The uncoupling of berry ripening : what we have learned from InnoVine

Stefano Poni

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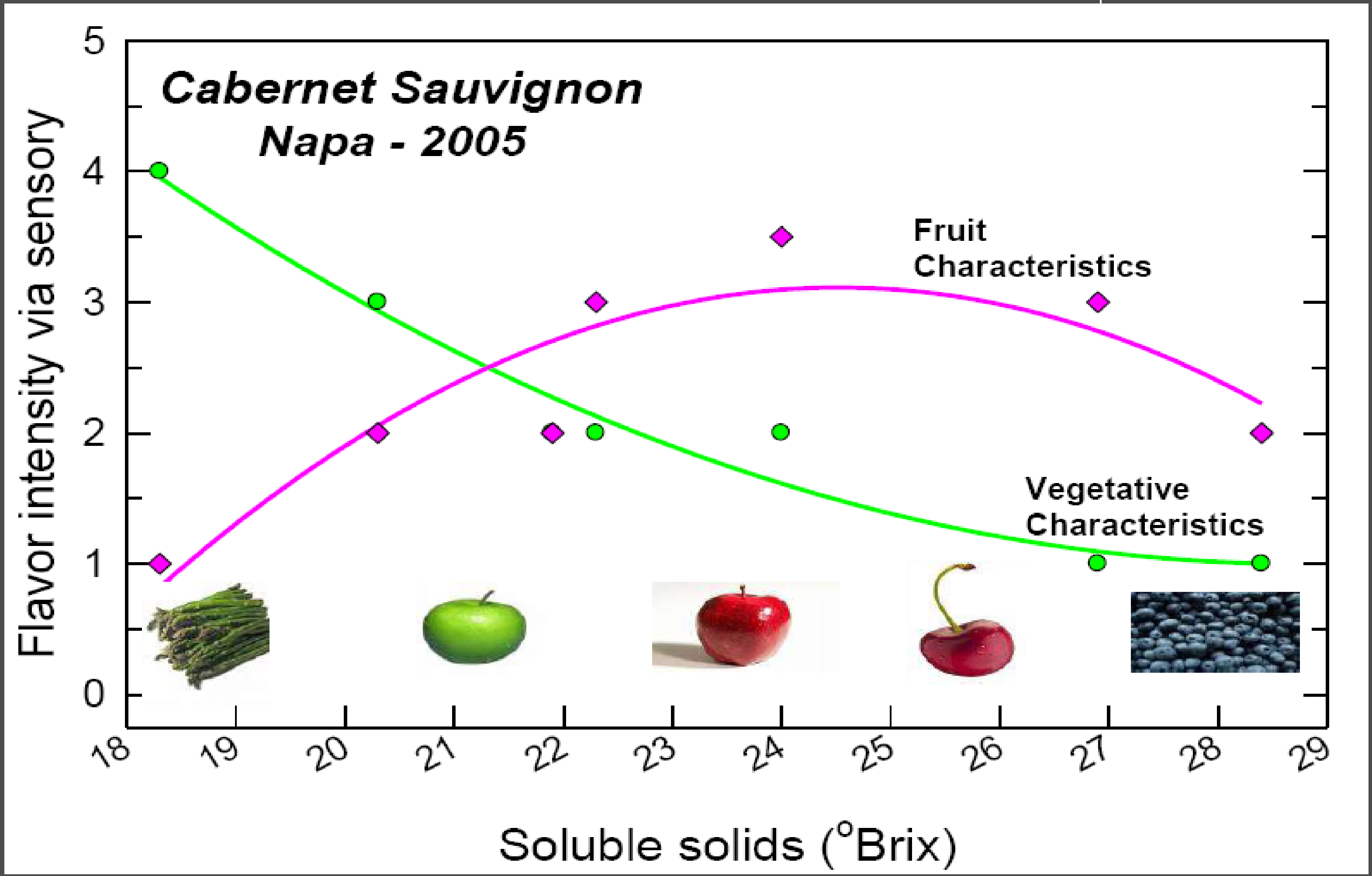
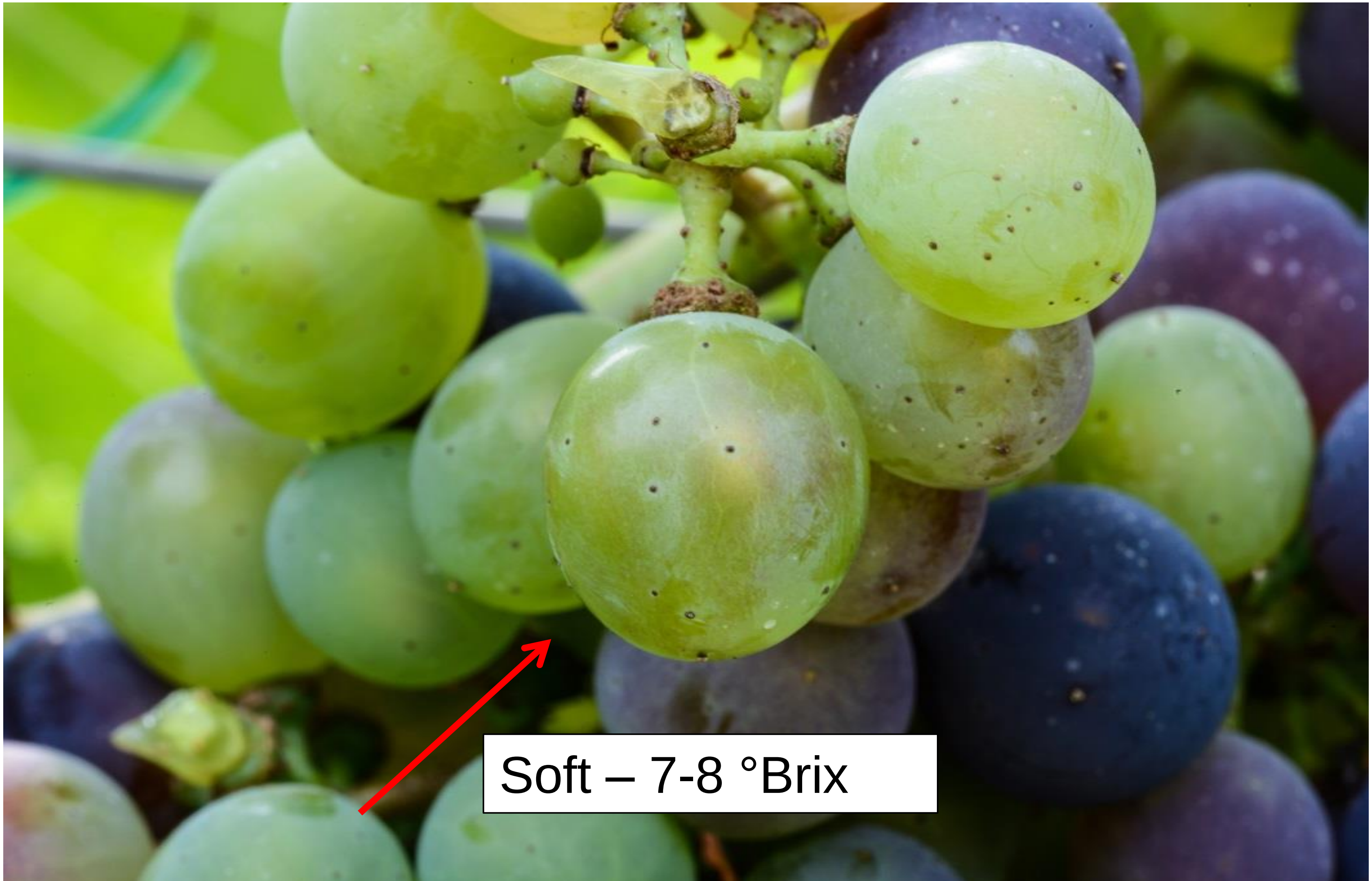


From Dokoozlian, 2005


Soft – 7-8 °Brix

Problems

- ❑ Red grapes: too fast sugar accumulation while phenolics and flavour still lag behind.
- ❑ White grapes: it is hard to mantain acidity and freshness in sparkling and spumante wine types.
- ❑ Issues of grape delivery and logistic.

Obiectives

- ❑ Sugar:anthocyanins decoupling (delaying sugaring without delaying the rest of maturity is the challenge)
- ❑ Safeguard acidity without compromising adequate sugar level and aroma.
- ❑ More in general, decompress maturity by delaying the whole annual cycle?.

Tools and techniques

- First, always assess if your accelerated ripening is not due to trivial reasons (i.e. maybe vines are undercropped??)
- New genetic material or drawing from existent biodiversity
- Targeted leaf removal
- Use of anti-transpirants
- Delayed winter pruning

Tempranillo somatic variants differed in their response to elevated temperature during grape sugar and anthocyanin accumulation

Objective

The aim of this study was to assess the effect of elevated temperature on the accumulation of sugars and anthocyanins of thirteen accessions of Tempranillo grapevine, which differed in their cycle length.

Experimental design

Treatments

Thirteen Tempranillo Accessions with different cycle length:

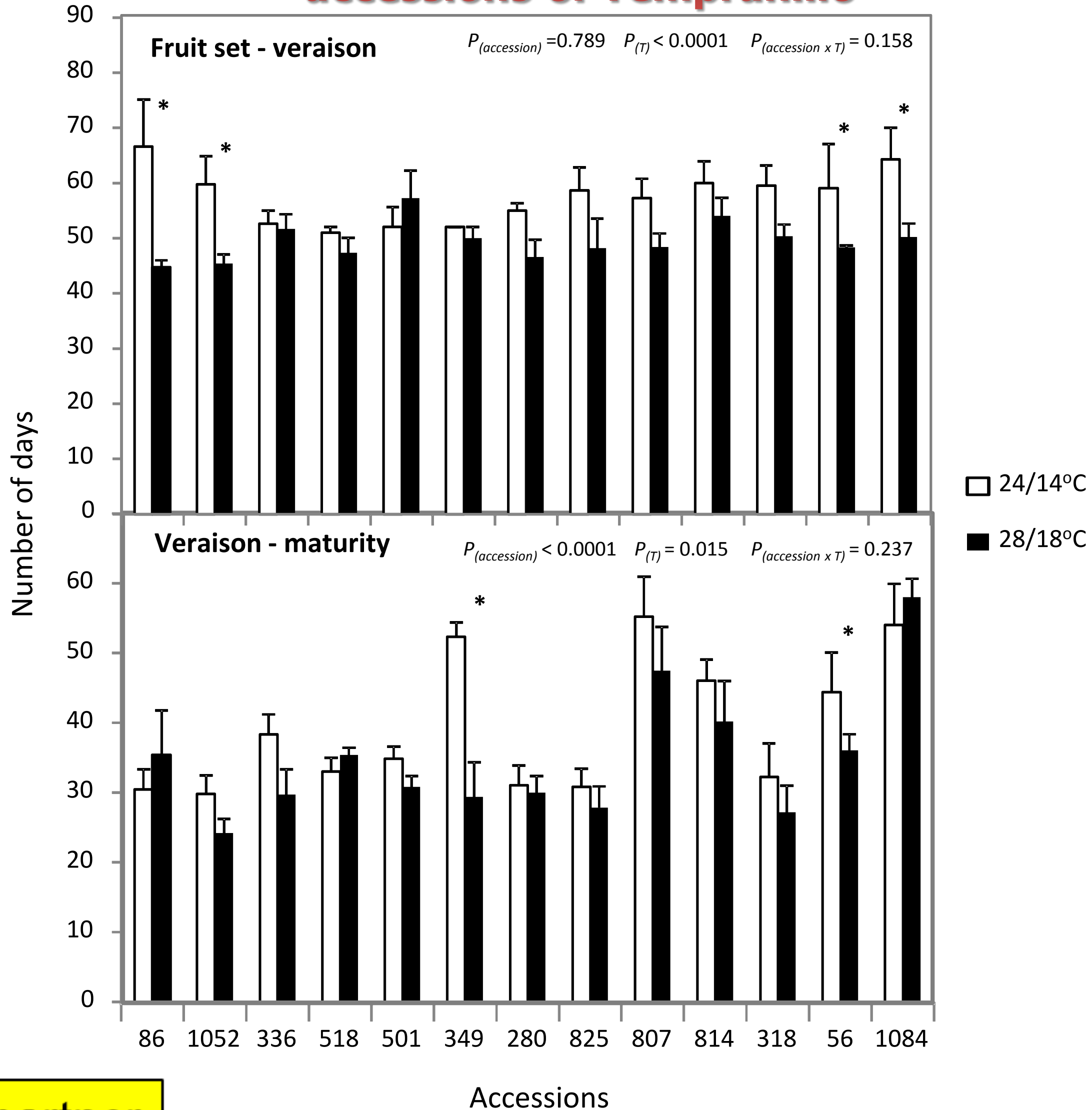
86, 1052, 336, 518, 501, 349, 280, 825, 807, 814, 318, 56, and 1084 (Government of La Rioja, Spain)

Temperature regimes **(from fuit set to maturity)**

- **24/14ºC day/night**
- **28/18ºC day/night**

n=3-6

Number of days from fruit set to veraison and from veraison to maturity of thirteen accessions of Tempranillo



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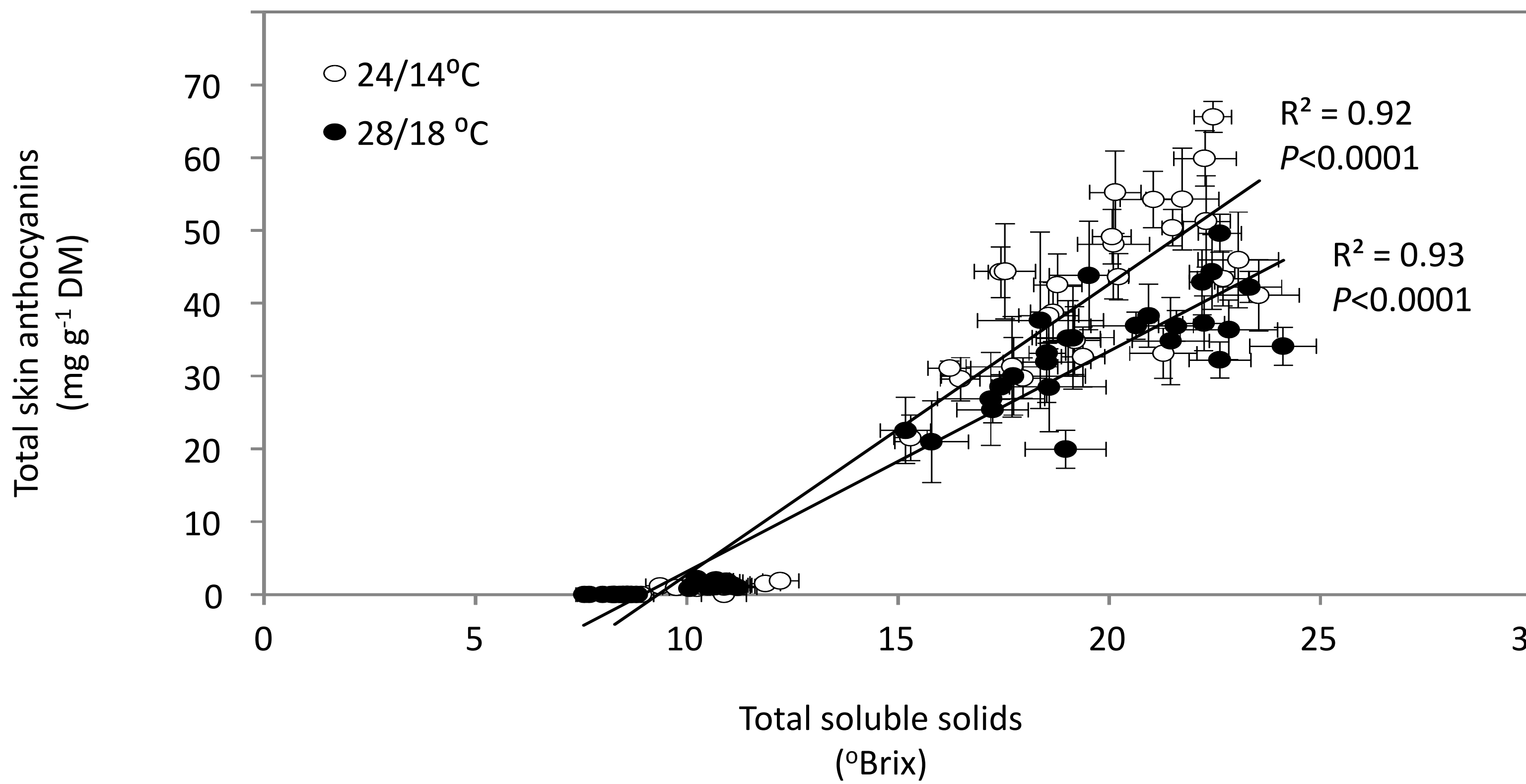
INNOVINE – Project FP7-311775

Effect of elevated temperature on the relationship between the concentration of anthocyanins and total soluble solids in thirteen accessions of Tempranillo



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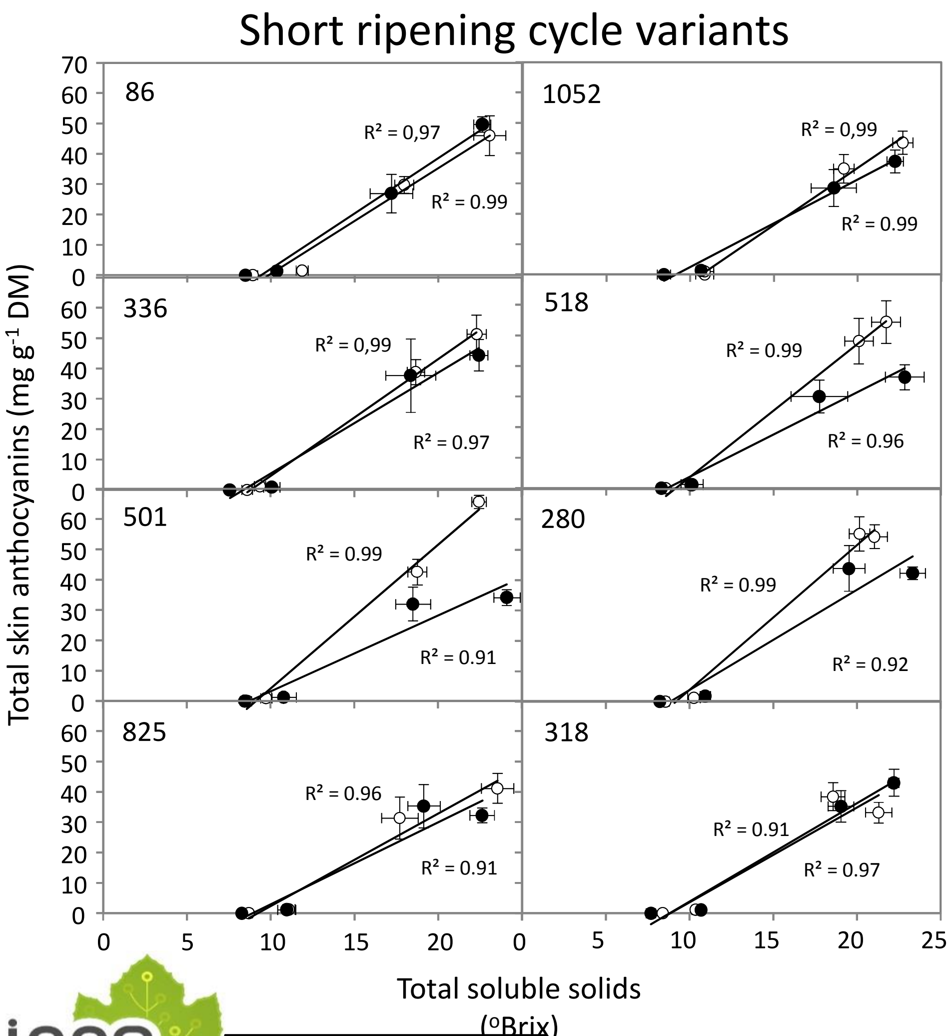

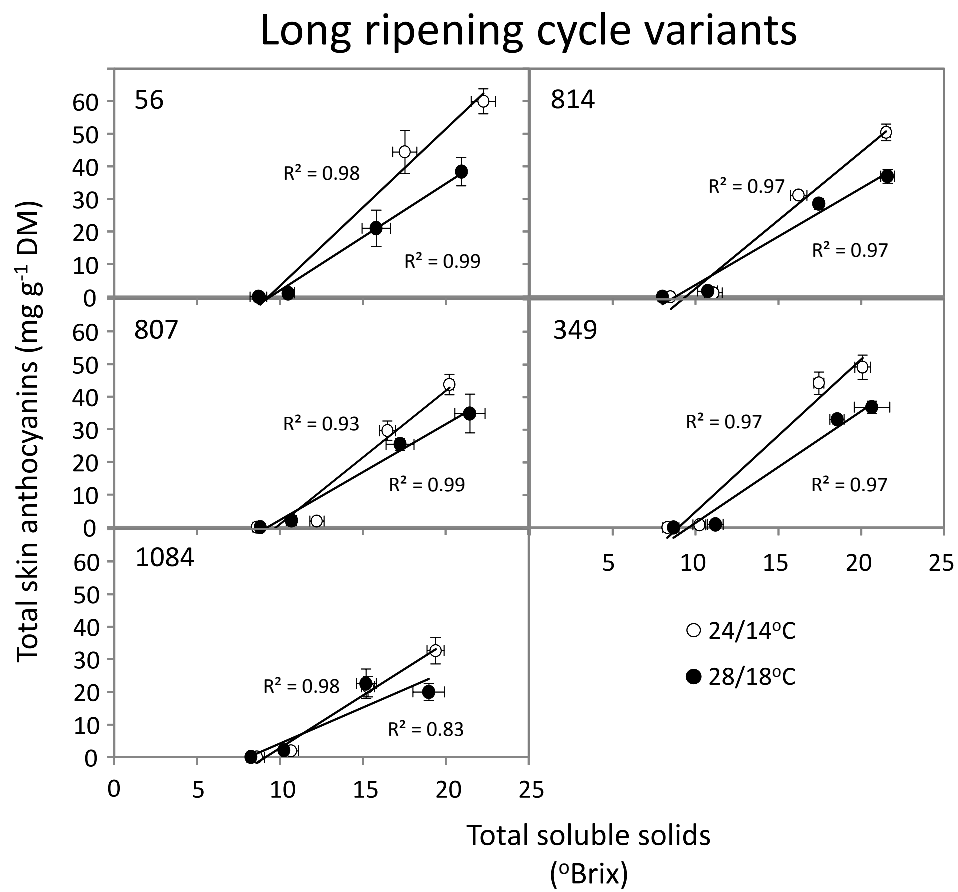

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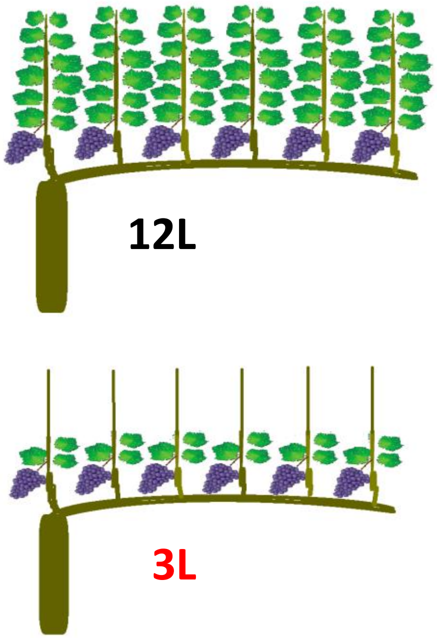
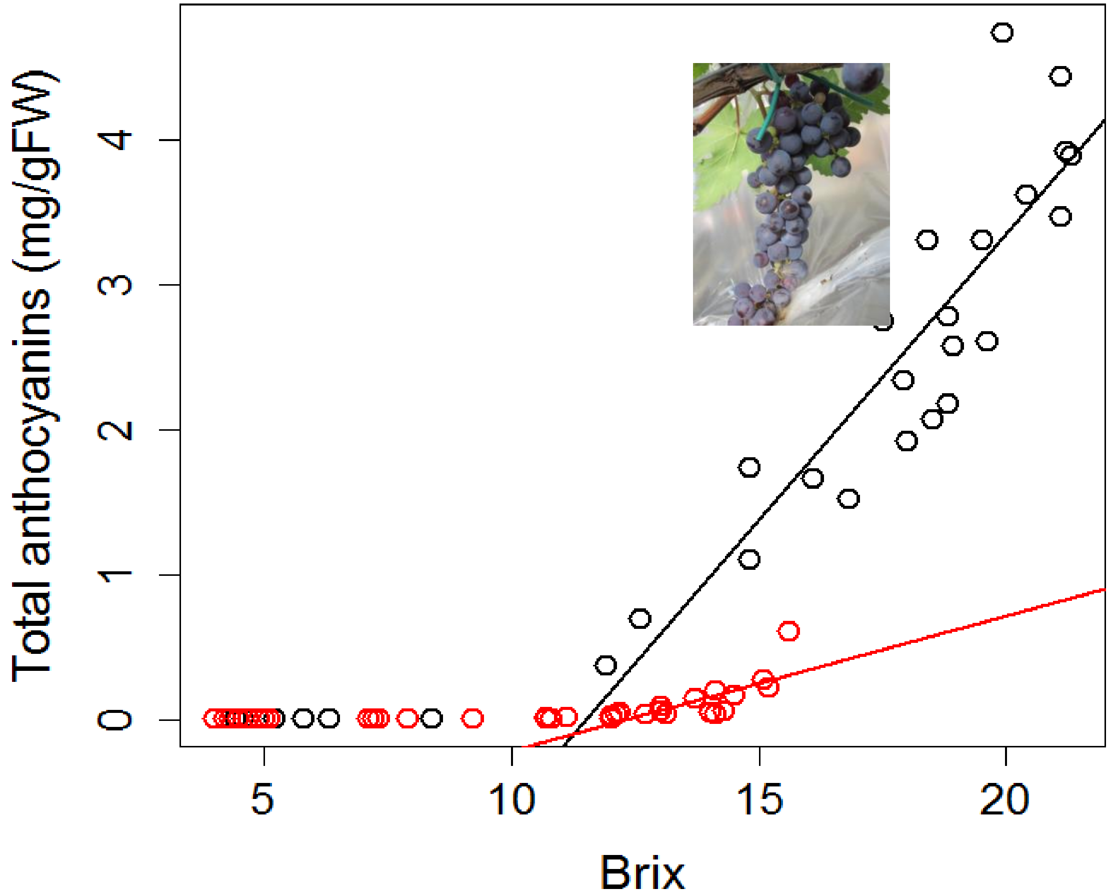
Source limitation affects sugar:anthocyanins relationships



cv. Sangiovese



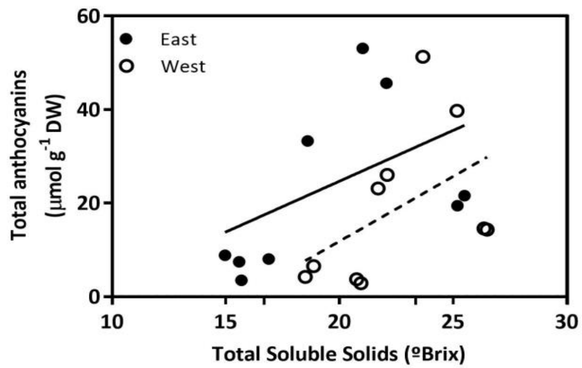
Bobeica et al., 2015 Front. Plant Sci.

INRA + UCSC

Anthocyanin : Sugars

Hours T_{berry} > 35ºC from véraison to full maturation

	2013	2014
SDIE	88	35
SDIW	112	48
RDIE	73	20
RDIW	106	56



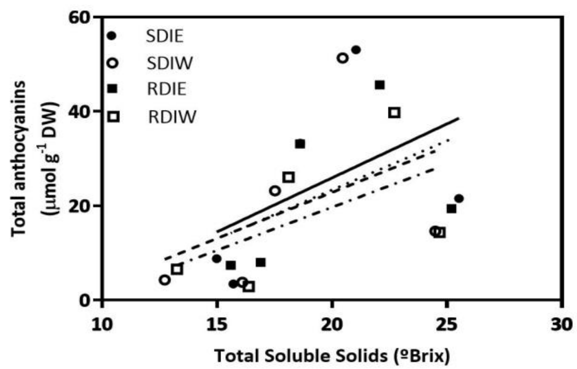
A thermal disruption of the anthocyanin : sugar relationship east versus west berries

Decoupling due to high temperature at west side

Cumulative water stress (Pre-dawn water stress integral ($S\Psi_{pd}$ MPa day^{-1}) from véraison to full maturation)

	2013	2014
SDI	3.75	5.42
RDI	6.43	6.91

SDI: sustained deficit irrigation 30%ET_c
RDI: regulated deficit irrigation 15% ET_c



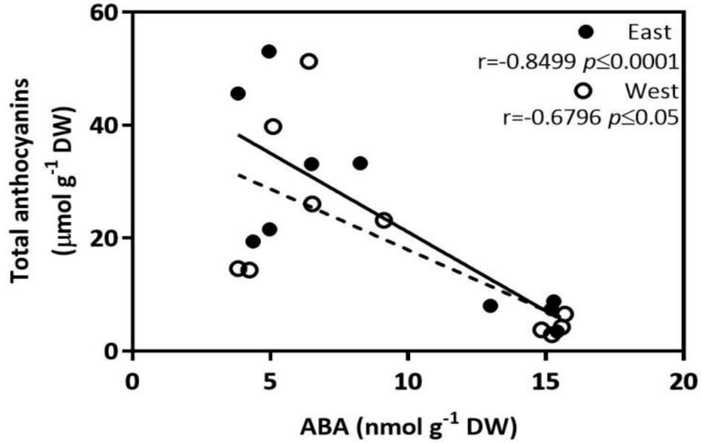
Anthocyanin : sugar decoupling slightly larger in RDIW

RDI more susceptible to high temperature

SDIE: SDI east side
SDIW: SDI west side
RDIE: RDI east side
RDIW: RDI west side

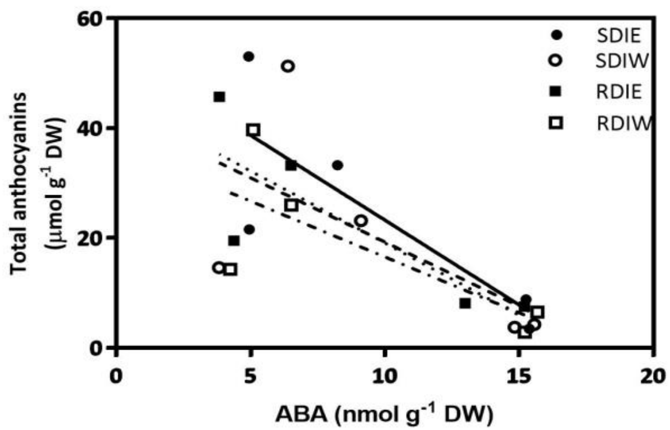
ITQB

Anthocyanin : ABA



-Highly significant correlation at the east side
- significant but smaller correlation at the west side

high temperature at west side account for the differential modulation of these metabolites



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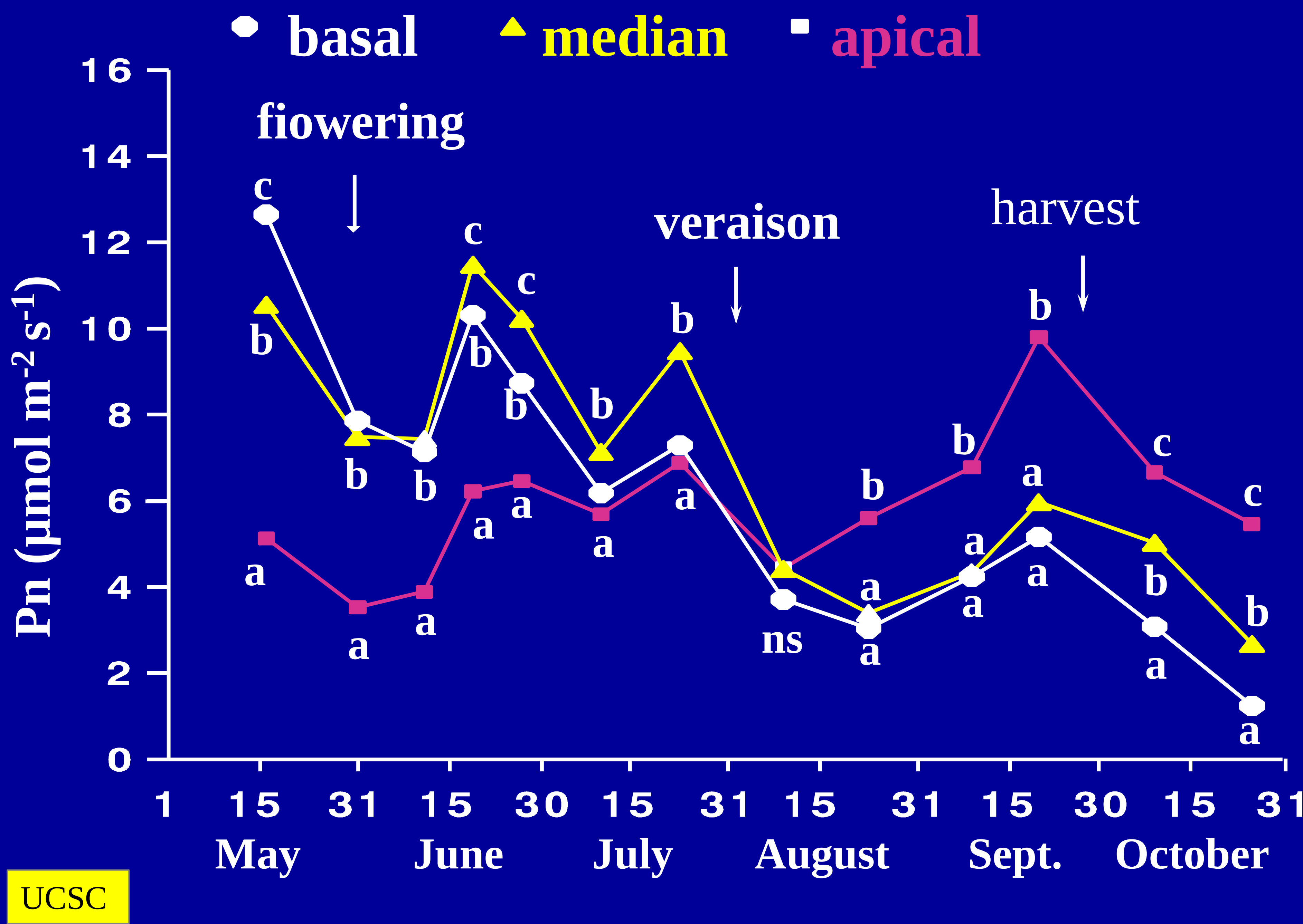

basal
median
apical
flowering
veraison
harvest
Pn (µmol m-2 s-1)
0
2
4
6
8
10
12
14
16
1
15
31
15
30
15
31
15
31
15
30
15
31
May
June
July
August
Sept.
October
ns
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Apical to the cluster late Leaf Removal

Leaf Plucker

Detail of the fruit zone

Late leaf removal aimed at delaying ripening in cv. Sangiovese: physiological assessment and vine performance

Australian Journal of Grape and Wine Research
[Volume 19, Issue 3,](http://onlinelibrary.wiley.com/doi/10.1111/ajgw.12040/full#ajgw12040-fig-0001) pages 378-387, 12 AUG 2013
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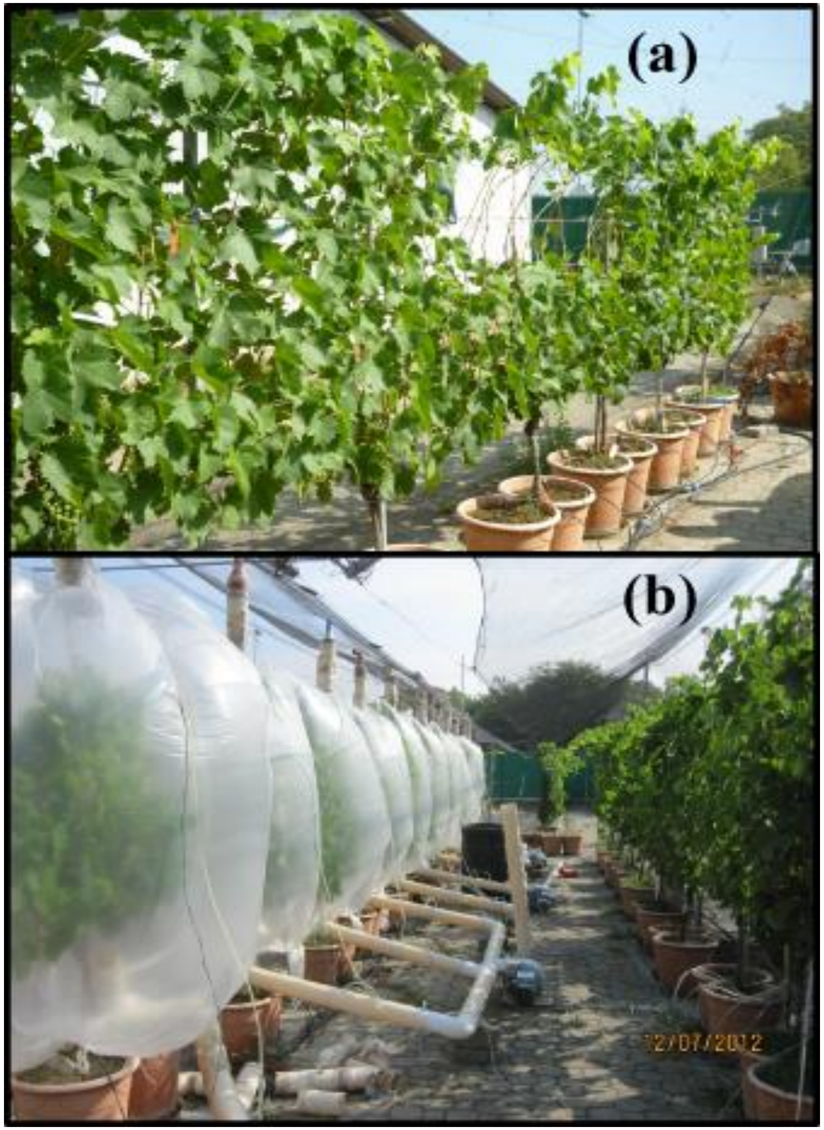
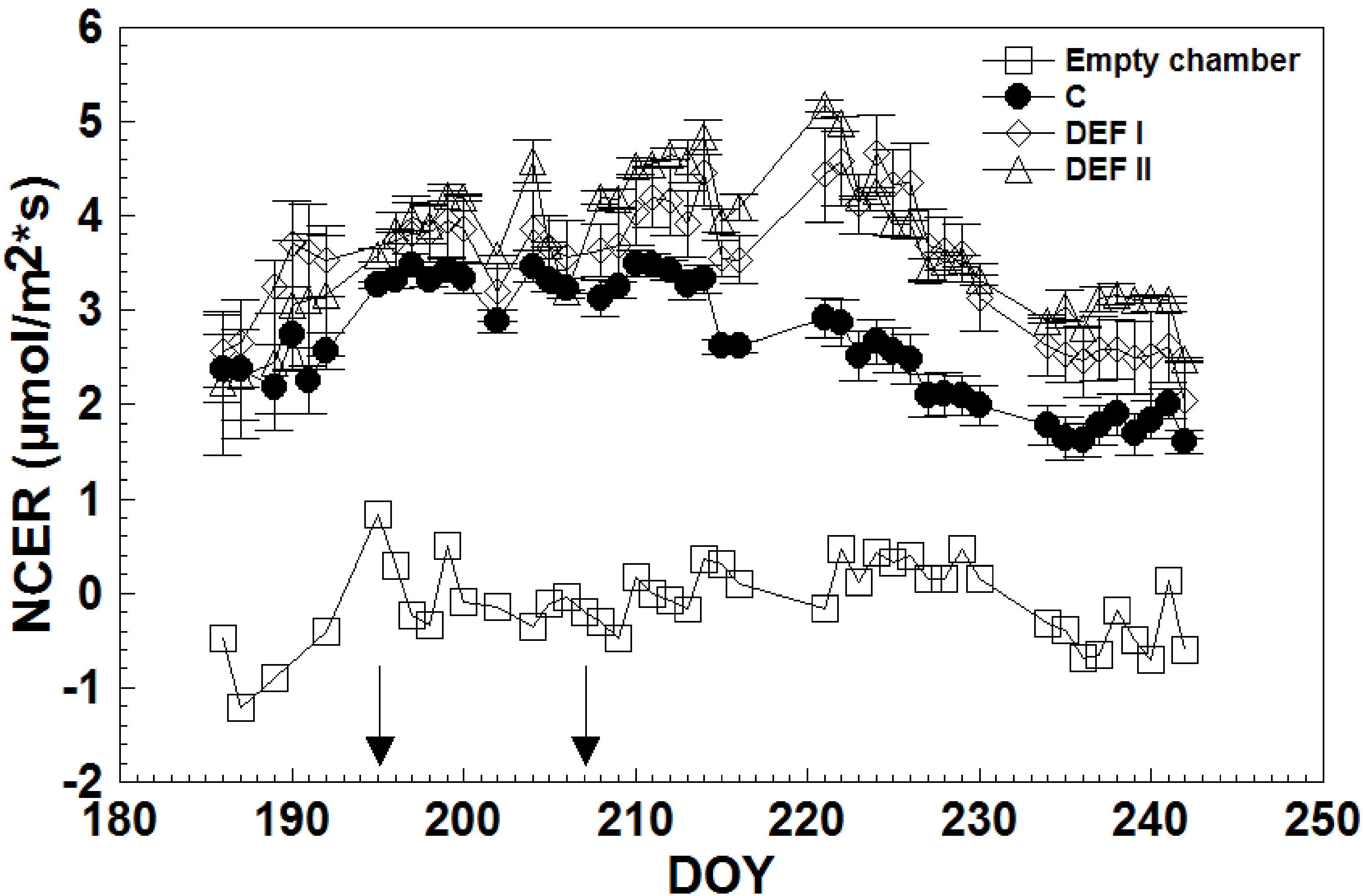


From Poni et al. 2013, AJGWR, 19: 378-387.



Grape composition determined on Sangiovese grapevines either non-defoliated or defoliated pre- (DEF-I) and post-veraison (DEF-II) at the two different harvest dates.

	Soluble solids (°Brix)	TA	pH	Color (mg/g)	Phenolics (mg/g)
Harvest 04/09					
Control	18.8 a	5.34 a	3.13	0.63	2.14
DEF-I	17.5 b	6.03 b	3.24	0.67	2.31
DEF-II	16.4 c	6.22 b	3.22	0.64	2.27
Sig.	**	**	ns	ns	ns
Harvest 11/09					
Control	-	-	-	-	-
DEF-I	18.9	6.54	3.19	0.67	1.90
DEF-II	18.0	6.69	3.18	0.67	1.98
Sig.	ns	ns	ns	ns	ns

From Poni et al. 2013, AJGWR, 19: 378-387.

Mechanical leaf removal:
August 23
(4 weeks after veraison)

Grape harvest: September 19 (27 days after leaf removal)

Driven at 2 km/h (3-4 h/ha)

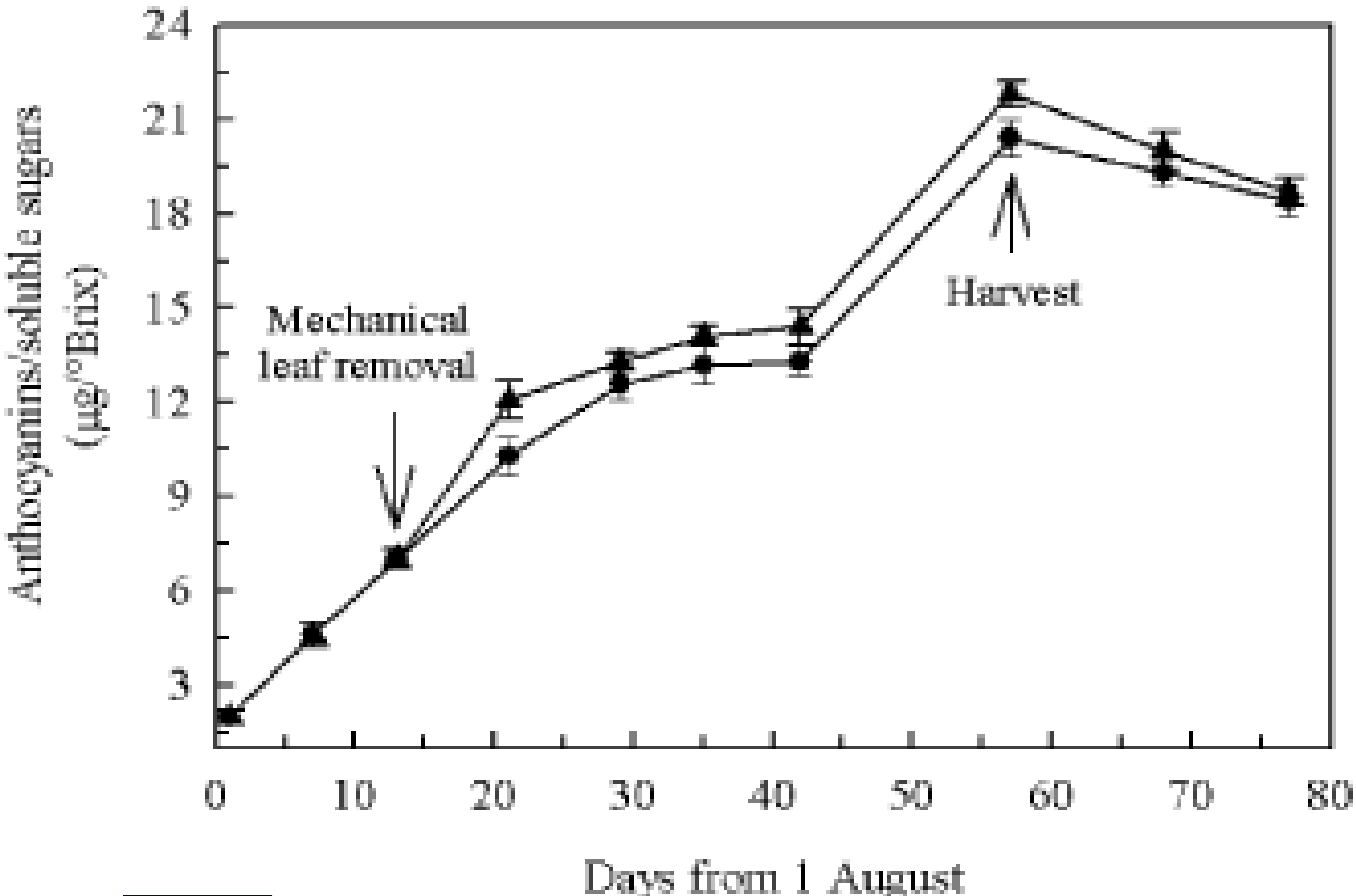
Opening of a window about 50-60 cm tall above the cluster zone

From Palliotti et al. (2013). AJGWR 19: 369-377

Parameter	Defoliation			Year		
	C	D	Sig.†	2011	2012	**Sig.†**
Total leaf area/vine (m^2)	4.28^{a}	2.80^{b}	**	3.88^{a}	3.20^{b}	*****
Lateral leaf area/vine (m^2)	1.60^{a}	0.72^{b}	**	1.36 ^{a}	0.96^{b}	*****
Clusters/vine	10.0	10.3	ns	10.6	9.8	**ns**
Yield/vine (kg)	2.51	2.63	ns	3.26^{a}	1.88^{b}	******
Cluster weight (g)	250.0	243.0	ns	310.0^{a}	183.0^{b}	******
Berry weight (g)	2.05	2.03	ns	2.54^{a}	1.54^{b}	******
Total soluble solids (°Brix)	23.9^{a}	22.7^{b}	*	22.9^{b}	23.8^{a}	*****
Titratable acidity (g/L)	6.35	6.15	ns	6.23	6.40	**ns**
Must pH	3.26	3.31	ns	3.30	3.47	**ns**
Anthocyanins (mg/cm^2 skin)	0.419	0.411	ns	0.344^{b}	0.486^{a}	******
Total phenolics (mg/cm^2 skin)	0.59	0.57	ns	0.56	0.59	**ns**
Leaf-to-fruit ratio (m^2/kg)	**1.77^{a}**	**1.13^{b}**	*	**1.21^{b}**	**1.70^{a}**	*****

†Means within rows designed by different superscript letters are significantly different by the Student-Newman-Keuls test. *, **, ns indicate significance at $P \leq 0.05$ and 0.01 or not significant, respectively

Influence of mechanical postveraison leaf removal apical to the cluster zone on delay of fruit ripening in Sangiovese (*Vitis vinifera* L.) grapevines



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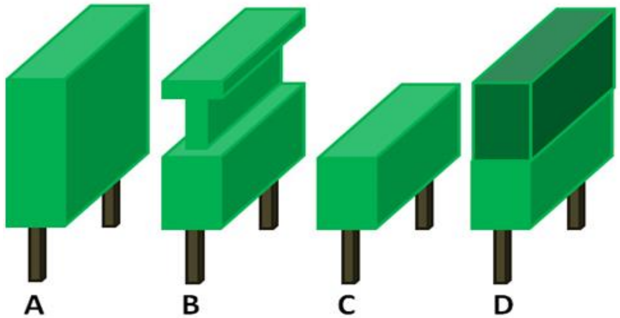
Material and Methods

- climate: moderate temperature conditions (1981-2010):

season	temperature [°C]	precipitation [mm]	sunshine hours [h]
winter	2,4	123	174
spring	10,4	125	509
summer	18,8	155	661
autumn	10,4	139	305
vegetation period	**15,2**	**336**	**1298**

- Varieties tested: Riesling and Müller-Thurgau
- canopy manipulation treatments:
  - Control [A]
  - MDC: mechanically defoliated canopy [B]
  - SSP: severe summer pruning [C]
  - Anti-transpirant spray [D]



- measurements on phenology [Coombe, 1995], physiology [A, g_s], bunch architecture and fruit components as well as fruit sanitary

GRC

The uncoupling of berry ripening:
Partner GRC (contributors: S. Tittmann, V. Stöber and M. Stoll)

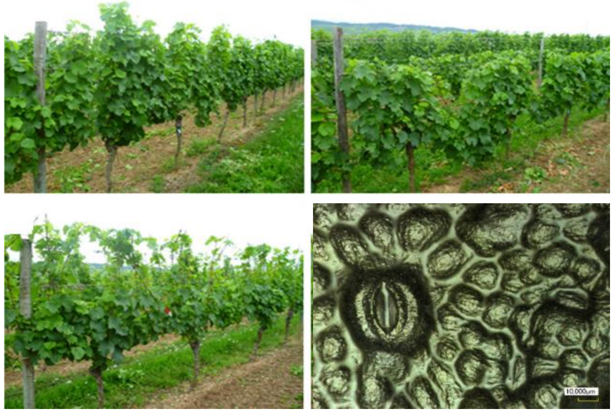
• Results

— Phenology:

➲ **no alteration of phenology through canopy manipulation treatments**

— Variation in **Leaf Area to Fruit Weight** (LA/FW) ratio

- control: app. 2 m^2kg^{-1}
- SSP: severe summer pruning: app. 0.4 m^2kg^{-1}
- MDC: mechanically defoliated canopy: app. 1.2 m^2kg^{-1}
- Anti-transpirant spray: app. 1.4 m^2kg^{-1} [[m^2kg^{-1} for main leaves]]



Tittmann 2013

➲ **only anti-transpirant significantly impacts on net-assimilation rate [A, $\mu mol m^{-2} s^{-1}$] whilst other treatments did not significantly alter A**

➲ **within canopy manipulation treatments the <u>intensity, timing and positioning</u> of defoliation practices are the main clues to alter berry ripening**

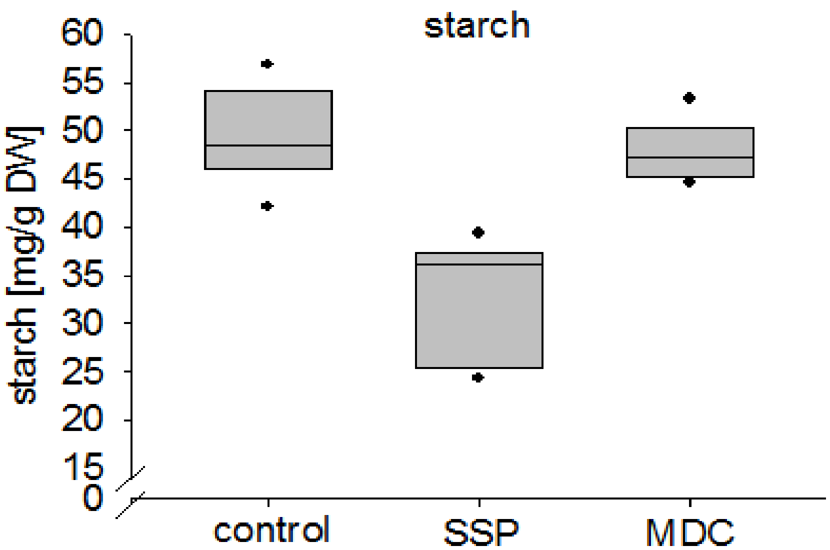
➲ **velocity of sugar accumulation becomes reduced under restricted leaf area**

➲ **similar to severe defoliation practices applying anti-transpirant spray reduces sugar accumulation or the velocity of fruit ripening drastically**

GRC

Results

- Fruit composition:
  - no changes in pH or total acidity
  - higher content of yeast available nitrogen using severe summer pruning
  - in Riesling: higher total phenol content under either defoliation of the bunch zone or severe summer pruning; flav<u>a</u>noles remain unchanged, hydroxycinnamic acid derivatives whilst <u>flavonols</u> increase
- Carbohydrate allocation
  - reduction in starch reallocation under severe summer pruning



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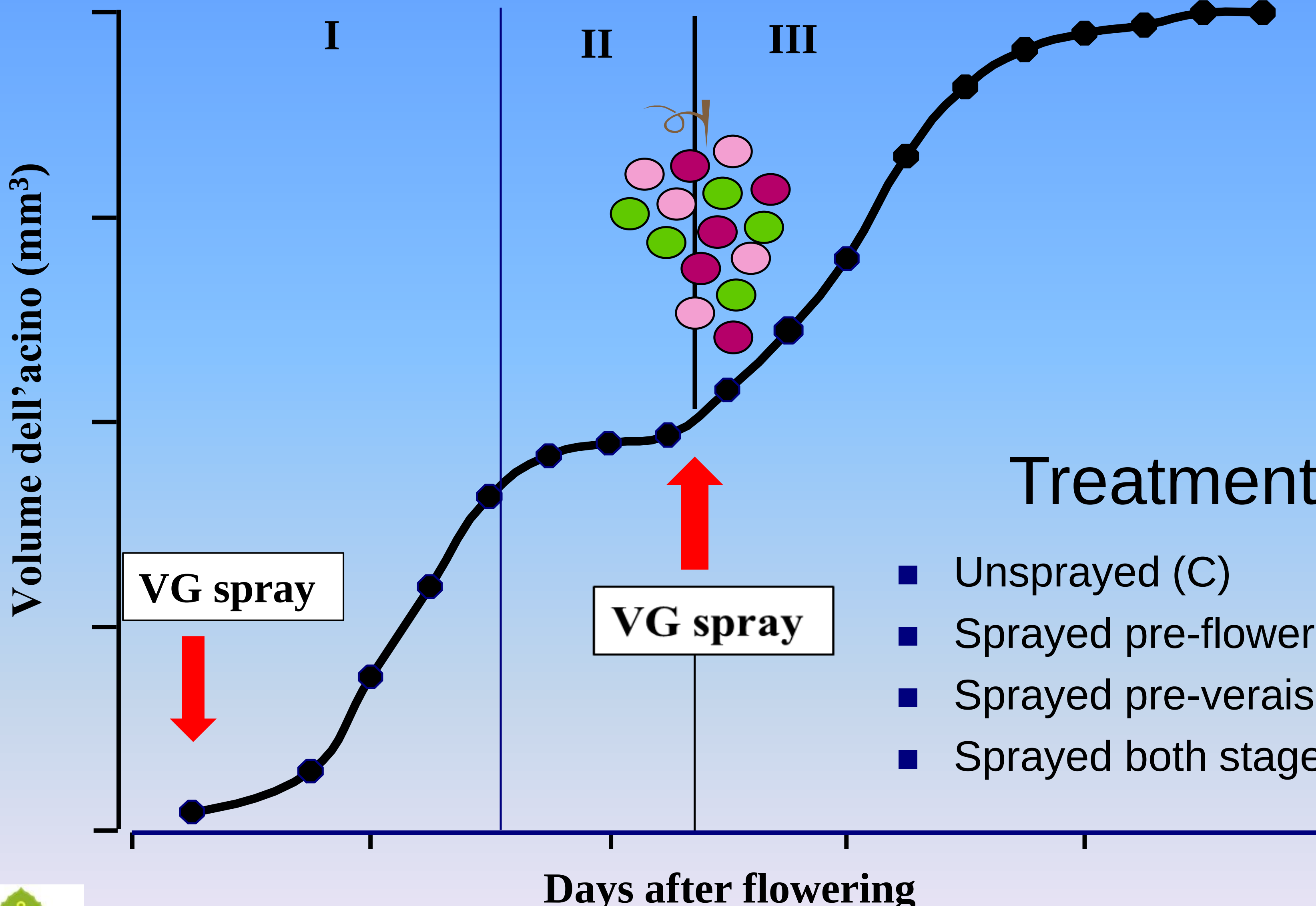
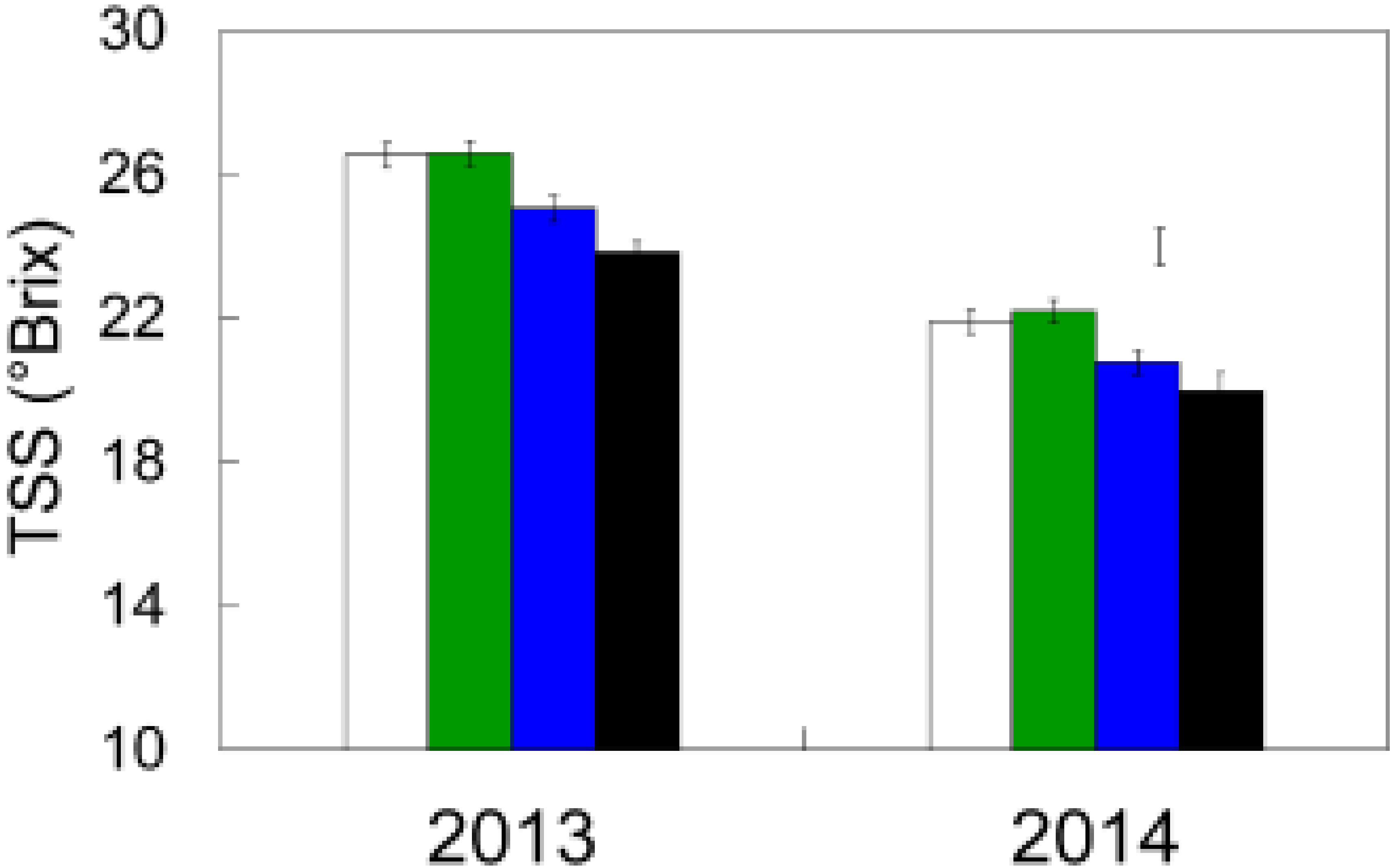


Treatments

- Unsprayed (C)
- Sprayed pre-flowering (PF)
- Sprayed pre-veraison (PV)
- Sprayed both stages (BS)

Manipulation of ripening via antitranspirants in cv. Barbera (*Vitis vinifera* L.)



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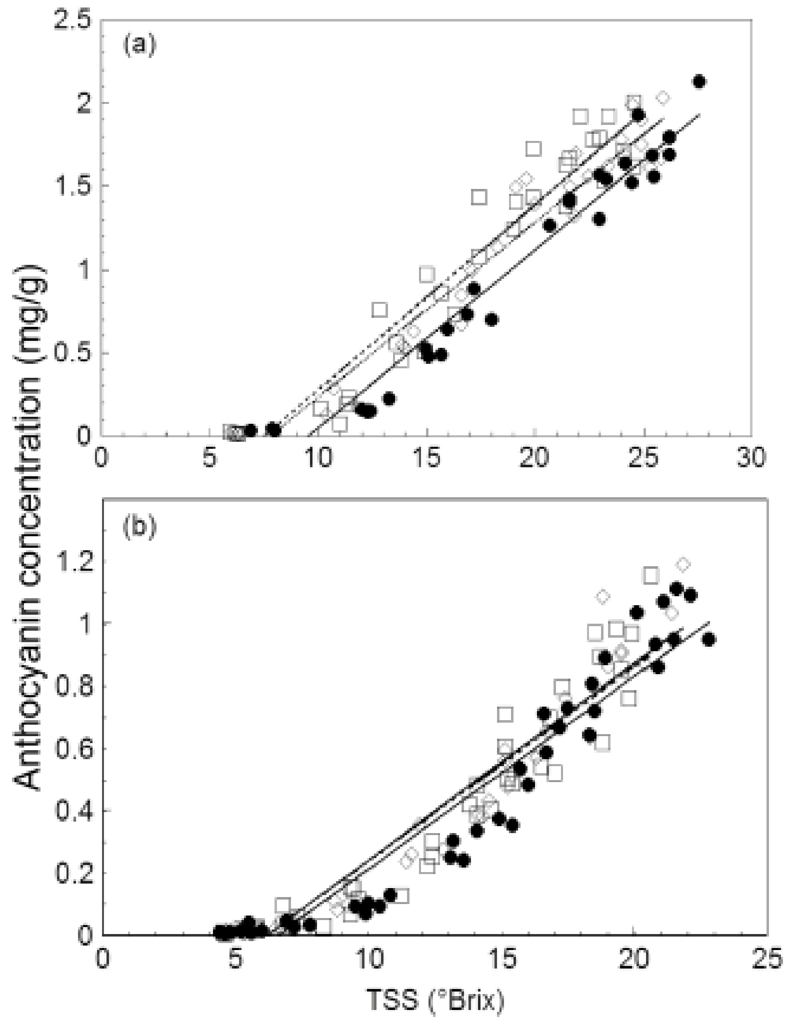

Linear relationships between TSS and anthocyanins for (a) 2013 and (b) 2014 for the application of antitranspirant at pre-veraison (◊) and at pre-flowering and pre-veraison (□) and for the unsprayed control (●).

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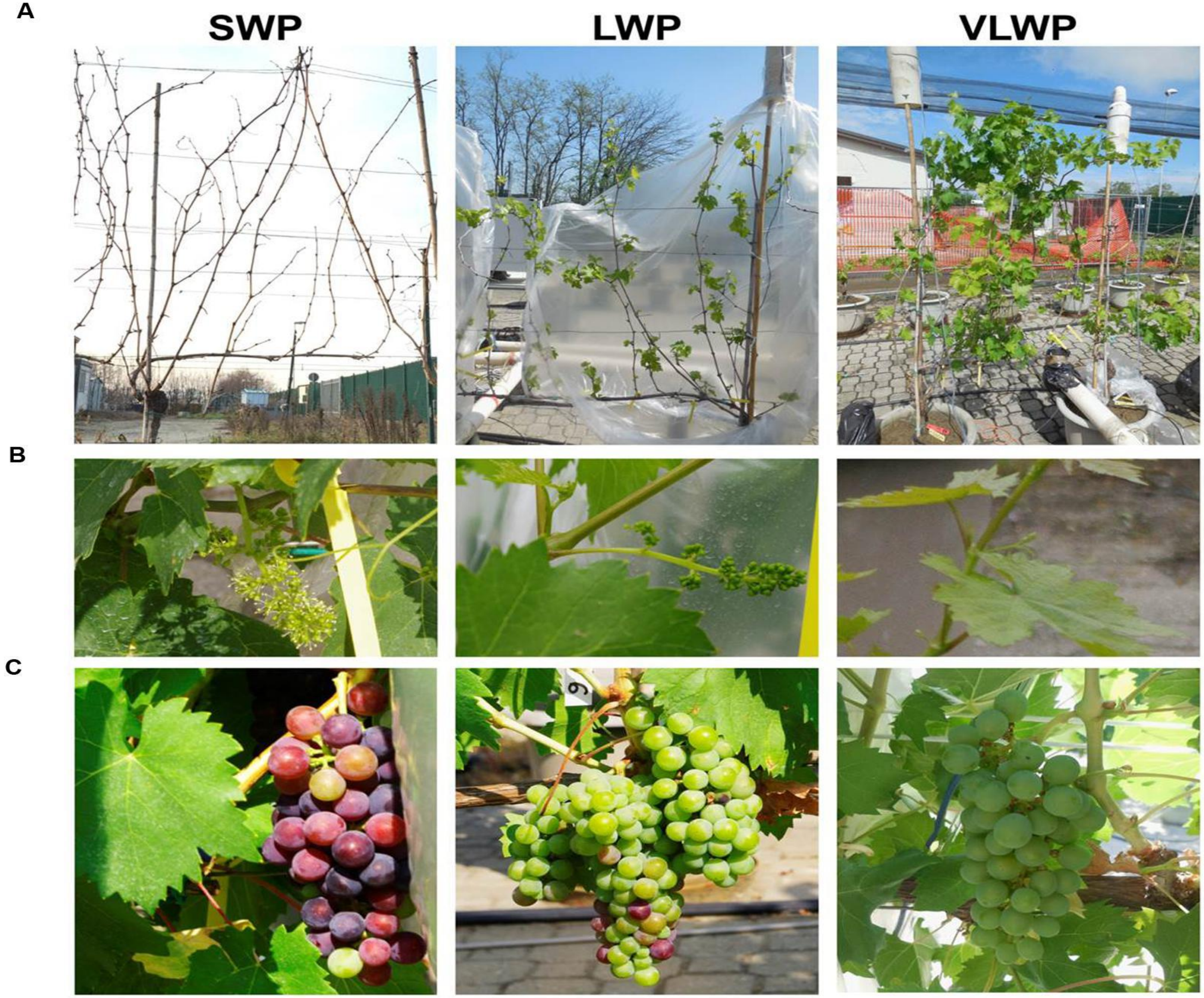
A
SWP
LWP
VLWP
B
C

Field trial on Pinot Noir

Thanks to All Contributors and to Your Attention