BIO-ORGANIC CATALYST

THE POWER IN NATURE®

Increasing Grapevine Health By Increasing AMF

Using a biocatalyst in a new vineyard plantings in first productive year to increase AMF mycorrhizal colonization 80%-150%, thereby increasing plant growth and health.

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Study

Using a biocatalyst in new vineyard plantings in first productive year to increase AMF mycorrhizal colonization 80%-150%, thereby increasing plant growth and health.

This is a summary of a preliminary study, performed by Prof. Kaan Kurtural of U.C. Davis, California, to characterize the response of young Merlot grapevines to Phyto-C_3™ at 2 ppm subjected to two different irrigation amounts in their first productive year.

Phyto-C_3™ is a biocatalyst produced by Bio-Organic Catalyst, Inc. https://www.bio-organic.com/.

This summary was prepared by Bio-Organic Catalyst, Inc. from the original presentation by Prof. Kurtural.

Summary

This study tested whether Phyto-C_3™, added at 2ppm into the irrigation water during the first year of berry production, could help increase vine health by increasing the amount of AMF (Arbuscular Mycorrhizal Fungi) in the soil. During the first year of berry production, because the berry harvest is not yet economically meaningful, the farmer's goal is to maximize the growth and health of the vines.

The vines were deliberately stressed. One group of vines received normal irrigation and one group received half this amount, thus creating water stress. Additionally, the 2020 growing season was the hottest and driest in 20 years.

Key findings:

- At full irrigation, Phyto-C_3™ increased mycorrhizal colonization 80%. At half irrigation (more stress), Phyto-C_3™ increased mycorrhizal colonization 150%.
- At half irrigation, the vines showed increased trunk size and leaf cover.
- Phyto-C_3™ increased photosynthetic activity.
- Phyto-C_3™ improved C assimilation and water use efficiency.

About Bio-Organic Catalyst, Inc.

Bio-Organic Catalyst, Inc. is a California company that has developed a breakthrough water treatment, currently being used in over ten countries, which helps solve major environmental problems in waste/water (nitrogen, organic pollution, H_2S, odors), agriculture (water demand, soil health, crop yields) and industry (effluent, emissions, fouling) in a simple and profitable way.

Bio-Organic Catalysts ("BOCs") are highly concentrated liquid biocatalytic agents that immediately increase oxygen transfer, increase dissolved oxygen and break down biofilm and FOGs.

This triggers beneficial effects wherever water is present, so there are surprisingly many useful applications, including pulp & paper, cooling towers, agriculture, anaerobic digestion, aquaculture, fire control, hydrocarbon remediation, commercial cleaning and many others.

BOCs are made from plant and mineral extracts, yeast fermentation by-products and a non-ionic surfactant.

BOCs are easy to use (just add to water), cost-effective (just 1 - 4 parts per million), increase operating profits (important for rapid large-scale adoption) and are completely safe and green.

Introduction

- Vineyard plantings/replantings are subject to many risks, including heat and water stress and diseases such as red blotch virus, trunk diseases, leaf roll disease and other viruses. These can cause substandard fruits and economic loss.

- The California climate is shifting. 2020 was the hottest and driest growing season in 20 years, with little to no cloud cover and intermittent heat spikes.

- AMF (Arbuscular Mycorrhizal Fungi) are natural soil symbiont fungi that penetrate the cortical cells of the roots of the 80% of vascular plants and forms arbuscules.

- Greenhouse studies have shown that AMF help the plant in many ways. AMF increase growth, drought tolerance and nutrient uptake. They protect against pathogens, stimulate phenylpropanoid biosynthesis key genes and inhibit pathogen transmission.

- The goal of this study was to determine whether, by using irrigation optimized with 2ppm of Phyto-C_3™, we could increase AMF in real field conditions, and whether this increase in AMF would contribute to plant growth and health.

Methods

Plant Material & Growth Conditions

- Conducted at UC Davis Oakville Experimental Vineyard Napa Co. CA
- Merlot (clone 181) grafted on 3309C rootstock.
- Spacing 3.0 m x 2.0 m (row x vine)
- Orientation: East –West

Methods

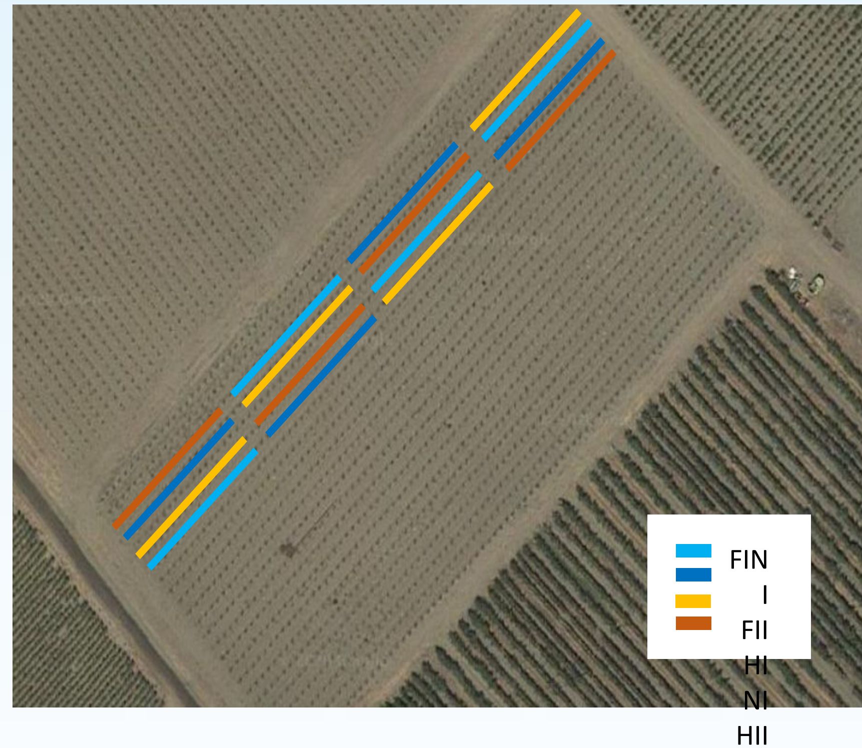
Plant Material & Growth Conditions

- Spur pruned to quadrilateral trellis system
- Drip-irrigated 1 Gallon/vine/h system

Methods

Experimental design

- 2 x 2 factorial design
  - No-Phyto-C_3™ and full irrigated (FINI)
  - Phyto-C_3™ (2ppm) and full irrigated (FII)
  - No Phyto-C3™ and half irrigated (HINI)
  - Phyto-C_3™ (2ppm) and half irrigated (HII)



Methods

Variables monitored

Grapevine water status and Gas exchange parameters

- Stem water potential (Ψ_{stem})
- C assimilation (A_{net})
- Stomatal conductance (g_s)
- Water Use Efficiency (WUE)

Canopy architecture, grapevine growth, yield components and mineral content

- Green pruning weight
- Leaf area
- Trunk diameter
- Yield
- Leaf mineral content

Berry Composition

Primary metabolism

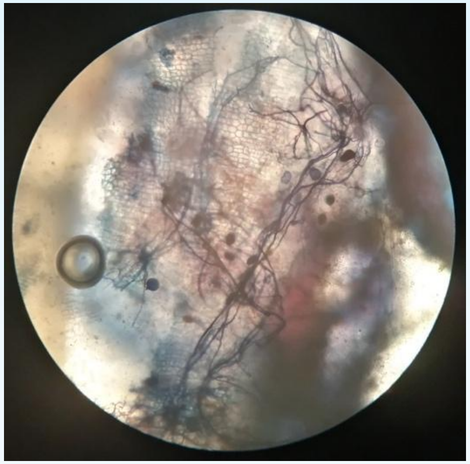
- Total soluble solids (TSS)
- Titratable acidity (TA)
- Must pH

Secondary metabolism

- Anthocyanins
- Flavonols

Results

At full irrigation, Phyto-C_3™ increased mycorrhizal colonization 80%. At half irrigation (more stress), Phyto-C_3™ increased mycorrhizal colonization 150%.



		Mycorrhizal colonization (%)			RMD (%)
		Native	After 3 months	Harvest	
Treatments					
	FINI	1.68 ± 1.04	4.19 ± 1.16 b	14.14 ± 4 ab	78.43 ± 10.64 b
	FII	1.11 ± 0.45	21.16 ± 2.66 a	26.28 ± 3.47 a	
	HINI	2.21 ± 0.67	7.91 ± 0.76 b	9.23 ± 1.99 b	116.52 ± 8.54 a
	HII	2.78 ± 0.67	16.38 ± 5.17 a	24.09 ± 4.02 a	
LMEM					
	Irrigation (I)	*	ns	ns	*
	Phyto-C_3(M)	ns	**	**	
	I × M	ns	ns	ns	

Results

Half irrigation decreased vegetative growth and yield. However, with Phyto-C_3™, vines showed increased growth and more leaves.

Treatments	Green pruning (kg/plant)	Trunk diameter (cm)	Leaf area (cm^2)	Yield (kg/plant)	Leaf area to fruit ratio (m^2/kg)
FINI	0.239 ± 0.023 a	1.44 ± 0.04 a	10498.0 ± 2980.3	0.317 ± 0.03	3.32 ± 0.91
FII	0.212 ± 0.016 ab	1.34 ± 0.04 ab	7402.8 ± 835.8	0.257 ± 0.03	3.00 ± 0.50
HINI	0.156 ± 0.015 b	1.19 ± 0.05 b	4694.4 ± 921.0	0.246 ± 0.01	1.89 ± 0.30
HII	0.185 ± 0.013 ab	1.30 ± 0.03 ab	5274.8 ± 857.9	0.209 ± 0.02	2.62 ± 0.56
LMEM					
Irrigation amount(I)	***	**	*	*	ns
Phyto-C_3(M)	*	ns	ns	ns	ns
I × M	*	*	ns	ns	ns

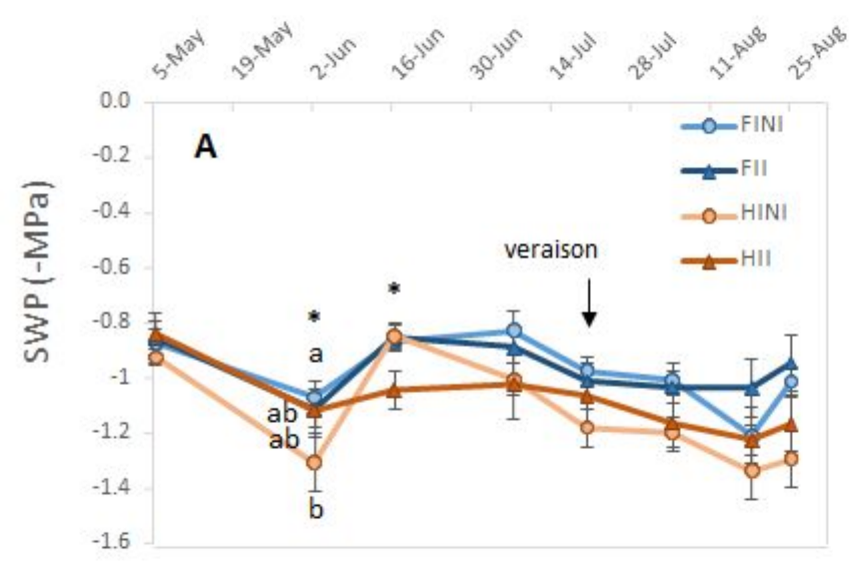
Results

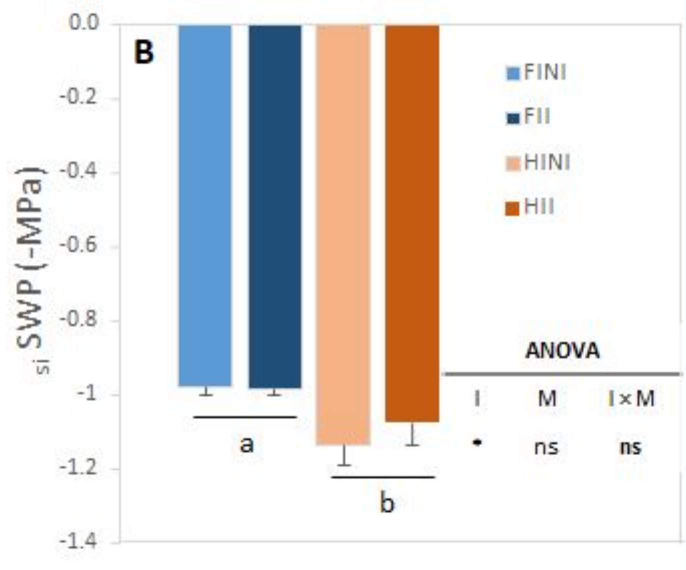
No effect on leaf mineral content

		N	P	K	Zn	Mn	Na	Ca	B	Mg	Fe	Cu
		%	%	%	mg/kg	mg/kg	%	mg/kg	%	%	mg/kg	mg/kg
Treatments												
	FINI	3.26 ± 0.09	0.26 ± 0.01	1.23 ± 0.12	472.0 ± 73.0	156.0 ± 24.0	0.018 ± 0.003	1.73 ± 0.18	77.50 ± 9.60	0.39 ± 0.02	220.25 ± 12.80	100.3 ± 34.7
	FII	3.13 ± 0.06	0.26 ± 0.02	1.34 ± 0.03	389.8 ± 49.5	119.5 ± 12.4	0.010 ± 0.004	1.39 ± 0.08	62.25 ± 2.56	0.35 ± 0.02	201.75 ± 13.97	96.5 ± 41.8
	HINI	3.26 ± 0.06	0.27 ± 0.01	1.28 ± 0.05	406.0 ± 52.5	134.5 ± 18.6	0.013 ± 0.003	1.51 ± 0.09	63.25 ± 9.32	0.38 ± 0.01	225.75 ± 10.25	122.0 ± 22.3
	HII	3.25 ± 0.05	0.26 ± 0.02	1.29 ± 0.11	351.8 ± 32.9	123.8 ± 21.0	0.010 ± 0.004	1.48 ± 0.23	58.50 ± 6.46	0.37 ± 0.05	227.50 ± 31.67	122.0 ± 55.5
LMEM												
	Irrigation amount(I)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	Phyto-C_3(M)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	I × M	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Results

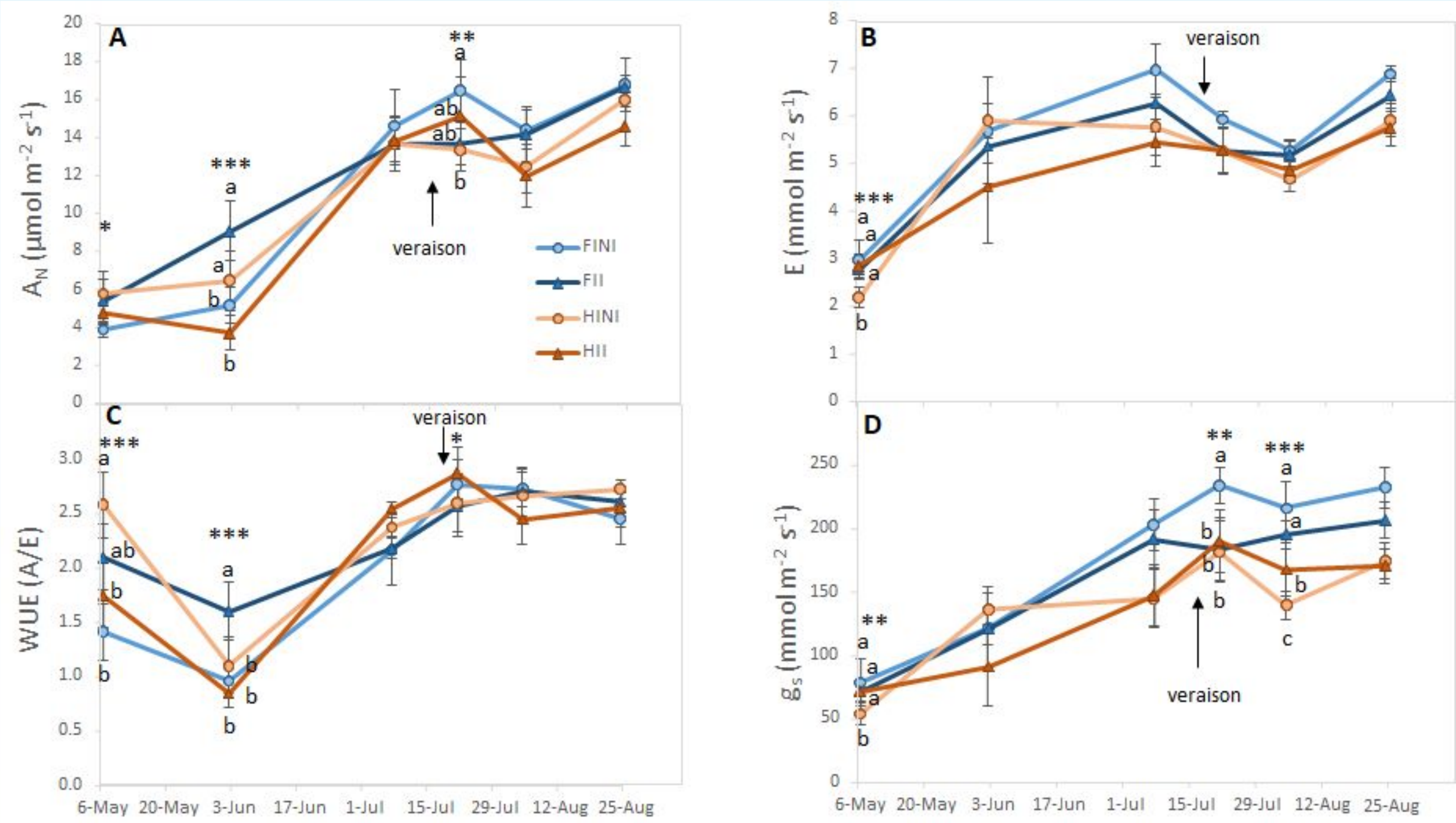
Irrigation amounts affected grapevines water status





Results

Phyto-C_3™ improved C assimilation and water use efficiency



Results

Phyto-C_3™ increased berry fresh weight with full irrigation and decreased with half irrigation

		Juice pH	TA (g/L)	TSS (°Brix)	BFW (g/berry)
Treatments					
	FINI	3.31 ± 0.02	0.76 ± 0.03	25.43 ± 0.98	0.89 ± 0.06 ab
	FII	3.32 ± 0.02	0.73 ± 0.01	25.08 ± 0.26	0.99 ± 0.05 a
	HINI	3.31 ± 0.03	0.73 ± 0.02	26.48 ± 0.58	0.89 ± 0.02 ab
	HII	3.32 ± 0.02	0.71 ± 0.05	24.60 ± 1.87	0.84 ± 0.03 b
LMEM					
	Irrigation amount(I)	ns	ns	ns	.
	Phyto-C_3 (M)	ns	ns	ns	.
	I × M	ns	ns	ns	.

Results

Half irrigation decreased flavonol compounds

FLAVONOLS

		Myricetin-3-O-galactoside	Myricetin-3-O-glucoside	Quercetin-3-O-galactoside	Quercetin-3-O-glucoside	Laricitrin-3-O-glucoside	Kaempferol-3-O-glucoside	Isorhamnetin-3-O-glucoside	Syringetin-3-O-glucoside	Total flavonols
Harvest										
Treatments										
	FINI	0.18 ± 0.01	0.45 ± 0.04	0.20 ± 0.02 b	0.60 ± 0.07	1.49 ± 0.14	0.24 ± 0.02	0.16 ± 0.02	0.06 ± 0.01 ab	3.24 ± 0.46
	FII	0.19 ± 0.02	0.53 ± 0.06	0.17 ± 0.02 b	0.63 ± 0.05	1.77 ± 0.18	0.27 ± 0.03	0.22 ± 0.03	0.07 ± 0.01 a	3.11 ± 0.27
	HINI	0.17 ± 0.02	0.44 ± 0.05	0.12 ± 0.01 c	0.50 ± 0.06	1.28 ± 0.14	0.21 ± 0.02	0.14 ± 0.01	0.04 ± 0.00 bc	3.51 ± 0.47
	HII	0.17 ± 0.02	0.41 ± 0.04	0.25 ± 0.03 a	0.55 ± 0.02	1.27 ± 0.15	0.19 ± 0.02	0.15 ± 0.02	0.03 ± 0.00 c	3.30 ± 0.08
LMEM										
	Irrigation amount(I)	ns	ns	ns	*	*	*	*	***	*
	Phyto-C_3 (M)	ns	ns	***	ns	ns	ns	ns	*	ns
	I × M	ns	ns	***	ns	ns	ns	ns	*	ns

Results

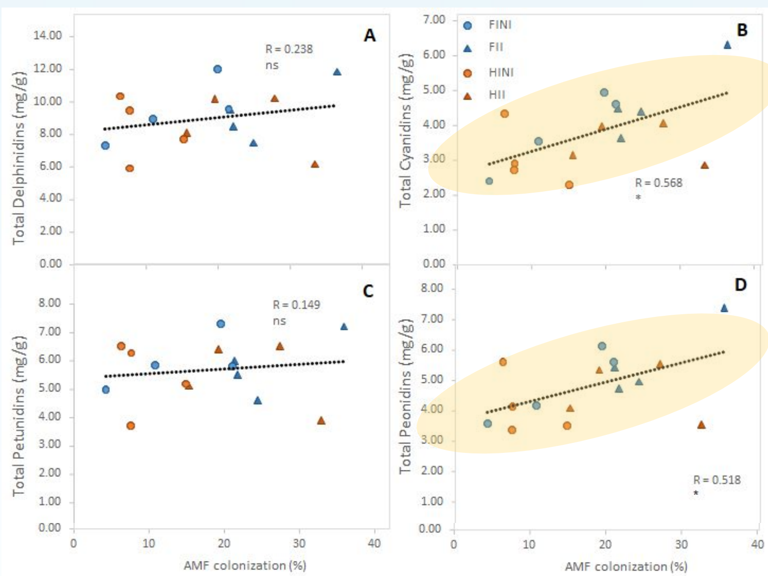
Half irrigation decreased anthocyanin compounds

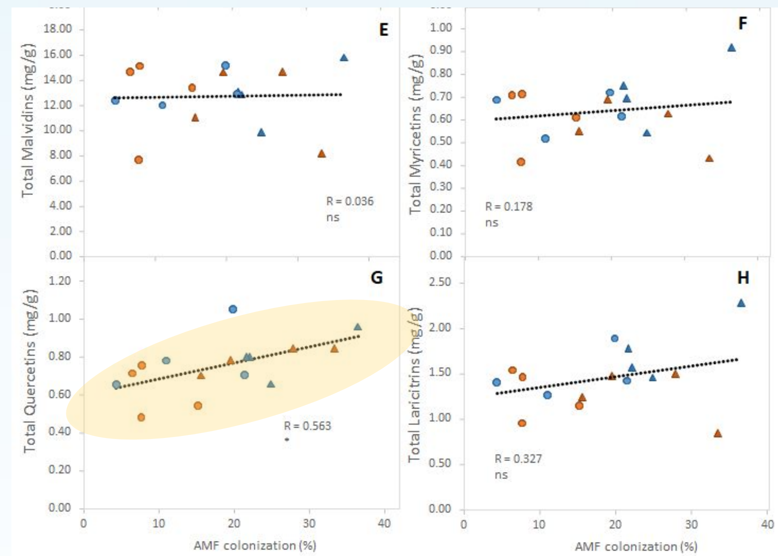
ANTHOCYANIN

	3-Monoglucoside					3-Acetyl-glucoside					3-p-Coumaroyl-glucoside					Total anthocyanins
HARVEST	Delphinidin	Cyanidin	Petunidin	Peonidin	Malvidin	Delphinidin	Cyanidin	Petunidin	Peonidin	Malvidin	Delphinidin	Cyanidin	Petunidin	Peonidin	Malvidin	
Treatments																
FINI	7.54 ± 0.75	3.05 ± 0.38	4.51 ± 0.36	3.85 ± 0.50	9.21 ± 0.52	1.20 ± 0.15	0.47 ± 0.06	0.94 ± 0.10	0.43 ± 0.04	2.32 ± 0.15	0.74 ± 0.08	0.36 ± 0.04	0.53 ± 0.03	0.59 ± 0.06	1.63 ± 0.08	37.4 ± 4.5
FII	7.46 ± 0.76	3.79 ± 0.48	4.40 ± 0.42	4.49 ± 0.52	9.06 ± 0.82	1.15 ± 0.10	0.52 ± 0.05	0.89 ± 0.08	0.48 ± 0.03	2.25 ± 0.22	0.74 ± 0.09	0.41 ± 0.04	0.53 ± 0.05	0.66 ± 0.06	1.63 ± 0.19	38.5 ± 2.6
HINI	6.68 ± 0.79	2.43 ± 0.13	4.08 ± 0.47	3.28 ± 0.43	8.87 ± 1.16	1.03 ± 0.13	0.34 ± 0.03	0.83 ± 0.10	0.37 ± 0.04	2.25 ± 0.31	0.67 ± 0.08	0.29 ± 0.03	0.51 ± 0.06	0.52 ± 0.06	1.83 ± 0.07	33.8 ± 3.4
HII	6.87 ± 0.78	2.76 ± 0.24	4.14 ± 0.47	3.67 ± 0.38	8.55 ± 1.12	1.10 ± 0.10	0.43 ± 0.03	0.86 ± 0.09	0.38 ± 0.03	2.12 ± 0.24	0.73 ± 0.09	0.33 ± 0.03	0.49 ± 0.06	0.63 ± 0.05	1.40 ± 0.18	34.5 ± 2.8
LMEM																
Irrigation amount(I)	ns	*	ns	ns	ns	ns	*	ns	*	ns	ns	*	ns	ns	ns	ns
Phyto-Cat (M)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I × M	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Results

Phyto-C_3™ application was related with the amount of Cyanidins, Peonidins and Quercetins.





Results

Phyto-C_3™ and water management did not affect the cost of labor operations in spite of irrigating with half amount but may lead to decreases in yield.

	Labor operation cost	Phyto-C_3 Injection($/Ha)	Irrigation ($/Ha)	Total ($/Ha)	Yield (kg/Ha)	Gross income ($/Ha)
Treatment						
	FINI	0	529.25	529.25	528.3 ± 50.0	264.5 ± 30.6
	FII	15	529.25	544.25	428.3 ± 50.0	104.5 ± 47.1
	HINI	0	363.86	363.86	410.0 ± 16.7	251.1 ± 30.2
	HII	15	363.86	378.86	348.3 ± 33.3	127.4 ± 22.5
LMEM						
Irrigation amount(I)		-	-	-	*	ns
Phyto-C_3(M)		-	-	-	ns	ns
I × M		-	-	-	ns	ns

Results

HI contributed to a decrease of total WF in the first productive year of Merlot grapevine.

	Water footprint (WF)	green WF (m3/ton)	blue WF (m3/ton)	grey WF (m3/ton)	total WF (m3/ton)
Treatment					
	FINI	1061.7 ± 121.5	1706.1 ± 195.3	ND	2767.8 ± 316.8
	FII	1331.3 ± 180.9	2139.2 ± 290.7	ND	3470.5 ± 471.5
	HINI	1326.7 ± 65.2	1065.8 ± 52.4	ND	2392.5 ± 117.6
	HII	1597.7 ± 152.5	1283.6 ± 122.5	ND	2881.3 ± 275.0
LMEM					
Irrigation amount(I)		*	***	-	.
Phyto-C_3 (M)		ns	ns	-	ns
I × M		ns	ns	-	ns

Conclusion

- Phyto-C_3™ improves vegetative growth, photosynthetic activity and water status of grapevines, especially when facing mild water deficits in field grown grapevines.
- Phyto-C_3™ regulates anthocyanin and flavonol metabolisms.
- These results may be affected by edaphoclimatic characteristics and living microbiota in vineyard soils.
- Phyto-C_3™ by itself was not sufficient to avoid the yield losses due to excess water deficit in the first productive year of Merlot when facing a hyper-arid growing season. However, when applied to more mature vines during the same dry 2020 season, Prof. Kurtural achieved yield increases of 50% - 90%.

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HUMAN, ANIMAL & MARINE LIFE

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