EFFECT OF REGULATED DEFICIT IRRIGATION REGIME ON AMINO ACIDS CONTENT OF MONASTRELL (*VITIS VINIFERA* L.) GRAPES

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1. INTRODUCTION

- ✓ Amino acids representing around 25–30 % of total nitrogen in grapes [1]. They influence the yeast growth, fermentation kinetics, flavor metabolism and the formation of secondary metabolites, especially higher alcohols and esters [1]. Moreover, amino acids are precursors of biogenic amines [2]. Therefore, amino acids play a key role on must and wine quality.
- ✓ In the current climate scenario, with higher temperatures and global dynamics of the rainfalls changed, for viticulture, the water scarcity would be even more limiting factor in the not-too-distant future. Therefore, in order to deal with these challenges, an efficient water management become an fundamental tool for controlling vegetative growth, the sustainability, yield production and grape composition [3].
- ✓ The sensitivity of grapevine to water stress varies according to its phenological stage. Regulated deficit irrigation (RDI) promotes a mild water stress based on the evapotranspiration (ETc) estimated by the crop throughout the vegetative cycle or in previously established phenological periods. So, RDI is a strategy that allows to save water and achieve different objectives such as reducing vine vigor and berry size, increasing anthocyanin concentration or improving grape quality [3-5].
- ✓ Based on the key impact of the irrigation strategy on the grape composition and quality, the main objective of this work was to evaluate the influence of the Rainfed or RDI regimes on Monastrell grape amino acid composition.

2. MATERIALS AND METHODS

❑ Plot properties

- Vineyard planting: 2007 in North-South rows orientation (Fuente Álamo, Albacete, Southeaster of Spain) (Fig. 1).
- Variety: Monastrell (syn. Mourvedre) grapevines grafted on 1103-P rootstock.
- Training system: double Guyot on a vertical trellis (Fig. 2).
- Climate: Continental Mediterranean: hot and dry summers, with average anual rainfall around 450 mm (60 % falls during grapevine durmand period).

Fig. 1. Map of the vineyard location.

Fig. 2. Vines of the plot.

❑ Treatments

1) Non-irrigated grapevines (non-irrigated).
2) Regulated deficit irrigation strategy (RDI), where grapevines were watered at 30 % of the estimated crop evapotranspiration (ETc). The irrigation began when the grapevines stem water potential (Ψs) reached values of -0.8 MPa (prior to veraison) and finished after harvest. Two or three weekly irrigations of about 3.3 mm each were applied with a total of 15 irrigations per year and an irrigation volume of 137.4 mm in 2019.

- The experimental field treatments were applied in quadruplicate and were arranged in a complete randomized block design. Each replicate involved four consecutive rows of vines, randomly distributed in the vineyard.

❑ Grapes enological parameters, nitrogen fractions and amino acids determination

- 300 grapes were collected in each repetition and treatment at harvest (October 7th): 100 grapes were counted and weighed, 150 were destemmed and crushed for obtained must in order to analyzed the enological parameters [6] and the nitrogen fractions, by enzymatic methods.
- The amino acids content were performed in other set of 50 grapes per each treatment and repetition, according to Garde-Cerdán et al. [7].

❑ Statistical analysis

- The statistical analysis was performed by ANOVA (Duncan, $p \leq 0.05$) with the SPSS statistical software (SPSS, version 21.0).

Table 1. Monastrell enological parameters and nitrogen fractions from non irrigated and regulated deficit irrigation (RDI) conditions.

	Non-irrigated	RDI
Weight of 100 berries (g)	149.4±15.9 a	185.1±18.6 b
°Brix	22.1±1.1 a	20.3 ±2.5 a
Probable alcohol (%, v/v)	12.9 ±0.8 a	11.6 ±1.7 a
pH	3.7 ±0.1 a	3.5 ±0.1 a
Total acidity* (g/L)	5.5 ±0.3 a	5.4 ±0.7 a
Amino N (mg N/L)	68.6 ±11.4 a	69.5 ±13.7 a
Ammonium N (mg N/L)	33.5 ± 6.6 a	32.5 ±5.8 a
YAN (mg N/L)	109.8 ± 21.4 a	103.0 ±19.5 a

* As g/L of tartaric acid; YAN: yeast assimilable nitrogen. All the parameters are given with their standard deviation (n = 4). Different letters indicate significant diferences between water status ($p \leq 0.05$).

3. RESULTS AND DISCUSSION

✓ The deficit irrigation regime favored a higher grapes weight compared to non-irrigated ones (Table 1), as also has been observed by different authors [8, 9]. The water regime indirectly influences the temperature and the irradiance of the grapes, which may have an effect on the enological parameters. However, although the non-irrigated grapes tended to have higher °Brix, probable alcohol, pH and acidity values, the differences were not significant, possibly conditioned by the rainfall during the cycle that minimized the water stress created in the plot (Table 1). YAN, the sum of amino N and ammonium N, showed a trend to increase in the non-irrigated samples compared to the RDI ones, maybe because the berries were smaller and more concentrated (Table 1).

✓ Grapes from non-irrigated vines showed higher concentration of several amino acids, such as asparagine (1.7 times), arginine (1.7 times), tyrosine (1.3 times), cysteine (1.6 times), isoleucine + tryptophan (1.5 times), leucine (1.2 times), ornithine (1.8 times), lysine (1.4 times) and total amino acids without proline (1.2 times) than RDI (Table 2). The reported effects might be because yield was 70 % higher in RDI vines than in the non-irrigated ones and, therefore, the sink demand was increased in the irrigated vines. In addition, non-irrigated vines suffered more water stress and it is known that the amino acids synthesis and accumulation can be influenced by the plant response to stress.

Table 2. Amino acids content (mg/L) from non-irrigated and regulated deficit irrigation (RDI) Monastrell grapes.

	Aspartic acid	Glutamic acid	Asparagine	Serine	Glutamine	Histidine	Glycine	Threonine	Arginine	Alanine	GABA*	Proline	Tyrosine	Valine	Methionine	Cystine	Isoleucine+ Tryptophan	Leucine	Phenylala nine	Ornithine	Lysine	Total	Total without proline
Non-irrigated	11.6±3.1	30.3±7.5	16.3±2.1	48.9±6.5	53.1 ±12.0	30.3±6.0	7.0±0.6	60.1±9.8	288.3±103.3	66.0±16.2	181.0±13.5	55.7±13.0	5.1±2.1	20.5±1.8	4.1±2.7	0.8±0.1	29.9±2.9	21.6±0.2	16.7±1.2	3.1±1.3	6.0±0.4	956.2±165.1	900.5±153.6
RDI	11.0±2.1	32.6±3.0	9.5±1.1	47.8 ±8.1	84.6 ±12.8	35.1±3.5	5.8±1.7	50.0±11.6	170.0±60.9	61.4±13.2	171.2±32.2	55.9±18.0	3.9±0.2	19.1±1.9	3.9±1.1	0.5±0.1	19.5±0.8	17.9±1.8	20.7±4.1	1.7±0.2	4.2±0.5	826.4±11.4	770.4±101.8
Sig.	ns	ns	***	ns	ns	ns	ns	ns	*	ns	ns	ns	**	ns	ns	**	**	*	ns	**	***	ns	***

* GABA: γ-Aminobutyric acid. All the parameters are given with their standard deviation (n = 4). Statistical significance between water regime strategies: * $p \leq 0.05$, ** $p \leq 0.01$ and *** $p \leq 0.001$; ns: not significant differences between the water regime samples ($p > 0.05$).

4. CONCLUSIONS

✓ According to the results, the irrigation regime showed effect on amino acids concentration in Monastrell grapes under semiarid conditions. Grapes from non-irrigated vines showed a higher content of several amino acids. It is demonstrated that the final content of nitrogen-related components in grapes is influenced by the irrigation regime. The convenience of the irrigation strategy to suggest will depend on the desired wine style and the target yield levels.

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References: [1] Garde-Cerdán, T., Ancín-Azpilicueta, C., 2008. LWT-Food Sci. Technol. 41, 501; [2] Smit, A.Y., du Toit, M., 2013. Food Bioproc. Tech. 6, 198; [3] Romero, P. et al., 2010. Am. J. Enol. Vitic. 61, 300; [4] Niculcea, M. et al., 2014. Aust. J. Grape Wine Res. 20, 281; [5] Buesa, I. et al., 2017. Aust. J. Grape Wine Res. 23, 251; [6] OIV, 2016. Compendium Inter. Methods Wine Must Analysis. Paris (France); [7] Garde-Cerdán, T. et al., 2009. J. Agric. Food Chem. 57, 2410; [8] Intrigliolo, D.S., Castel, J.R., 2010. Irrig. Sci. 28, 113; [9] Pérez-Álvarez, E.P. et al., 2021. Agric. Water Manage. 248, 106772.