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RESPONSE OF GRAPEVINE CV. "TINTA RORIZ" (*VITIS VINIFERA* L.) TO MODERATE IRRIGATION IN THE DOURO REGION, PORTUGAL

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Introduction

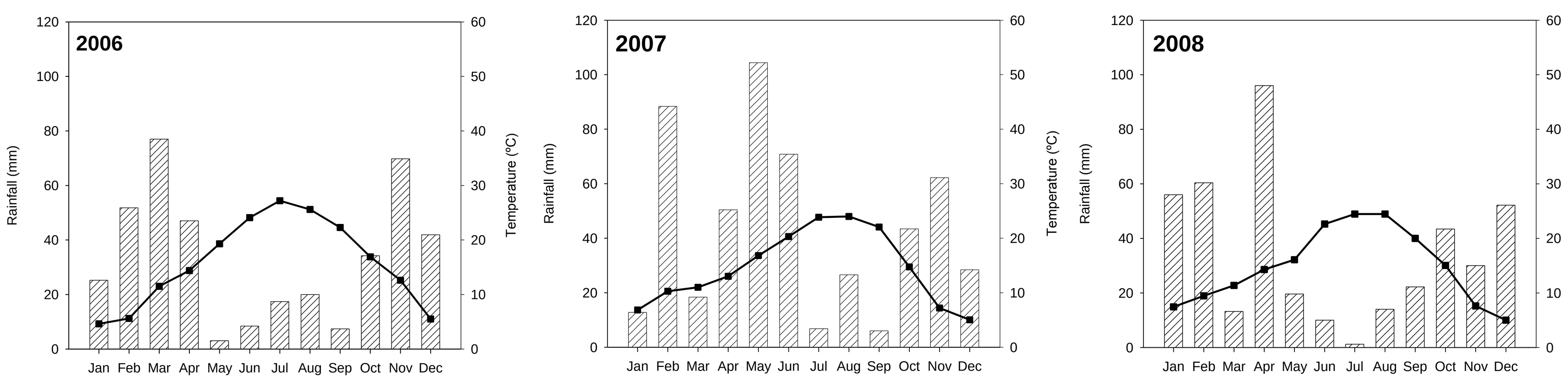
A large proportion of vineyards are located in regions with seasonal drought (e.g. climate of the Mediterranean type) where soil and atmospheric water deficits, together with high temperatures, exert a large constraints in yield and quality (Chaves *et al.*, 2007). In the hot and dry Douro Region, limitations in water supply have a great impact on grape production as the annual rainfall is not adequate to provide grapevines with their water requirements, and water deficits usually develop gradually during summer causing important crop losses (Malheiro, 2005).

The objective of this study was to determine the effect of different irrigation amounts in physiology, production and grape composition of Portuguese grapevine variety Tinta Roriz, growing in Douro region.

Materials and methods

- The research was conducted during three seasons (2006-2008) in a commercial vineyard, located near Torre de Moncorvo (41º11′ W, 7º6′ N, elevation 116 m) in the Douro Region.
- The vineyard was planted in 1999, grafted onto 110 R, at a spacing of 2.2 m by 1.1 m (4132 vines ha^{-1}). The vines were trained as unilateral cordon. Rows were NW-SW oriented.
- Irrigation water was applied with drip emitters (2.3 L h^{-1}). The water (R) was supplied according to the daily reference evapotranspiration (ETo) using the following equation: $R = (K \times ETo - P)$, where P represents effective rainfall and K a constant coefficient. Three irrigation treatments were established: 0R - not irrigated; 2R - irrigated with a constant fraction of the ETo (K=0.2) and 4R - irrigated with a constant fraction of the ETo (K=0.4).
- Each treatment had four replicates in a randomized complete block design. Each plot consisted of four rows with six vines per row and the surrounding perimeter vines were used as buffers. The beginning of water supplied was determined by the threshold value (-0.4 MPa) of pre-dawn leaf water potential (Malheiro, 2005) and the frequency of water applications was the same for all treatments and varied from 2 to 3 days per week applied continuously until harvest.
- Leaf water potential was measured in fully expanded leaves at predawn (Ψ_{pd}) (1 h before sunrise) with a pressure chamber
- Leaf gas-exchange rates were measured using a portable gas exchange system and measurements were performed in eight fully expanded leaves per treatment.
- Three 100-berry samples per treatment were collected after pea size was reached and processed to determine berry composition.
- At harvest, yield components were assessed, following manual harvesting and weighing the production on-site. At winter, pruning weight per vine was recorded and crop load (yield/pruning weight) was calculated.

- Total rainfall (bars) and monthly mean air temperature (line) at the experimental vineyard during 2006, 2007 and 2008 growing seasons

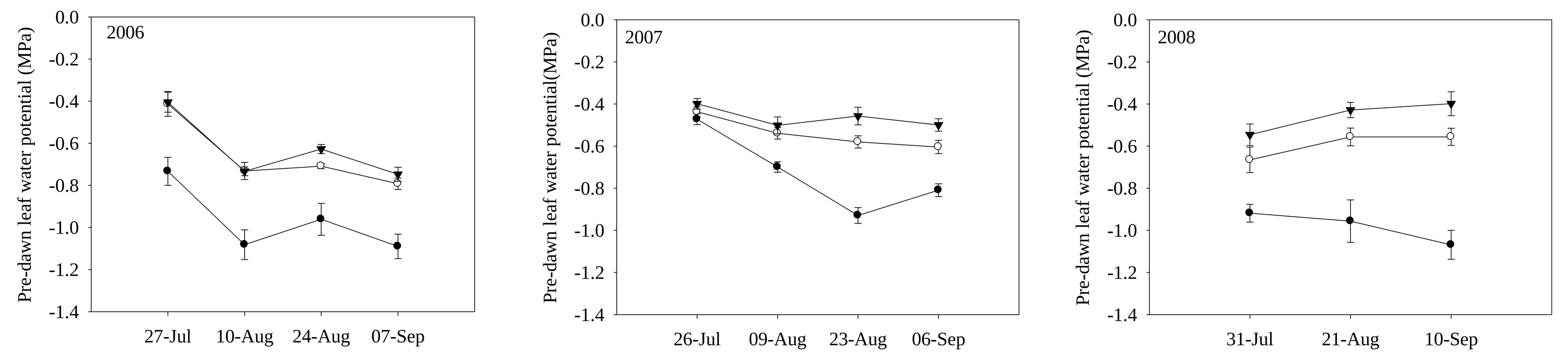


- Dates of first and last irrigation and total water applied for the three treatments.

Growing season	Dates		Water applied (L vine^{-1})		
	First irrigation	Last irrigation	0R	2R	4R
2006	07/Jul	05/Sep	0	37.5	75.0
2007	19/Jul	04/Sep	0	24.6	49.2
2008	14/Jul	08/Sep	0	31.7	63.4

Results

- Seasonal evolution of pre-dawn leaf water potential for the three treatments (●- 0R, ○-2R, ▼-4R) during 2006, 2007 and 2008 growing seasons. Each point represents the average of eight measurements with SE. Bars not visible indicate SE smaller than symbol



- Transpiration rate (E) and net CO_2 assimilation rate (A) measured during hot and clear days in the ripening period for the different water treatments in 2006, 2007 and 2008 growing seasons.

Year	Treatment	E (mmol m^{-2} s^{-1})				A (μmol m^{-2} s^{-1})			
		27 Jul	**10 Aug**	**24 Aug**	**7 Sep**	**27 Jul**	**10 Aug**	**24 Aug**	**7 Sep**
2006	0R	2.79^{a}	2.39^{a}	2.32^{a}	2.26^{a}	8.99	7.33	4.61	1.15^{a}
	2R	3.90^{b}	3.84^{b}	2.94^{b}	3.28^{b}	11.92	9.13	4.93	4.91^{b}
	4R	4.23^{b}	3.80^{b}	2.51^{b}	3.50^{b}	13.74	9.23	4.16	4.81^{b}
	Sig.	*	***	*	***	*ns*	*ns*	*ns*	*
			9 Aug	**23 Aug**	**6 Sep**		**9 Aug**	**23 Aug**	**6 Sep**
2007	0R		1.83^{a}	1.21^{a}	1.23^{a}		4.15^{a}	2.66^{a}	2.34^{a}
	2R		2.80^{b}	2.28^{b}	2.46^{b}		6.31^{b}	5.51^{b}	4.80^{b}
	4R		4.62^{c}	4.30^{c}	4.32^{c}		11.32^{c}	9.68^{c}	8.19^{c}
	Sig.		***	***	***		***	***	***
				21 Aug	**10 Sep**			**21 Aug**	**10 Sep**
2008	0R			1.47^{a}	1.40^{a}			0.52^{a}	0.95^{a}
	2R			4.46^{b}	4.16^{b}			1.48^{b}	1.80^{b}
	4R			7.62^{c}	5.57^{b}			2.38^{b}	2.35^{b}
	Sig.			***	***			**	***

Means within a column, for each date and season, flanked by se same letter are not significantly different at P ≤ 0.05 (Tukey HSD test). Significance of difference between treatments: ns – not significant; * 0.01< P≤0.05; ** 0.001< P≤0.01; *** P≤0.001

- Yield components at harvest, pruning weight and yield/pruning weight ratio for the different water treatments in 2006, 2007 and 2008 growing seasons.

Year	Treatment	Yield (Y) (kg vine^{-1})	Cluster: Number per vine	Cluster: Mean weight (g)	Pruning weight (Pw) (kg vine^{-1})	Y/Pw
2006	0R	2.7	14.5	183.3	0.58	5.3
	2R	2.7	15.8	169.7	0.55	5.2
	4R	3.0	15.0	193.8	0.53	6.2
	Sig.	*ns*	*ns*	*ns*	*ns*	*ns*
2007	0R	2.1	12.0	166.2	0.71	4.7
	2R	2.1	11.7	179.6	0.72	3.6
	4R	2.1	12.4	175.4	0.81	3.6
	Sig.	*ns*	*ns*	*ns*	*ns*	*ns*
2008	0R	1.9^{a}	13.3	139.1^{a}	0.50^{a}	3.9^{a}
	2R	2.7^{a}	12.4	207.0^{b}	0.64^{a}	4.5^{a}
	4R	4.3^{b}	15.2	271.0^{c}	0.66^{b}	6.8^{b}
	Sig.	***	*ns*	***	*	*

Means within a column, for each date and season, flanked by se same letter are not significantly different at P ≤ 0.05 (Tukey HSD test). Significance of difference between treatments: ns – not significant; * 0.01< P≤0.05; ** 0.001< P≤0.01; *** P≤0.001

- Berry composition at harvest for the different water treatments in 2006, 2007 and 2008 growing seasons.

Year	Treatment	Total soluble solids (ºBrix)	Titratable acidity (g L^{-1} tartaric acid)	pH	Colour intensity	Total phenols
2006	0R	21.08	2.43	3.76	1.97^{a}	62.87
	2R	20.87	2.19	3.67	3.43^{a}	56.27
	4R	21.91	2.22	3.75	4.53^{b}	61.22
	Sig.	*ns*	*ns*	*ns*	*	*ns*
2007	0R	20.57	3.21	3.98	5.33	76.53
	2R	21.10	3.68	3.84	3.43	63.07
	4R	21.53	4.05	3.79	3.33	65.23
	Sig.	*ns*	*ns*	*ns*	*ns*	*ns*
2008	0R	21.55	3.18	3.72	4.57	55.97^{a}
	2R	21.87	2.86	3.60	4.17	44.17^{b}
	4R	21.75	3.40	3.69	4.07	43.50^{b}
	Sig.	*ns*	*ns*	*ns*	*ns*	*

Means within a column, for each date and season, flanked by se same letter are not significantly different at P ≤ 0.05 (Tukey HSD test). Significance of difference between treatments: ns – not significant; * 0.01< P≤0.05; ** 0.001< P≤0.01; *** P≤0.001

Conclusions

The results showed that moderate water supplies during ripening period, for the region where the study was conducted (severe water deficits), did not benefit yield and fruit composition in two of the three seasons of experiments. The differences in yield between moderate water supplies and rainfed vines only occurred in the growing season with the driest summer (2008).

The moderate irrigation applied did not significantly affected berry sugar accumulation, titratable acidity and pH. The total phenols were significantly lower in musts from irrigated vines.

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