

SUPPLEMENTARY DATA

Grebneva, Y., Bilogrevic, E., Rauhut, D., Herderich, M.J., & Hixson, J.L. Impacts of photosensitive bunch zone shading on the volatile composition and sensory attributes for *Vitis vinifera* L. cv. Riesling. *OENO One*, 56(3). <https://doi.org/10.20870/oeno-one.2022.56.3.5364>



Figure S1. Experimental setup showing bunch zone shading treatments applied in the vineyard during grape ripening in 2018 and 2019 growing seasons.

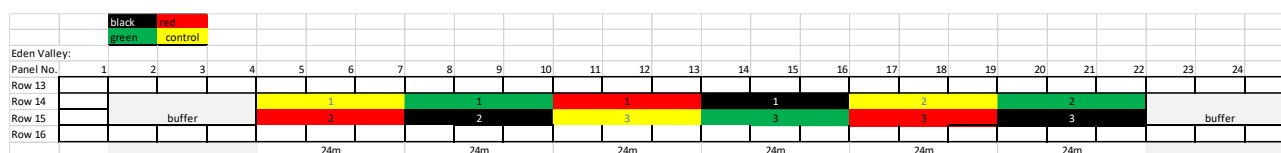


Figure S2. Schematic of the shading block design used in the vineyard during grape ripening in 2018 and 2019 growing seasons. Fill colour corresponds to shade cloth colour applied to those panels except for the control vines which are represented by a yellow fill.

Table S1. Eden Valley climate data for 2018 and 2019 vintages compared to the 1961-1990 and 1991-2017 average[^].

Time period	Mean Jan temp (MJT)	Annual rainfall (July-June)	Growing season rainfall (GSR)*	Growing degree days (GDD)*
1961-1990 average	20.1 °C	606 mm	230 mm	1531
1991-2017 average	21.1 °C	575 mm	229 mm	1660
2017-18 season	22.8 °C	495 mm	145 mm	1918
2018-19 season	24.4 °C	347 mm	101 mm	2031

*Calculated from October to April.

[^] Data taken from: Wine Australia. (2019). Regional snapshot 2018 - Eden Valley; Wine Australia. (2020). Regional snapshot 2019 - Eden Valley.

Table S2. Attributes, definitions and reference standards for terms used in all sensory descriptive analyses.

Attribute	Definition/Synonyms	Standard
<i>Appearance</i>		
Yellow colour	Intensity of the yellow colour	
Green colour	Intensity of the green colour	
<i>Aroma</i>		
Tropical A	Intensity of the aroma of tropical fruits: pineapple, mango and melon	8 g pineapple flesh & 4 g mango
Passionfruit A	Intensity of the aroma of passionfruit, box hedge, sweat	1 µL of 14.3 mg/L 3-MHA
Citrus/Lemon/ Lime A	Intensity of the aroma of citrus fruits: lemon and lime	1 slice lemon (7.5 g) & 1 slice lime (3 g)
Stonefruit A	Intensity of the aroma of stone fruits: apricot and peach	Half an apricot (in syrup) & 1/8 peach (in syrup)
Floral	Intensity of the aroma of white and orange blossoms	20 µL of 200 mL/L 2-Phenylethanol & 30 µL of 10 mL/L Linalool
Honey A	Intensity of the aroma of honey, nutty and cardboard	5 g honey
Confection A	Intensity of the aroma of confectionary: banana and red lollies	1 banana lolly & half red snake
Cooked Fruit	Intensity of the aroma of cooked fruits: cooked pear and lime cordial	1 tablespoon Goulburn Valley mixed fruit, 1 tsp brown lime cordial
Flint A/ Mineral/Wet stone A	Intensity of the aroma of struck matches and wet minerals	10 µL of 1mg/L benzyl mercaptan
Kerosene	Intensity of the aroma of kerosene, petrol, wax and plastic	50 µL of 100 mg/L TDN
Cheesy	Intensity of the aroma of cheese	10 µL of 11.87 g/L isovaleric acid
Confection	Intensity of the aroma of confection: candy floss, 'estery' and pineapple lollies	1 banana lolly (Black and Gold), <i>no wine</i>
Grassy A	Intensity of the aroma of green grass and hay	Blades of grass
Bruised Apple/ cardboard	Intensity of the aroma of bruised apples	1 µL of acetaldehyde (neat)
Pungency	Intensity of the aroma and effect of alcohol.	4 mL of 95% food grade ethanol.
<i>Palate</i>		
Overall fruit F	Overall intensity of fruit flavours in the wine	
Tropical fruit F	Flavour of tropical fruits: pineapple, passionfruit, melon, mango, guava, lychee	
Stonefruit F	Flavour of stone fruit: peach, apricot, nectarine	
Citrus F	Flavour of citrus fruits: lemon, lime	
Floral F	Flavour of flowers: blossoms, musk	
Sweetness	Taste of sucrose	
Viscosity	Perception of the body, weight or thickness of the wine in the mouth	
Acidity	Taste of acid in the mouth including aftertaste	
Hotness	Alcohol hotness perceived in the mouth, after expectoration	
Astringency	Drying and mouth-puckering sensation in the mouth	

A, aroma ; F, flavour.

Table S3. Mean temperatures for control and coloured shade cloth treatments in 2018 and 2019 as measured by Tinytag temperature loggers. Data shows average, minimal and maximal temperature across the growing season dates shown. Each value is an average of the daily mean, minimum and maximum temperatures across two temperature sensors in each treatment.

Temp. (°C)	22.12.17 - 14.03.2018				16.01. - 13.03.2019			
	Control	Green	Red	Black	Control	Green	Red	Black
Avg	21.0	21.1	21.1	21.1	21.6	21.7	21.8	21.7
Min	11.1	11.0	11.0	11.2	10.9	10.0	10.3	10.5
Max	32.1	32.6	32.4	32.0	33.0 ^b	34.1 ^a	34.2 ^a	33.9 ^{a,b}

^{a-b} Different letters indicate significant differences (significance level 95%) between treatments for each year.

Table S4. Mean total (free and bound) C₁₃-norisoprenoid concentration by coloured shade cloth treatments after acid hydrolysis (pH 1, 100 °C, 60 min) in 2018 Riesling juice samples, as analysed by GC-MS (mean ± SD in µg/L, n = 3 vineyard replicates).

Analyte	Control	Black	Green	Red
TDN	330.1 ± 65.1	154.9 ± 11.9	170.4 ± 12.3	184.9 ± 12.3
β-Damascenone	40.6 ± 4.1	40.3 ± 2.9	41.1 ± 2.0	40.0 ± 1.7

Table S5. Basic fruit composition of 2016 Riesling grapes from control and whole vine shade treatments (mean ± SD, n = 2 vineyard replicates).

Analyte	Control	Whole-vine shading
Alpha Amino Nitrogen (mg/L)	113.0 ± 11.3	98.0 ± 25.5
Yeast Assimilable Nitrogen (mg/L)	202.5 ± 26.2	203.0 ± 41.0
TSS (Baume)	11.3 ± 1.2	10.2 ± 0.5
Malic Acid (g/L)	1.7 ± 0.6	2.8 ± 0.7
pH	3.09 ± 0.04	3.17 ± 0.01
Yield/Vine (kg)	3.0 ± 0.3	2.6 ± 0.0

Table S6. Mean free volatile compound concentrations in 2018 Riesling wines by shade cloth treatment (SC) adjusted to pH 3.0 at bottling, analysed after 10 months and 18 months of storage at 15 °C by GC-MS. Data (in µg/L ± SD) are the average of two bottle replicates.

Analyte	Treatment			
	Control	Green SC	Red SC	Black SC
<i>10 months post-bottling</i>				
<i>α-Terpineol</i>	18.7 ± 0.3 ^a	8.0 ± 0.1 ^b	7.3 ± 0.1 ^b	7.5 ± 0.1 ^b
<i>β-Damascenone</i>	6.5 ± 0.8 ^a	5.1 ± 0.7 ^a	5.2 ± 0.1 ^a	5.7 ± 0.1 ^a
<i>Vitispirane</i>	14.2 ± 0.1 ^a	7.9 ± 0.1 ^{b,c}	8.1 ± 0.1 ^b	7.8 ± 0.1 ^c
<i>Riesling acetal</i> *	n.d.	n.d.	n.d.	n.d.
<i>TPB</i> *	n.d.	n.d.	n.d.	n.d.
<i>Actinidol</i> *	5.2 ± 0.2 ^a	4.2 ± 0.1 ^b	4.2 ± 0.1 ^b	4.2 ± 0.1 ^b
<i>TDN</i>	5.2 ± 0.1	n.d.	n.d.	n.d.
<i>18 months post-bottling</i>				
<i>α-Terpineol</i>	16.8 ± 0.4 ^a	7.6 ± 0.2 ^b	7.3 ± 0.1 ^b	7.2 ± 0.1 ^b
<i>β-Damascenone</i>	n.d.	n.d.	n.d.	n.d.
<i>Vitispirane</i>	32.0 ± 0.3 ^a	17.5 ± 0.2 ^b	17.3 ± 0.1 ^b	16.7 ± 0.2 ^b
<i>Riesling acetal</i> *	n.d.	n.d.	n.d.	n.d.
<i>TPB</i> *	n.d.	n.d.	n.d.	n.d.
<i>Actinidol</i> *	6.7 ± 0.1 ^a	5.2 ± 0.1 ^b	5.0 ± 0.1 ^b	5.2 ± 0.1 ^b
<i>TDN</i>	9.5 ± 0.1 ^a	5.3 ± 0.1 ^b	n.d. [^]	5.0 ± 0.1 ^c

^{a-c} Different letters indicate significant differences (significance level 95%) between treatments for each compound.

* Quantified as TDN equivalent; n.d., not detected; ^ mean of 4.9 µg/L was below the limit of quantitation of 5.0 µg/L.

Table S7. Mean sensory attribute scores for the Australian 2018 Riesling wines from control and shade cloth trial 1-year post-bottling (n=3 wines x 2 presentation replicates x 10 assessors).

Attribute	Treatment				LSD*
	Control	Green SC	Red SC	Black SC	
<i>Appearance</i>					
Yellow	4.85	3.96	3.90	3.83	0.40
<i>Aroma</i>					
Tropical A	5.55	5.58	5.25	5.49	ns
Boxhedge A	2.55	2.05	2.72	2.27	ns
Citrus A	4.48	4.54	4.53	4.48	ns
Stonefruit A	4.24	3.81	3.44	3.64	0.50
Floral A	3.36	3.76	3.50	3.52	ns
Honey A	2.97	1.37	2.17	1.96	0.72
Confection A	2.74	3.14	2.83	3.26	ns
Flint A	3.19	2.35	2.69	2.78	0.50
Kerosene A	2.04	1.29	1.54	1.05	0.71
Cheesy A	2.24	1.85	2.73	2.18	ns
Grassy A	2.29	2.66	2.63	2.69	ns
Bruised Apple A	2.41	2.00	2.30	2.15	ns
Pungency	5.07	4.77	4.81	4.63	0.25
<i>Palate</i>					
Acidity	6.32	6.28	6.70	6.38	0.19
Astringency	4.98	4.55	5.09	4.65	0.30
Bitterness	4.31	4.15	4.38	4.03	ns
Viscosity	4.64	4.17	4.20	4.25	0.27
Hotness	4.30	3.88	4.05	3.85	0.26
Tropical F	5.23	4.75	4.51	4.84	0.46
Citrus F	5.46	5.66	5.89	5.54	0.31
Stonefruit F	4.31	3.53	3.47	3.60	0.35
Grassy F	2.67	3.01	3.34	2.92	0.45

*Fisher's least significant difference (LSD) value was calculated following ANOVA ($p = 0.05$). A, aroma; F, flavour.

Table S8. Mean sensory attribute scores for the Australian 2018 Riesling wines from control and shade cloth trial 2-years post-bottling (n=2 wines x 2 presentation replicates x 8 assessors).

Attribute	Treatment				LSD*
	Control	Green SC	Red SC	Black SC	
<i>Appearance</i>					
Yellow	4.10	3.28	3.33	3.43	0.31
<i>Aroma</i>					
Tropical A	3.30	3.54	3.53	3.58	ns
Passionfruit A	2.81	2.78	3.09	3.33	ns
Citrus A	2.08	2.37	2.34	2.45	ns
Pear A	2.07	2.61	2.06	2.16	ns
Stonefruit A	3.17	3.35	2.98	2.69	ns
Floral A	2.07	2.61	2.37	2.44	ns
Honey A	2.29	1.57	2.67	1.62	ns
Confection A	2.27	3.18	2.90	2.41	ns
Kerosene A	3.89	1.92	2.11	1.92	1.27
Grassy A	1.80	1.70	1.68	1.66	ns
Bruised Apple A	2.84	2.62	2.57	1.87	ns
Pungency	4.24	4.05	4.09	4.13	ns
<i>Palate</i>					
Acidity	5.27	5.29	5.75	5.44	ns
Astringency	4.06	3.71	3.92	3.79	ns
Bitterness	3.83	3.87	4.07	3.83	ns
Viscosity	4.82	4.25	4.17	4.25	0.42
Hotness	4.41	3.94	4.05	4.23	ns
Tropical F	3.894	3.95	3.82	3.95	ns
Citrus F	4.04	4.26	4.31	4.53	ns
Stonefruit F	3.19	3.09	2.54	2.94	ns
Grassy F	2.40	2.72	2.73	2.55	ns

*Fisher's least significant difference (LSD) value was calculated following ANOVA (p = 0.05). A, aroma; F, flavour.

Table S9. Mean sensory attribute scores for the Australian 2019 Riesling wines from control and shade cloth trial 1-year post-bottling (n=2 wines x 2 presentation replicates x 9 assessors).

Attribute	Treatment				LSD*
	Control	Green SC	Red SC	Black SC	
<i>Appearance</i>					
Yellow	3.35	3.76	3.48	4.02	0.35
<i>Aroma</i>					
Overall Fruit A	4.36	4.39	4.51	4.36	ns
Passionfruit A	2.88	3.23	2.87	3.38	ns
Citrus A	2.44	2.31	2.67	1.93	0.55
Stonefruit A	3.55	4.09	4.02	4.01	ns
Honey A	2.19	2.71	1.90	3.51	0.93
Confection A	2.07	2.77	2.38	2.75	ns
Grassy A	1.72	1.91	1.95	1.57	ns
Earthy A	1.87	1.84	1.76	1.62	ns
Wet Tea Towel A	1.93	1.99	1.38	2.34	ns
Pungency	4.21	4.20	4.53	4.34	ns
<i>Palate</i>					
Acidity	5.81	5.38	5.96	5.16	0.44
Astringency	3.46	3.28	3.85	3.13	0.34
Bitterness	3.48	3.75	4.12	3.98	ns
Viscosity	4.26	4.58	4.33	4.34	ns
Hotness	4.11	3.84	4.25	3.99	ns
Overall Fruit F	4.06	4.35	3.87	4.07	0.60
Citrus F	4.64	4.10	4.97	3.29	ns
Stonefruit F	3.39	3.76	3.39	4.21	0.79

*Fisher's least significant difference (LSD) value was calculated following ANOVA ($p = 0.05$). A, aroma; F, flavour.