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THE EFFECT OF DIFFERENT IRRIGATION REGIMES ON THE INDIGENOUS CYPRIOT GRAPE VARIETY XYNISTERI AND COMPARISON TO SAUVIGNON BLANC

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Abstract

Aims: The aims of this study were to (1) assess the response of the indigenous Cypriot variety Xynisteri to different irrigation regimes and (2) compare the performance of Xynisteri to Sauvignon Blanc grown in pots with different irrigation regimes.

Methods and Results: The investigation involved two irrigation trials conducted in Lemesos, Cyprus during the 2019 season. Irrigation trial one was established in a commercial Xynisteri vineyard. Three different irrigation regimes - full irrigation, deficit irrigation (50%) and no irrigation were used. Irrigation trial two was a potted trial of Xynisteri established from cuttings collected from two different regions (KX and ZX) and Sauvignon blanc. Three irrigation regimes - full irrigation, deficit irrigation (50%) and minimal irrigation (25%) were applied to ten treatment replicates.
Vine performance, vine phenology and bunch architecture measures were taken at five developmental growth stages during the growing season in both trials. Fruit composition analysis, yield (field trial only) and shoot, trunk and root weights measurements were performed at the end of the season.
Very few differences between measures were found between irrigation regimes in the commercial vineyard. However, in 2019 the vineyard received 194mm of rain in the growing season (April-September). Fruit composition analysis revealed fructose to be lowest in the full irrigation group compared to deficit and non-irrigated treatments.
The potted trial demonstrated that for all three irrigation regimes, both Xynisteri KX and ZX had higher stem water potential, stomatal conductance and chlorophyll content when compared to Sauvignon blanc. Additionally, Xynisteri KX had higher chlorophyll content with minimal irrigation compared to the Xynisteri ZX.
Furthermore, Xynisteri KX and ZX produced greater end of season root, trunk and shoot weights than Sauvignon blanc under all irrigation regimes and Xynisteri KX had greater root, trunk and shoot weights than Xynisteri ZX with full irrigation

Conclusions: This study identified the greater potential for the indigenous Cypriot grape variety Xynisteri to cope successfully with hot and dry conditions when compared to Sauvignon blanc. It also highlights the possible existence of different biotypes that may be important for future clonal selection.

Significance and Impact of the Study: The world's changing climate is placing great pressure on the resources for sustainable viticulture in warm/hot wine growing regions. Many vineyards and wineries base their businesses on European grape varieties traditionally grown in regions with abundant water resources. It is therefore necessary for these wine regions to investigate grape varieties that are indigenous to hot climates. The eastern Mediterranean island of Cyprus is one such place with 12 indigenous grape varieties that grow well in a hot climate without irrigation.

Keywords: Climate change, alternative varieties, vine performance, adaptation

Introduction

The threat of climate change to the global wine industry is well documented, with many wine regions in the world expected to face significant impacts in the next 50 years due to increasing temperatures, reduced rainfall, earlier harvests and heat induced berry composition changes (Jones *et al*., 2005; Jarvis *et al*., 2019; Remenyi *et al*., 2019; Liles and Verdon-Kidd, 2020; Cameron *et al.,* 2020). This threat has led to many countries investigating options to adapt to these challenges, with a focus on the drought and heat tolerant indigenous grape varieties of hot Mediterranean climates. The Island of Cyprus is one such hot wine growing region with a recent upsurge in interest and research into heat and drought tolerance and a return to their indigenous varieties (Chrysargyris *et al*., 2018, 2020; Grigoriou *et al.,* 2020; Tzortzakis *et al*., 2020; Theodorou *et al*., 2019; Azri *et al*., 2020). The aims of this study were to (1) assess the response of the indigenous Cypriot variety Xynisteri to different irrigation regimes and (2) compare the performance of Xynisteri to Sauvignon Blanc grown in pots with different irrigation regimes.

Materials and Methods

The investigation involved two irrigation trials conducted in Lemesos, Cyprus during the 2019 season. Irrigation trial one was established in a commercial Xynisteri vineyard, latitude 34°53N and elevation 840 metres. Three different irrigation regimes - full irrigation, deficit irrigation (50%) and no irrigation, were allocated to twelve vines (four vines per treatment) within a row and replicated three times. Irrigation trial two was a potted trial of Xynisteri established from cuttings collected from two different regions (KX and ZX) and Sauvignon blanc (SB). All cuttings were grown in pots for 18 months prior to testing to ensure root establishment, no rootstocks were used. Three irrigation regimes - full irrigation, deficit irrigation (50%) and minimal irrigation (25%) were applied to ten treatment replicates (vines).

Vine performance measures including midday stem water potential, stomatal conductance, chlorophyll content, vine phenology and bunch architecture were taken at five developmental growth stages during the growing season in both trials.

Fruit from each sample vine was collected separately at harvest and weighed. Berries were removed from the rachis and the fruit was homogenised in a blender. Samples were allowed to settle overnight at 5°C, then 100 mL sample of the juice underwent compositional analysis with FOSS Wine Scan FT120. Shoot, trunk and root weights measurements were performed at the end of the season for the potted trial.
Data sorting and preparation was conducted with Microsoft Excel 2010 and analysed by one-way ANOVA using the statistical package XLSTAT (version 2019.4.2, Addinsoft SARL, Paris, France).

Results and Discussion

Vineyard Trial
No differences between physiological measures and bunch weight and size were found with the three irrigation regimes in the commercial vineyard (Table 1 and Table 2). However, in 2019 the vineyard region received 194mm of rain in the growing season (April-September). Must composition analysis revealed fructose to be lowest in the full irrigation group compared to deficit and non-irrigated treatments (Table 3). Fructose production is favoured in warmer conditions (Wilkes, 2016) and can be an indication of over ripeness and higher potential alcohol. The full irrigation regime may have had a role in reducing the amount of fructose produced. Similar reductions in Total Soluble Solids (TSS) with full irrigation have been demonstrated with the Cypriot variety Maratheftiko (Chrysargyris *et al*., 2018a) and the Greek varieties Agiorgitiko and Xinomavro (Theodorou *et al*., 2019).

Table 1: Physiological measures at harvest.

Irrigation Regime	Stomatal Conductance (mmol/m²/s)	SPAD	SWP (MPa)
Full	53.75	38.60	-1.27
Half	47.50	38.24	-1.28
Nil	54.58	39.69	-1.20
Pr>F	0.60	0.74	0.28

Statistical significance p<0.05. SWP- Stem water potential.
SPAD- Chlorophyll Content. Full- 44 litres, Half- 22 litres, Nil- 1.7 litres.

Table 2: Reproductive measures at harvest.

Irrigation Regime	Bunch Length (cm)	Bunch Width (cm)	Bunch weight (kg/vine)
Full	20.3	11.3	5.4
Half	19.3	10.8	6.2
Nil	19.5	10.6	6.5
Pr>F	0.67	0.55	0.77

Statistical significance p<0.05. Full- 44 litres, Half- 22 litres, Nil- 1.7 litres.

Table 3: Must analysis from three irrigation regimes.

Irrigation	Volatile Acidity (g/L)	Malic Acid (g/L)	Glucose (g/L)	Reducing Sugars (g/L)	FolinC
Full	0.27	1.60	107.4	194.3	103.4
Half	0.29	1.57	112.3	204.4	107.7
Nil	0.31	1.53	114.1	206.3	104.1
Pr>F	0.37	0.96	0.07	0.05	0.71

Statistical significance p<0.05. FolinC (Folin–Ciocâlteu)-
Gallic Acid Equivalence phenolic index. Full- 44 litres, Half- 22 litres, Nil- 1.7 litres.

Potted Trial

The potted trial demonstrated that for all three irrigation regimes, both Xynisteri KX and ZX had higher stem water potential, stomatal conductance and chlorophyll content when compared to Sauvignon blanc (Table 4). Additionally, Xynisteri KX had higher chlorophyll content with minimal irrigation compared to the Xynisteri ZX. These results compare with work by Tzortzakis *et al.* (2020) who found that Xynisteri responded to drought stress better than Chardonnay by improved stomata conductance regulation and reduction of photosynthetic rates.

Furthermore, Xynisteri KX and ZX produced greater end of season root, trunk and shoot weights than Sauvignon blanc under all irrigation regimes and Xynisteri KX had greater root, trunk and shoot weights than Xynisteri ZX with full irrigation (Table 4).

Table 4: Physiological measures and total vine weight at end of season.

Variable	Irrigation	ZX	KX	SB	Pr>F
gs	Full	67.0a	50.5a	48.0a	0.065
	Deficit	27.5a	32.5a	19.5a	0.083
	Min	28.5a	28.3a	704b	0.001
SPAD	Full	35.2a	32.6a	29.04b	0.002
	Deficit	31.5a	31.7a	26.8b	0.001
	Min	33.5ab	33.9a	29.03b	0.035
SWP	Full	-1.11a	-1.13a	-1.15a	0.625
	Deficit	-1.34a	-1.30a	-1.30a	0.698
	Min	-1.50a	-1.42a	-1.72b	<0.0001
Total Weight	Full	1201.2b	1676.5a	732.3c	<0.0001
	Deficit	970.7a	1086.5a	539.1b	0.002
	Min	602.5a	824.4a	293.8b	<0.0001

KX, ZX- Xynisteri, SB- Sauvignon blanc. Full= 12 litres per pot per week, Deficit= 6 litres per pot per week, Min= 3 litres per pot per week. Different letters next to the measures indicate significant differences ($p<0.05$), measures with the same letters are not significant. gs- Stomatal Conductance (mmol/m²/s). SWP- Stem water potential (MPa), SPAD- Chlorophyll Content, Total Weight (g).

Conclusion

This study, along with recent studies described above highlights the potential of the indigenous Cypriot grape varieties to tolerate drought stress. Xynisteri in particular has shown itself to be more able to cope with drought stress than the more commonly cultivated varieties of Sauvignon blanc and Chardonnay. While the mechanism by which this occurs is not yet fully understood, it provides a platform for further research into these drought tolerant varieties and their potential use in climate change adaptation in the global wine industry.

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