plant according to the previous distances is of 3.6 m^2 (3×1.2), 4.5 m^2 (3×1.5) and 5.4 m^2 (3×1.8). It has been maintained one shoot per 10 cm of cordon row in all treatments.

The vegetal material has been Tempranillo variety (*Vitis vinifera* L.) grafted onto 110 Richter, planted in 2000 and trellis trained with the pruning system called bilateral Royat cordon.

The experimental design of the trial has consisted of randomized blocks with 4 replications of all treatments (1.2, 1.5 and 1.8). The elemental plot has 9 to 14 control vines depending on the distance between plants and each replication has adjacent rows for buffer effect.

There has been a plot trial with deficit moderated irrigation located in Pollos (Valladolid) (altitude: 672 m) and a plot trial without irrigation located in Rodilana (Valladolid) (altitude: 800 m). Both experimental vineyards belong to the A.O. Rueda.

The water amounts (mm), due to irrigation as well as to annual rainfall (P), that the trials have received during the three years of study are shown in the following table:

Trial	P (annual)			P (1_apr-30_sep)			Irrigation in the cycle		
	2005	2006	2007	2005	2006	2007	2005	2006	2007
Irrigated	205	333	550	64	133	366	52	46	52
Non irrigated	249	254	518	74	83	157	-	-	-

Experimental determinations

Pruning weight (t/ha) and vigour of shoot (g) have been determined like parameters of vegetative development. Yield (t/ha), cluster weight (g), number of clusters by linear metre and berry weight (g) have been calculated like parameters of production. Sugar concentration (ºBrix), total acidity (g/l), pH and Total Polyphenols Index (TPI) have been calculated like parameters of grape quality, based on the analysis of 200 berries sample per replication in the day of grape harvest.

Results

Vegetative development

In general, pruning weight (t/ha) has shown a slight tendency to increase as the planting density increases in both growing situations. Statistically significant differences between treatments have not been observed in the irrigated trial, nevertheless, differences between treatments 1.2 and 1.8 in 2006 and 2007 have been observed in the non irrigated trial. In a similar way, vigour of shoot displays the same tendency, increasing as the planting density goes up. Statistically significant differences between

treatments 1.2 and 1.8 have been observed in non the irrigated trial in 2006 and 2007, whereas there have not found statistically significant differences in the irrigated trial.

T	Pruning weight						Vigour of shoot					
	Irrigation			Non irrigation			Irrigation			Non irrigation		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1.2	3.08	3.98	3.94	2.64	2.18[a]	3.41[a]	93.7	119.3	118.8	79.3	64.5[a]	104.4[a]
1.5	2.76	3.65	3.85	2.84	1.85[ab]	3.05[ab]	84.6	111.6	115.8	85.2	55.9[ab]	92.7[ab]
1.8	2.65	3.44	3.50	2.39	1.45[b]	2.59[b]	80.4	104.1	104.7	71.6	44.2[b]	78.4[b]
sig	ns	ns	ns	ns	*	*	ns	ns	ns	ns	*	*

Table 1 Average values (2005, 2006 and 2007) of pruning weight (t/ha) and vigour of shoot (g), corresponding to the treatments (T) 1.2, 1.5 and 1.8 with distance between plants of 1.2, 1.5 and 1.8 metres respectively, in the irrigation trial (Pollos) and non ir

Production

Yield (t/ha) has not shown statistically significant differences between treatments in the irrigated trial, although there has been observed a slight tendency of treatment 1.5 to show smaller yield than the others in the three years of study. Statistically significant differences have been observed between both treatments 1.5 and 1.2 and treatment 1.8 in the non irrigated trial in 2007, showing a tendency to increase the yield when the number of plants in the row is increased. In this trial the yield has been remarkably higher in 2007 than in 2005 and 2006, due mainly to the bigger size reached by the cluster throughout the vegetative period.

Cluster weight has not shown any clear tendency between treatments in the irrigated trial conditions, not being observed statistically significant differences between treatments. In the non irrigated trial a tendency to increase the cluster size when the planting density increases has been observed, with statistically significant differences between treatment 1.2 and the rest of treatments in 2007. In this year the cluster size has been remarkably higher than in 2005 and 2006, due mainly to the greater rainfall amount in the opportune phase of the grapevine vegetative period in the zone of this trial.

The number of clusters per linear metre has not shown statistically significant differences between treatments, not having observed any clear tendency in any of both trials of study. In 2007, the number of clusters per linear metre has been lower than in 2005 and 2006 in the irrigated trial.

Berry weight has not shown statistically significant differences between treatments, not being observed any clear tendency, with very similar values between treatments in both growing situations. In the non irrigation trial, berry size has increased in all three treatments from year 2005 to 2007, due mainly to the increase of rainfall in the phase of berry development from year 2005 to 2007.

T	Yield						Cluster weight					
	Irrigation			Non irrigation			Irrigation			Non irrigation		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1.2	16.19	18.75	14.16	5.63	8.38	11.89[a]	0.277	0.341	0.303	0.153	0.188	0.280[a]
1.5	14.50	18.11	13.46	5.18	7.89	9.74[b]	0.263	0.325	0.286	0.139	0.166	0.232[b]
1.8	15.81	18.75	14.23	5.08	7.08	9.54[b]	0.271	0.322	0.288	0.132	0.159	0.229[b]
sig	ns	ns	ns	ns	ns	*	ns	ns	ns	ns	ns	*

T	Number of clusters per linear metre						Berry weight					
	Irrigation			Non irrigation			Irrigation			Non irrigation		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1.2	17.55	16.41	13.85	11.10	13.29	12.77	1.92	2.36	2.24	1.25	1.78	2.28
1.5	16.50	16.45	13.75	11.14	14.14	12.63	2.00	2.37	2.27	1.32	1.71	2.23
1.8	17.41	17.08	14.54	11.26	13.10	12.26	1.89	2.33	2.23	1.21	1.70	2.38
sig	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 2 Average values (2005, 2006 and 2007) of yield (t/ha), cluster weight (g), clusters per linear metre and berry weight (g) corresponding to the treatments (T) 1.2, 1.5 and 1.8 with distance between plants of 1.2, 1.5 and 1.8 metres respectively, in the ir

Grapevine quality

Soluble solids concentration has not shown statistically significant differences between treatments in any trial of study. Any clear tendency between treatments has not been observed with very similar values among them, although higher soluble solids concentration has been observed in 2006 in both growing situations, being this difference higher in the non irrigation trial.

Total acidity has not shown statistically significant differences between treatments in any of both trials, except in 2007 in the irrigated trial between treatment 1.2 and rest of treatments. A clear tendency between treatments has not been observed in the irrigated trial, nevertheless a slight tendency of treatment 1.5 to display lower total acidity than the rest of treatments has been observed in the non irrigated trial.

The pH has not shown statistically significant differences between treatments in any of both growing situations. Values of pH very similar between treatments have been observed in both trials, although in 2006 the values were higher than in the other two years.

Total polyphenols index has not shown statistically significant differences between treatments. Any clear tendency between treatments has not been observed in any of both growing situations, although in the conditions of the non irrigated trial the total polyphenols index is higher than in the irrigation conditions.

T	Soluble solids concentration						Total acidity					
	Irrigation			Non irrigation			Irrigation			Non irrigation		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1.2	22.85	24.23	23.28	23.65	27.10	23.30	5.54	5.49	5.93[a]	5.49	6.94	6.40
1.5	22.87	24.10	23.00	23.07	27.03	23.70	5.42	5.56	5.43[b]	5.27	6.86	5.98
1.8	22.87	23.98	22.95	22.78	27.33	23.55	5.62	5.52	5.28[b]	5.62	6.93	6.00
sig	ns	ns	ns	ns	ns	ns	ns	ns	*	ns	ns	ns

T	pH						Total polyphenols index					
	Irrigation			Non irrigation			Irrigation			Non irrigation		
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
1.2	3.29	3.72	3.40	3.47	3.63	3.55	51	40	44	76	66	50
1.5	3.32	3.79	3.43	3.48	3.65	3.48	52	51	43	78	67	52
1.8	3.30	3.78	3.45	3.46	3.65	3.45	56	50	46	74	62	53
sig	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 3 Average values (2005, 2006 and 2007) of soluble solids concentration (ºbrix), total acidity (g/l), pH and total polyphenols index, corresponding to the treatments (T) 1.2, 1.5 and 1.8 with distance between plants of 1.2, 1.5 and 1.8 metres respectively,

Conclusions

The increase of planting density through the reduction of distance between plants in the row has had as a direct consequence the increase of vegetative development measured through pruning weight per hectare and vigour of shoot in both growing conditions. Remarkable differences between both growing conditions exist due to the effect of irrigation in the vegetative development.

The increase of planting density has not provoked a clear effect in yield in the deficit irrigation conditions, although the treatment 1.5 has shown a lower level. In the conditions of the non irrigated trial there is a tendency to increase yield when the number of plants in the row increases. Cluster weight shows the same tendency as yield in both growing conditions. In the deficit irrigation conditions, the fertility expressed as number of clusters per linear metre has been higher than in the non irrigation conditions. Berry weight has not shown a clear tendency between treatments, although in 2005 the berry sizes were smaller than in 2006 and 2007, due mainly to the lower rainfall amount during the vegetative period in this year in both growing conditions.

The variation of distance between plants has not substantially modified the parameters of grape quality in both growing conditions. Remarkable differences in total polyphenols index between both growing conditions exist since in the non irrigation conditions this index is higher than in the deficit irrigation conditions.

The obtained results suggest the convenience of different vineyard management depending on the particular growing conditions, based on the election of distance between plants in the row more suitable to these conditions, with the purpose of not damage either the grape amount or the grape quality due to an excess of competition. Thus, it is of doubtful effectiveness the increase of plants number according to the results obtained in the present work if there is no any limiting factor that substantially alters the growing conditions.

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