

Effects of water stress on the sugar accumulation and organic acid changes in Cabernet Sauvignon grape berries

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Electronic supplementary material (ESM)

Table S1. Reference standard for different water stress treatments

Treatments	Setting-veraison	After veraison-harvest	Note
CK		mild ($-0.2 \text{ MPa} \geq \Psi_b \geq -0.4 \text{ MPa}$)	mild - mild
T1	mild ($-0.2 \text{ MPa} \geq \Psi_b \geq -0.4 \text{ MPa}$)	moderate ($-0.4 \text{ MPa} \geq \Psi_b \geq -0.6 \text{ MPa}$)	mild - moderate
T2		severe ($-0.6 \text{ MPa} \geq \Psi_b$)	mild - severe
T3		mild ($-0.2 \text{ MPa} \geq \Psi_b \geq -0.4 \text{ MPa}$)	moderate - mild
T4	moderate ($-0.4 \text{ MPa} \geq \Psi_b \geq -0.6 \text{ MPa}$)	moderate ($-0.4 \text{ MPa} \geq \Psi_b \geq -0.6 \text{ MPa}$)	moderate - moderate
T5		severe ($-0.6 \text{ MPa} \geq \Psi_b$)	moderate - severe
T6		mild ($-0.2 \text{ MPa} \geq \Psi_b \geq -0.4 \text{ MPa}$)	severe - mild
T7	severe ($-0.6 \text{ MPa} \geq \Psi_b$)	moderate ($-0.4 \text{ MPa} \geq \Psi_b \geq -0.6 \text{ MPa}$)	severe - moderate
T8		severe ($-0.6 \text{ MPa} \geq \Psi_b$)	severe - severe

Table S2. Irrigation time and irrigation quantity of each treatment groups

Treatments	Days after anthesis									Total irrigation volume
	18	38	45	55	68	77	98	108	118	
CK	3.0	6.6	7.8	8.6	2.7	13.5	1.8	6.0	16.6	66.6
T1	3.0	6.6	7.8	8.6	2.7	5.7	0.9	2.4	4.5	42.2
T2	3.0	6.6	7.8	8.6	2.7	3.9	–	0.8	3.3	36.7
T3	1.5	–	3.6	4.6	–	13.2	1.8	6.0	18.4	49.1
T4	1.5	–	3.6	4.6	–	9.9	0.9	2.4	7.5	30.4
T5	1.5	–	3.6	4.6	–	3.9	–	0.8	3.3	17.7
T6	–	–	4.8	4.5	–	14.4	1.8	6.0	16.6	48.1
T7	–	–	4.8	4.5	–	11.4	0.9	2.4	4.5	28.5
T8	–	–	4.8	4.5	–	3.9	–	0.8	3.3	17.3

– indicates no amount of irrigation

Unit – L•⁻¹

Table S3. Three kinds of sugar linear regression equation

Standards	Retention time/min	Regression equation	R value
Ffructose	8.666	$Y = 601948 X - 26418.3$	$R = 0.9996879$
Glucose	9.852	$Y = 532986 X - 46477$	$R = 0.9991250$
Ssucrose	15.025	$Y = 633297 X - 63664.7$	$R = 0.9985763$

Table S4. Effect of water stress on fructose content in grape berries

Treatments	40	60	80	90	100	110	120
CK	1.93 ± 0.03 ^c	19.58 ± 0.28 ^b	37.93 ± 0.82 ^b	65.18 ± 0.04 ^e	75.40 ± 0.17 ^d	81.70 ± 0.09 ^d	81.43 ± 0.02 ^d
T1	1.93 ± 0.03 ^c	19.58 ± 0.28 ^b	37.93 ± 0.82 ^b	50.88 ± 0.29 ^h	57.83 ± 0.07 ⁱ	81.13 ± 0.11 ^e	79.73 ± 0.17 ^g
T2	1.93 ± 0.03 ^c	19.58 ± 0.28 ^b	37.93 ± 0.82 ^b	59.05 ± 0.10 ^g	65.33 ± 0.07 ^h	78.85 ± 0.06 ^g	80.15 ± 0.06 ^f
T3	2.40 ± 0.05 ^b	10.80 ± 0.05 ^c	38.23 ± 0.3 ^b	66.03 ± 0.08 ^d	68.20 ± 0.06 ^f	77.13 ± 0.12 ^h	75.18 ± 0.07 ^h
T4	2.40 ± 0.05 ^b	10.80 ± 0.05 ^c	38.23 ± 0.3 ^b	66.70 ± 0.07 ^c	83.90 ± 0.04 ^a	82.80 ± 0.16 ^c	90.88 ± 0.04 ^a
T5	2.40 ± 0.05 ^b	10.80 ± 0.05 ^c	38.23 ± 0.3 ^b	69.45 ± 0.11 ^b	78.30 ± 0.32 ^b	80.65 ± 0.11 ^f	82.10 ± 0.07 ^c
T6	3.18 ± 0.1 ^a	37.50 ± 0.17 ^a	56.38 ± 0.09 ^a	70.03 ± 0.09 ^a	76.60 ± 0.19 ^c	84.83 ± 0.17 ^a	82.18 ± 0.07 ^c
T7	3.18 ± 0.1 ^a	37.50 ± 0.17 ^a	56.38 ± 0.09 ^a	59.20 ± 0.05 ^g	67.15 ± 0.21 ^g	83.93 ± 0.04 ^b	86.530 ± 0.09 ^b
T8	3.18 ± 0.1 ^a	37.50 ± 0.17 ^a	56.38 ± 0.09 ^a	60.20 ± 0.11 ^f	71.58 ± 0.17 ^e	75.93 ± 0.07 ⁱ	80.88 ± 0.02 ^e

Different lowercase letters in the same column indicate the difference of $p < 0.05$ level, the same blow;

Unit – mg/g F

Table S5. Effect of water stress on glucose content in grape berries

Treatments	Days after anthesis						
	40	60	70	90	100	110	120
CK	4.83 ± 0.02 ^b	20.95 ± 0.08 ^b	41.9 ± 0.09 ^b	68.88 ± 0.10 ^e	76.10 ± 0.11 ^d	79.63 ± 0.46 ^e	82.08 ± 0.32 ^d
T1	4.83 ± 0.02 ^b	20.95 ± 0.08 ^b	41.9 ± 0.09 ^b	53.60 ± 0.38 ^g	60.40 ± 0.42 ^h	86.48 ± 0.24 ^b	81.15 ± 1.11 ^d
T2	4.83 ± 0.02 ^b	20.95 ± 0.08 ^b	41.9 ± 0.09 ^b	63.23 ± 0.05 ^f	68.43 ± 1.36 ^g	81.20 ± 0.36 ^d	81.33 ± 0.21 ^d
T3	4.75 ± 0.12 ^b	14.88 ± 0.14 ^c	40.68 ± 0.19 ^c	71.30 ± 0.28 ^b	70.88 ± 0.20 ^{ef}	80.73 ± 0.15 ^d	75.15 ± 0.74 ^g
T4	4.75 ± 0.12 ^b	14.88 ± 0.14 ^c	40.68 ± 0.19 ^c	70.35 ± 0.15 ^d	86.68 ± 0.47 ^a	93.08 ± 0.46 ^a	103.03 ± 0.66 ^a
T5	4.75 ± 0.12 ^b	14.88 ± 0.14 ^c	40.68 ± 0.19 ^c	70.88 ± 0.07 ^c	79.63 ± 0.46 ^b	84.70 ± 0.41 ^c	83.68 ± 0.27 ^c
T6	6.43 ± 0.25 ^a	40.43 ± 0.08 ^a	58.40 ± 0.24 ^a	72.78 ± 0.17 ^a	78.33 ± 0.39 ^c	85.00 ± 0.36 ^c	79.55 ± 0.26 ^e
T7	6.43 ± 0.25 ^a	40.43 ± 0.08 ^a	58.40 ± 0.24 ^a	62.88 ± 0.09 ^f	70.48 ± 0.36 ^f	86.98 ± 0.45 ^b	87.08 ± 0.66 ^b
T8	6.43 ± 0.25 ^a	40.43 ± 0.08 ^a	58.40 ± 0.24 ^a	63.15 ± 0.47 ^f	71.83 ± 0.29 ^e	75.50 ± 0.38 ^f	77.88 ± 0.86 ^f

Unit – mg/g FW

Table S6. Effect of water stress on sucrose content in grape berries

Treatments	Days after anthesis						
	40	60	70	90	100	110	120
CK	2.13 ± 0.07b	2.98 ± 0.07c	4.43 ± 0.10b	5.53 ± 0.07cde	6.15 ± 0.02e	6.53 ± 0.28d	8.15 ± 0.04e
T1	2.13 ± 0.07b	2.98 ± 0.07c	4.43 ± 0.10b	3.58 ± 0.13f	3.75 ± 0.06g	7.18 ± 0.03c	7.95 ± 0.08f
T2	2.13 ± 0.07b	2.98 ± 0.07c	4.43 ± 0.10b	5.20 ± 0.06de	5.18 ± 0.05f	5.33 ± 0.08e	7.48 ± 0.02h
T3	2.85 ± 0.06a	3.21 ± 0.08b	3.20 ± 0.06c	5.00 ± 0.91e	6.28 ± 0.07de	7.48 ± 0.04b	7.65 ± 0.05g
T4	2.85 ± 0.06a	3.21 ± 0.08b	3.20 ± 0.06c	5.80 ± 0.06abc	6.90 ± 0.03b	6.63 ± 0.05d	10.15 ± 0.12a
T5	2.85 ± 0.06a	3.21 ± 0.08b	3.20 ± 0.06c	6.28 ± 0.05a	6.43 ± 0.04cd	7.38 ± 0.04b	8.63 ± 0.07d
T6	2.65 ± 0.21a	4.38 ± 0.06a	4.80 ± 0.03a	6.23 ± 0.10ab	7.80 ± 0.11a	8.40 ± 0.04a	9.45 ± 0.04b
T7	2.65 ± 0.21a	4.38 ± 0.06a	4.80 ± 0.03a	5.90 ± 0.08abc	6.25 ± 0.02e	8.33 ± 0.11a	9.33 ± 0.08c
T8	2.65 ± 0.21a	4.38 ± 0.06a	4.80 ± 0.03a	5.70 ± 0.04bcd	6.45 ± 0.22c	5.28 ± 0.03e	7.70 ± 0.03g

Unit – mg/g FW

Table S7. Effect of water stress on soluble sugar content in grape berries

Treatments	Days after anthesis						
	40	60	70	90	100	110	120
CK	12.41 ± 0.38c	36.74 ± 1.58b	91.56 ± 6.41b	144.93 ± 3.45bc	160.52 ± 10.16cd	195.98 ± 8.70a	183.27 ± 6.55bc
T1	12.41 ± 0.38c	36.74 ± 1.58b	91.56 ± 6.41b	126.24 ± 4.75d	141.57 ± 3.56e	196.51 ± 7.48a	181.93 ± 13.66bcd
T2	12.41 ± 0.38c	36.74 ± 1.58b	91.56 ± 6.41b	133.75 ± 6.70cd	151.85 ± 1.04de	187.82 ± 14.14b	171.42 ± 5.70cd
T3	14.35 ± 0.80b	61.87 ± 8.09a	116.93 ± 8.47a	148.44 ± 5.69bc	161.76 ± 20.17abc	191.50 ± 5.63ab	170.66 ± 11.08d
T4	14.35 ± 0.80b	61.87 ± 8.09a	116.93 ± 8.47a	157.55 ± 3.00ab	184.37 ± 7.10a	200.45 ± 0.68a	199.56 ± 11.31a
T5	14.35 ± 0.80b	61.87 ± 8.09a	116.93 ± 8.47a	166.96 ± 11.51a	172.39 ± 12.28ab	196.40 ± 4.77ab	198.22 ± 7.20a
T6	19.97 ± 0.15a	21.29 ± 4.83c	99.18 ± 10.20b	148.37 ± 19.02cd	181.55 ± 9.40a	198.25 ± 14.10a	194.22 ± 13.12ab
T7	19.97 ± 0.15a	21.29 ± 4.83c	99.18 ± 10.20b	150.03 ± 14.79bc	160.90 ± 3.97cd	205.44 ± 6.35a	190.58 ± 10.67ab
T8	19.97 ± 0.15a	21.29 ± 4.83c	99.18 ± 10.20b	141.84 ± 6.70bc	163.18 ± 2.86bcd	191.23 ± 9.95ab	181.42 ± 15.34d

Unit – mg/g FW

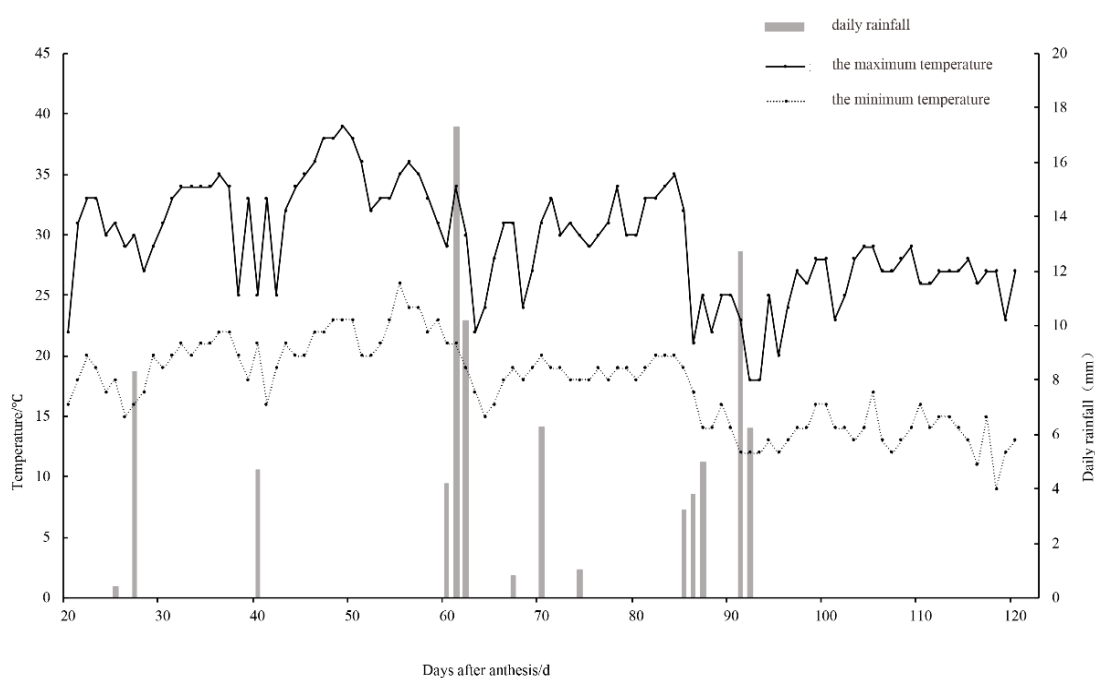
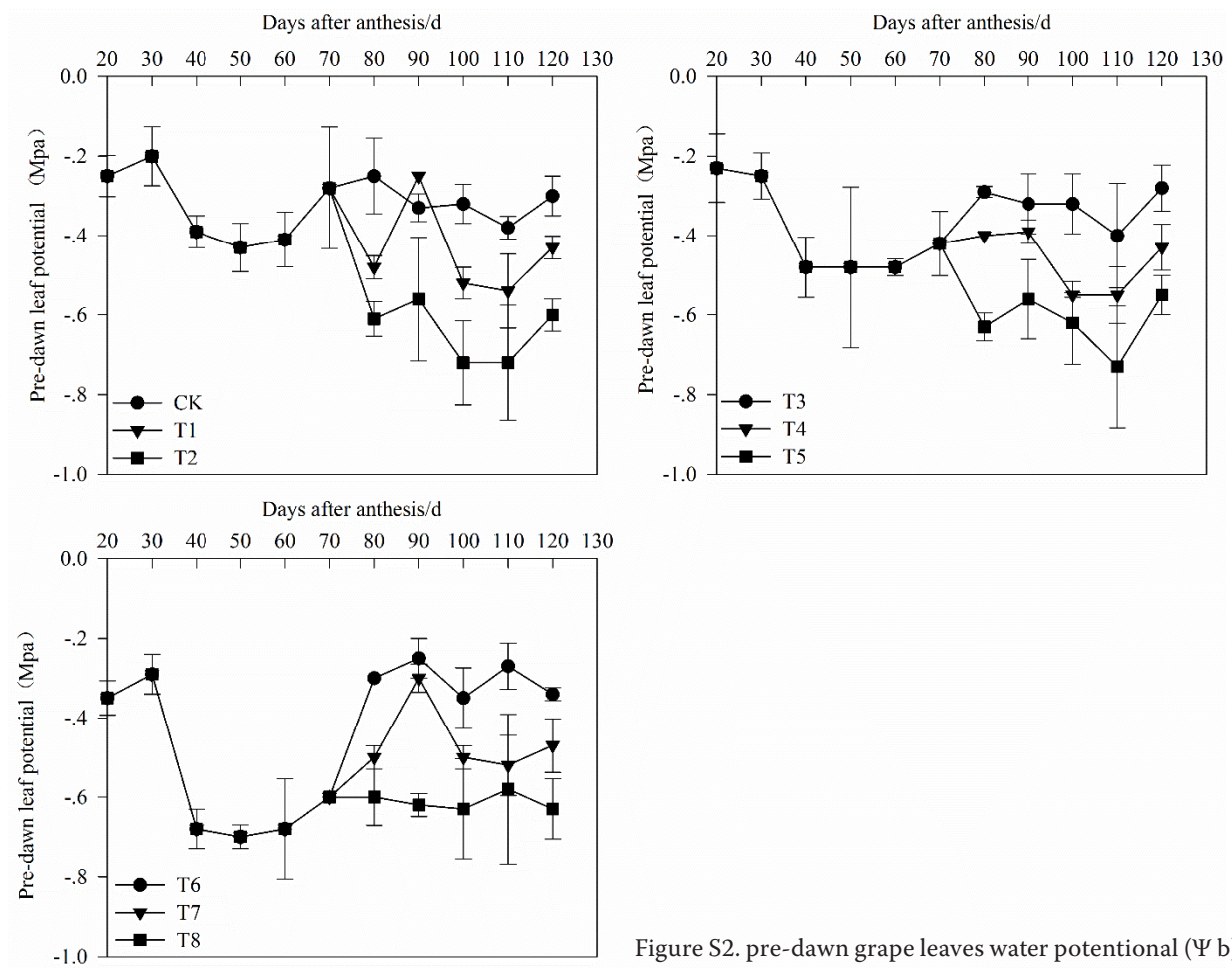


Figure S1. The rainfall and temperature during the test

Figure S2. pre-dawn grape leaves water potential (Ψ_b)