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Description of the *Vitis vinifera* L. phenotypic variability in eno-carpological traits by a Euro-Asiatic collaborative network among ampelographic collections

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Supplemental Table (SI1)

List of ampelographic collections involved in the network

Country	Code	Elevation (m a.s.l.)	Longitude*	Latitude*	Minimum distance from GSOD network*	Notes
Portugal	PRT051	110	-9.18	39.03	0.21	Plain area. Calcic fluvisol soil, with high levels of P and K and poor in N. Vines were trained and spur-pruned on ascendant bilateral cordon system with a plantation density of 3200 vines per hectare. Plants spaced by 2.6 m (interrow) 1.2 m (intrarow), grafted on SO4 rootstock.
Spain	ESP080	604	-3.28	40.52	0.17	Located in the central plateau of the Iberian Peninsula in a semi-arid Mediterranean climate. Plants are grafted onto Richter 110 rootstock, trained to a simple cordon, pruned at eight buds per vine and planting density 4444 vines·ha^{-1} (0.90 m x 2.50 m). Row direction SW-NE. Clay loam soil.
Spain	ESP217	345	-2.29	42.46	0.04	Flat terrace close to the river. Row direction N-S. Soil between loam and silty clay loam. Plants spaced by 2 x 1 m (interrow and intrarow respectively). Vines 20-30 years old trained at Cordon de Royat.
Luxembourg	LUX008	207	6.35	49.55	0.16	Experimental vineyards in Remich were trained in the Guyot system with appr. 5000 plants·ha^{-1} (2 m * 1 m). The fields of observation were slightly south-east exposed.
Switzerland	CHE001	457	6.66	46.51	0.01	Situation in weak slope (5-10 %) of south exposure. Deep colluviosol (15 % of clay). Plant spaced by 1.5 m x 0.85 m (about 7800 plants·ha^{-1}). Vines trained at classic Guyot system.
Italy	ITA360	220	7.99	44.65	0.19	Foot-hill slope facing S-SE, vertical trellis, transverse rows (NE-SO). Chalky loamy soil. Vine spacing: 2.8 m (between rows) x 1 m (within row): 3600 vine·ha^{-1}. Guyot pruning system, rootstock Kober 5 BB.
Germany	DEU098	195	8.05	49.22	0.17	Light slope with south exposition, soil loam-lime; plants spaced by 2 m (interrow) and 1.2 m (intrarow); about 4500 plant·ha^{-1}; Guyot pruning system; rootstock SO4.
Italy	ITA035	144	9.08	44.97	0.36	Hilly terrace with a slight east exposition (row direction SE-NW). Typical clay soil. Plants spaced by 2.5 m (interrow) 1 m (intrarow); about 4000 plants·ha^{-1}. Vines trained at classic Guyot system
Croatia	HRV041	260	16.00	45.86	0.05	South exposition, hillside, row direction S-N. Loamy-clay soil, pseudogley. Plants sopaced 2.2 m (interrow) and 1 m (intrarow); about 4500 plant·ha^{-1}. Vines trained at classic Guyot system.
Hungary	HUN007	110	17.24	46.75	0.02	South exposition, with moderate slope, row direction N-S. The soil type is a brown forest soil, type rendzina, based on a dolomite. Vine spacing of 2.9 meters between the rows and 1 meter between each plant. The training system is a vertical shoot positioning very similar to a Cordon de Royat pruning system.
Greece	GRC014	7	22.95	40.62	0.10	Vines are cordon trained and spur pruned, spaced by 2.2 (interrow) and 1.2 (intrarow), in a plane sandy-loam soil with a N-S row direction and grafted onto 110R rootstock.
Romania	ROM045	182	24.14	44.39	0.21	hilly- plane, with NE-SW exposition; soil forest brown-reddish; plants spaced by 2.2 m (interrow) and 1 m (intrarow); about 4000 plants·ha^{-1}; vines trained at bilateral cordon and Guyot on demi-high trunk
Romania	ROM06	87	26.03	44.28	0.15	plane surface with row direction N-S; soil brown-reddish; plants spaced by 2.2 m (interrow) and 1.2 m (intrarow); 3787 plants·ha^{-1}; vines trained at bilateral cordon and Guyot on demi-high trunk

Supplemental Table (SI1), continued

Country	Code	Elevation (m a.s.l.)	Longitude*	Latitude*	Minimum distance from GSOD network*	Notes
Republic of Moldova	MDA004	201	28.77	46.97	0.17	Slight slope with south exposition (row direction E-W). Typical black earth soil. Plant spaced by 3.0 m (interrow) x 1.5 m (intrarow); about 2222 plants·ha^{-1}. Vines trained at bilateral cordon.
Cyprus	CYP001	630	32.92	34.87	0.29	Vines are trained and spur-pruned on bilateral cordon system. Rows direction is E-W, and vines are spaced 2.0 m (interrow) 1.2 m (intrarow). All vines are own rooted. Soil is a sandy clay loam with 32 % clay. The average precipitation of the area is 740 mm and average temperature 14 °C.
Crimea	UKR050	28	33.65	44.85	0.19	Magarach ampelographic collection has 4120 samples. Cultivars and forms of collection grafted onto the rootstock Kober 5BB. Plants spaced by 3.0 m (interrow) 1.5 m (intrarow); about 2222 plants/ha; collection area of 16 hectares. Chestnut soils. Vines trained at bilateral horizontal cordone. slope -1o, exposition - south-west, row direction - east-west.
Georgia	GEO015	616	44.00	41.99	0.12	Skra Collection located in Inner Kartli province of Georgia. The collection was established in 2008, near the Skra village (41°58"6" North and 44°0"14" West, 640 m above sea level). The distance between rows is 2.5 m and the distance between vines is 1.5 m. The scheme of pruning is double Guyot system with 12-16 winter buds·vine^{-1}. The parcel is plain. Row direction is N-S. The type of soil is cinnamonic.
Armenia	ARM011-Merdzavan	936.66	44.40	40.18	0.13	Sandy soil with stone texture. Plants spaced by 2.7 m (inter row) 1.5 m (intra row); about 2400 plants·ha^{-1}. Vines trained fan-shaped.
Georgia	GEO038	586	44.77	41.91	0.16	Plain.Typical alluvial carbonated, deep, high skeleton, middle and heavy clay soil. Plants spaced by 2.35 m X 1.35m; about 3404 plants·ha^{-1}.Grape vine was cultivated by two side trellis system. Elevation (m asl) 580. Lighaura's collection rows of vineyard are directed from west to east, because of the wind direction
Armenia	ARM011-Tavush	1300.21	45.34	40.89	0.13	Sandy soil with stone texture. Plants spaced by 2.7 m (inter row) 1.5 m (intra row); about 2400 plants·ha^{-1}. Vines trained fan-shaped.

*decimal degrees

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PHENOTYPING TRIAL 2013
PROTOCOLS FOR PHENOTYPING BERRY ENOLOGICAL TRAITS

0. CULTIVARS SELECTION

Select only accessions identified and characterized (or in progress to be) in the framework of the Working group 1.

Note on cultivars selection. The 2012 year of work gave us important results concerning the methodology, especially thanks to the large partners' participation.

For 2013, to better describe and appreciate the phenotype, we still need replications (the same genotype should be studied in different environmental conditions, e.g.: site, year). Thus, all the participants are kindly encouraged to repeat the analysis of the same accessions phenotyped in 2012. Of course, additional accessions could be included to enlarge studied germplasm. If, for specific reasons the whole 2012 study cannot be repeated, we encourage the replication of at least some of accessions included in the 2012 phenotype records.

General remarks based on previous year experience

- Please, when sampling, be sure to select only bunches fully developed and free from any possible symptoms of diseases.
- Anthocyanin analysis should be performed only on pigmented grapes, while total phenolic analysis are recommended to be done also on white cultivars.
- We highly suggest to perform a complete record of all the indicated variables, with the purpose to limit the incomplete data.
- Please, avoid template modification
- Finally, we remind that the methodological uniformity is mandatory. For any doubt, do not hesitate to contact us.

1. PRELIMINARY RECORDS AND ACTIONS

1.1 Evaluation of yield vs. leaf area balance and possible bunch thinning

For each accession plot, before veraison, make an estimation of the yield vs. leaf area ratio. Count the bunches and estimate the leaf area of the plot.

- Yield (Y) = n° of bunches x expected bunch weight (see OIV 502 descriptors for a guide)
- Leaf area (LA) = [canopy height (m) x plot length (m) x leaf layers] – canopy open space (m^2)

If the Y/LA exceed 1 kg / m^2 consider to remove a part of the bunches to lower it in the optimal range of less 1 kg of grapes per square meter of leaf area.

1.2 Evaluation of the proper bunch microclimate

For a proper grapes ripening:

- in cool climate bunches should be sun exposed, if not remove leaves;

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- in warm climate bunches should be shaded by one leaf layer, if not please sample leaf shaded bunches.

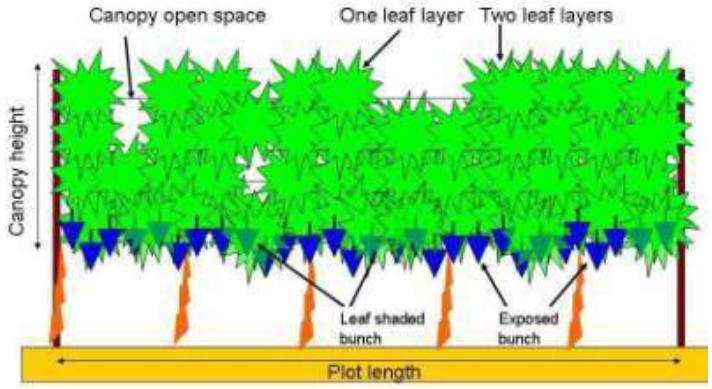

Fig. 1 - Around veraison the evaluation of the yield vs. leaf area balance and of the proper microclimate around the selected bunches for samplings should be done.

1.3 Early selection of representative bunches

At the end of veraison select at least 9 representative bunches among the ones fully developed in comparison to the expected varietal identity. Mark the bunches with a label.

1.4 Definition of ripening time

Follow weekly the sugar content by refractometric measures by collecting at least 50-100 berries from non selected bunches.

The full ripening should be defined when the concentration of sugars tends to reach stable values and just the first berries, by visual and tactile assessment of firmness and consistency, show initial symptoms of dehydration. Sampling may be anticipated to commercial harvest in relation to specific grapes attitudes (e.g. table grapes) or in case of risk of grapes mold decay.

2. SAMPLING AND ANALYSIS AT RIPENING TIME

2.1 Eno-carpological traits

- Bunch weight (6-9 representative bunches, see below)
- In triplicate on ten berry samples:
    - Total whole berry weight (see below)
    - Berry length and width (see below)
    - Total skins weight (see below)
    - Total seed number and weight (see below)

2.2 Eno-chemical traits (in triplicate)

- Juice sugars (by refractometer)
- Juice acidity (by titrating with NaOH 0.1N)

2.3 Phenolic analysis.

- Skins total antocyanins (by spectrophotometer, only on pigmented grapes)
- Skins total polyphenols (by spectrophotometer, also in white cultivars)
- Seed total polyphenols (by spectrophotometer, also in white cultivars)

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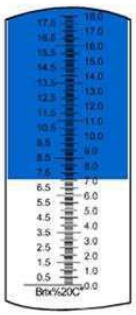
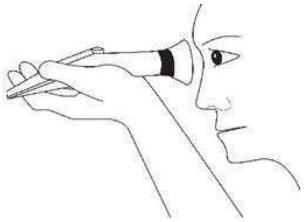
Collect the 6-9 representative bunches. Divide them in 3 samples of 2-3 bunches each. Arrived in the lab, **weigh each bunch.**

From each of the three sample, separate 10 non deformed and normally sized berries taken from the middle part of the representative bunches, for the phenolic analysis *(to be sure, it's better to keep 15-20, in case of problems)*. Keep the replications separated.
Press the rest of the samples (keeping the replications separated) to obtain juice for the sugar and titratable acidity content.

3 ANALYTICAL METHODS FOR THE JUICE SUGAR CONTENT AND TITRATABLE ACIDITY

3.1 Sugar content Read by a refractometer.





3.2 Titratable acidity

In a baker put 7.5 mL of grape juice, then, add some distilled water and few drops of Bromothymol blue. Finally, proceed with the titration using NaOH 0.1 N until pH 7 (measured by pHmeter or by Bromothymol blue indicator change of color).

The mL of NaOH used for the titration correspond to the juice titratable acidity expressed in g/l of tartaric acid (due to the fact that the equivalent weight of tartaric acid is 75).

If you use the Bromothymol blue, you have just to add few drops. Because it is an indicator, an exact volume is not necessary. It is important to exactly measure the 7.5 mL, but to simplify the analysis, you can add pure water without any problem (for example, to allow the measurement with the pHmeter) after the sample measurement of 7.5 mL. Avoid the addition of too much water: a bigger volume need more time to stabilize the pH and complicates the analysis.

If you use the Bromothymol blue, your solution is at pH 7 when its color appears green. This indicator appears yellow at acidic pH and blue at basic pH.

Calibrating the visual detection of pH 7 by Bromothymol green color: if you do not have a pHmeter, the color can be checked using a tartaric acid solution.

Prepare a 5 $g \cdot L^{-1}$ solution of tartaric acid in pure water and titrate 7.5 mL. Adding 5 mL of NaOH 0.1N you will obtain a pH=7 and, thus, the reference "Bromothymol blue" green color. This method is valid also to check the NaOH concentration.

The anthocyanins presence make a little bit more difficult to detect the change in color, but after few samples, you will easily succeed.

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3.3 Berry size, partition and analytical methods for phenolic content

Sample preparation: each replication of 10 berries should be analyzed separately.

Weigh the 10 berries. With a caliper measure **length and width of each berry**.

Separate the 10 skins by squeezing the pulp in a baker by pressing the berry between thumb and index finger. Dry a little bit the skins using a soft laboratory paper without losing the anthocyanins.

Weigh the 10 skins.

Put the 10 berry skins in 20 mL of chloridric ethanol (70% Ethanol, 29% water, 1% concentrate chloridric acid–37%) and leave in a dark place for one night.

Separate the seeds from the pulp, of the same 10 berries. **Count the number of seeds**. **Weigh the total seeds** of the ten berries. Put them in 20 mL of chloridric ethanol (70% Ethanol, 29% water, 1% concentrate [37%] chloridric acid) and leave in a dark place for one night (16-19 hours). The next morning, separate the solid parts (skins or seeds) from the extracts and proceed with the assays.

Note.
When you start to prepare a sample, try to complete it as quickly as possible. Phenolic compounds oxidize very fast. Sample by sample, just after the weighing of skins and seeds put them immediately in the chloridric ethanol. Do not worry if the extraction timing between the first and the last sample of the day differ for a few hours. Because we have to work with fresh samples during the
short ripening time, the suggestion to optimize the work is to collect and prepare the samples in the afternoon, and do the analysis the next morning. If you prefer to perform the phenolic assays all together, you can freeze the extracts (after the separation of the solid parts) at -20°C for a few days to obtain a higher number of samples to be analyzed.

Anthocyanin content. Read the absorbance of the skin extracts at 540 nm with 1 cm optical path (traditional cuvettes; because we work in the visible spectra, you can use the less expensive plastic ones). The maximum absorption signal of anthocyanins are obtained at a wavelength of 540 nm in this solvent. The measurement at this wavelength will decrease the errors in the pigment content estimation. The blank is the extraction solvent (chloridric ethanol).

To produce a measurement, you should first have an absorbance included in the range 0,3-0,7. A value of absorbance up to 1 is acceptable. If you have a higher value, dilute the skin extract with chloridric ethanol (70% Ethanol, 29% water, 1% concentrate chloridric acid–37%) until having the reading in the proper absorbance range.

Calculate the anthocyanin content using the following formula:

$$\text{Total anthocyanins } (mg \cdot L^{-1}) = E_{540,\,1\,cm} \times 16.17 \times d$$

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where $E_{540,\ 1\ cm}$ = absorbance at 540 nm; d = dilution

Phenolic content of skins and seeds (to measure separately from the two extracts)

Put in a 10 mL flask approximately* 2.5 mL of water and add 0.5 mL of (diluted**) extract.

Notes
** It is not important to measure exactly the volume; in the end the flask will be filled up to 10 mL.*
***At the end of the procedure your solution should have an absorbance included in the range 0.3-0.7. A value of absorbance up to 1 is acceptable. If you have a higher value, repeat the procedure with a diluted extract with chloridric ethanol (70% Ethanol, 29% water, 1% concentrate chloridric acid–37%) until having the reading in the proper absorbance range.*

Add 0.5 mL of Folin Ciocalteu (it is a mixture of phosphomolybdate and phosphotungstate which, reacting with the phenolic compounds, is reduced to obtain a solution blue in color).

After 3-5 minutes add 2 mL of 10% Na_2CO_3 .

Fill the flask up to 10 mL with water.

After 90 minutes read the absorbance at 700 nm (compared with a blank made in the same way, but with water instead of the tissue extract).

Total polyphenols will be calculated as catechin ($mg \cdot L^{-1}$) applying a simple mathematical formula:

$$\text{catechin } (mg \cdot L^{-1}) = 186.5 \times E_{700} \times$$

d where E_{700} = absorbance at 700 nm; d = dilution

4. FINAL REMARKS

With this protocols one person well organized can manage to do around 7-10 accessions/day, thus, around 35-50 accessions/week. By collecting all the data we can express the results in concentration and amount on berry, skin and seed basis, as well as referred to berry surface and volume, in relation to different objectives (physiological / enological / descriptive). Anyway, please, keep all the data (absorptions, dilutions …) and not only the elaborated results.

Inserting the data in the attached Excel file, you should directly have your results. Only the blue column needs to be completed, the white ones will be directly filled in.

Additional column in the Excel template: in order to make easier the identification of possible synonyms, the "VIVC variety number" has been added in the template (to select it please see: http://www.vivc.de/).

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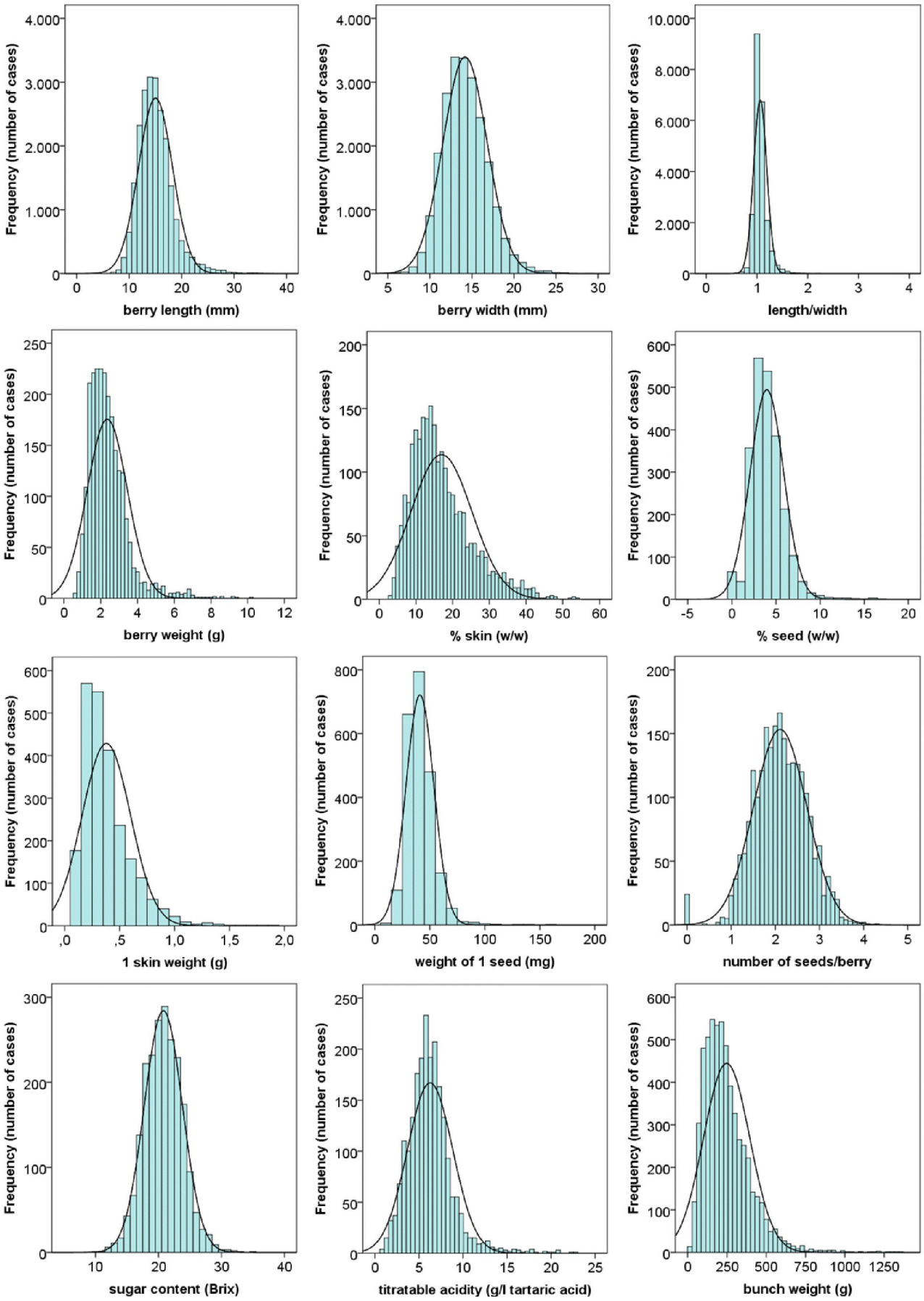
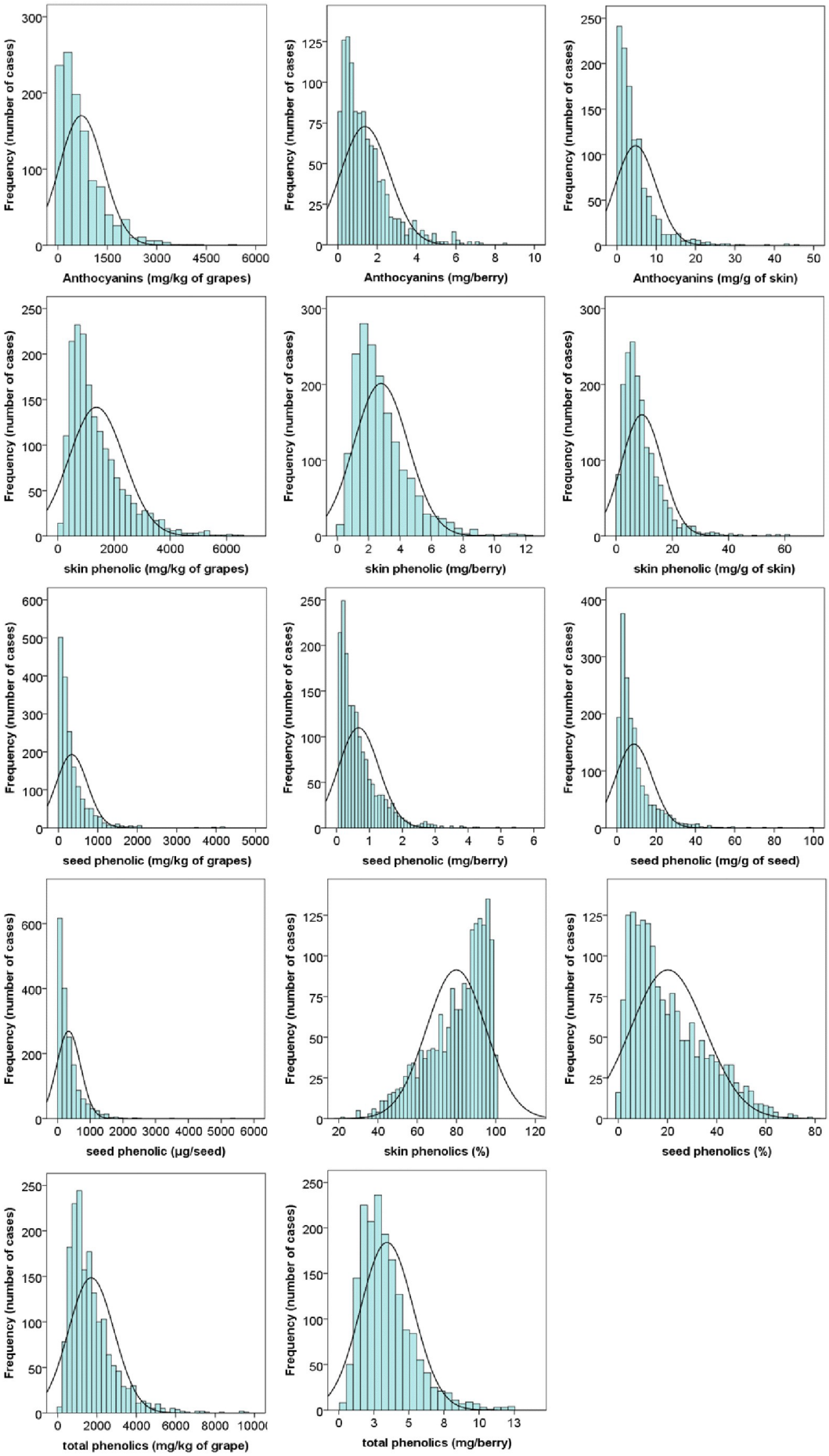
Supplemental Table (SI3)

Agrometeorological indexes applied to meteorological series

Index	Type	Description	Reference
Winkler	Thermal resource	Daily accumulation of thermal resources for plant development	Amerine and Winkler 1944
Huglin	Thermal resource	Daily accumulation of thermal resources for plant development	Huglin 1986
NHH	Thermal resource	Hourly accumulation of thermal resources for plant development	Mariani *et al.* 2012
LHH	Thermal stress	Hourly accumulation of thermal conditions of stress due to under-optimal temperatures	Mariani *et al.* 2012
HHH	Thermal stress	Hourly accumulation of thermal conditions of stress due to over-optimal temperatures	Mariani *et al.* 2012
Water	Water stress	Daily accumulation of water stress condition (1-WLF) derived from a single reservoir water balance (AWC = 150 mm)	Cola *et al.* 2014



Supplemenal Figure (SI4): Frequency distribution of the traits: berry length; berry width; length/width; berry weight; % skin; % seed; skin weight; seed weight; number of seeds·berry^{-1}; sugar content; titratable acidity; bunch weight.



Supplemental Figure (SI4), continued: Frequency distribution of the traits related to the polyphenolic contents in grapes.

Supplemental Table (SI5)

Pearson's correlations among the considered traits. Stars indicate the two tails significance (** = 0.01; * = 0.05)

	Bunch weight (g)	Berry length (mm)	Berry width (mm)	Length/width	Sugar content (Brix)	Titratable acidity (g·L^{-1} tartaric acid)	Berry weight (g)	% Skin (w/w)	% Seed (w/w)	1 Skin weight (g)	Number of seeds·berry^{-1}	Weight of 1 seed (mg)	Anthocyanins (mg·kg^{-1} of grapes)
Bunch weight (g)	1	**0.379****	**0.368****	0.135**	-0.256**	-0.108**	**0.414****	-0.244**	-0.266**	0.089**	0.109**	0,040	-0.215**
Berry length (mm)	0.379**	1	**0.848****	**0.515****	-0.161**	-0.058*	**0.716****	-0.122**	**-0.462****	0.338**	0,012	0.253**	-0.313**
Berry width (mm)	0.368**	0.848**	1	-0,001	-0.170**	-0,039	**0.671****	-0.183**	**-0.442****	0.267**	0,039	0.223**	-0.346**
Length/width	0.135**	0.515**	-0,001	1	-0,010	-0,038	0.280**	0.085**	-0.179**	0.234**	-0,046	0.138**	-0,004
Sugar content (Brix)	-0.256**	-0.161**	-0.170**	-0,010	1	0,001	-0.279**	0.124**	0.170**	-0.114**	0,023	-0,036	0.269**
Titratable acidity (g·L^{-1} tartaric acid)	-0.108**	-0.058*	-0,039	-0,038	0,001	1	-0,030	0.173**	0.072**	0.126**	-0,033	0.106**	0.078*
Berry weight (g)	0.414**	0.716**	0.671**	0.280**	-0.279**	-0,030	1	-0.238**	**-0.502****	**0.391****	0.049*	**0.407****	-0.315**
% Skin (w/w)	-0.244**	-0.122**	-0.183**	0.085**	0.124**	0.173**	-0.238**	1	0.236**	**0.709****	-0.056**	0.106**	0.132**
% Seed (w/w)	-0.266**	-0.462**	-0.442**	-0.179**	0.170**	0.072**	-0.502**	0.236**	1	-0.171**	**0.418****	0.095**	0.261**
1 Skin weight (g)	0.089**	0.338**	0.267**	0.234**	-0.114**	0.126**	0.391**	0.709**	-0.171**	1	0,003	0.345**	-0.147**
Number of seeds/berry	0.109**	0,012	0,039	-0,046	0,023	-0,033	0.049*	-0.056**	0.418**	0,003	1	-0.236**	0,051
Weight of 1 seed (mg)	0,040	0.253**	0.223**	0.138**	-0,036	0.106**	0.407**	0.106**	0.095**	0.345**	-0.236**	1	-0.143**
Anthocyanins (mg·kg^{-1} of grapes)	-0.215**	-0.313**	-0.346**	-0,004	0.269**	0.078*	-0.315**	0.132**	0.261**	-0.147**	0,051	-0.143**	1
Anthocyanins (mg·berry^{-1})	0,013	-0,037	-0.089*	0.099**	0.185**	0.075*	0.069*	0,024	-0,005	0,034	0.105**	0,019	0.835**
Anthocyanins (mg·g^{-1} of skin)	-0,065	-0.250**	-0.257**	-0,044	0.131**	-0,007	-0.160**	-0.253**	0.114**	-0.337**	0.084**	-0.152**	0.831**
Skin phenolic (mg·kg^{-1} of grapes)	-0.210**	-0.292**	-0.250**	-0.142**	0.323**	-0.076**	-0.398**	0.093**	0.343**	-0.226**	0,033	-0.213**	0.623**
Skin phenolic (mg·berry^{-1})	0,017	0.095**	0.098**	0,038	0.189**	-0.069**	0.145**	-0.058*	-0.057*	0,039	0.092**	0,037	0.449**
Skin phenolic (mg/g of skin)	-0,036	-0.185**	-0.143**	-0.125**	0.163**	-0.141**	-0.178**	-0.387**	0.123**	-0.475**	0,031	-0.207**	0.457**
Seed phenolic (mg·kg^{-1} of grapes)	-0.137**	-0.275**	-0.237**	-0.158**	0.090**	0,004	-0.295**	-0.083**	0.277**	-0.297**	-0.048*	-0.173**	0,052
Seed phenolic (mg·berry^{-1})	-0,032	-0,018	0,002	-0,040	0,029	0,024	0.073**	-0.213**	-0,030	-0.160**	-0,035	0,027	-0.112**
Seed phenolic (mg·g^{-1} of seed)	-0.079**	-0.115**	-0.083**	-0.095**	0,019	-0,020	-0.070**	-0.211**	-0.132**	-0.246**	-0.250**	-0.157**	-0.077**
Seed phenolic (µg·seed^{-1})	-0,055	0,005	0,013	-0,016	0,035	0,010	0.077**	-0.200**	-0.156**	-0.154**	-0.323**	0.116**	-0.106**
Skin phenolics (%)	-0,048	0.065*	0,040	0.066*	0.121**	-0.060*	0,017	0.204**	-0,016	0.190**	0,017	0,000	0.298**
Seed phenolics (%)	0,048	-0.065*	-0,040	-0.066*	-0.121**	0.060*	-0,017	-0.204**	0,016	-0.190**	-0,017	0,000	-0.298**
Total phenolics (mg·kg^{-1} of grape)	-0.216**	-0.335**	-0.285**	-0.174**	0.300**	-0.067**	-0.432**	0.052*	0.382**	-0.289**	0,022	-0.237**	0.545**
Total phenolics (mg·berry^{-1})	0,013	0.088**	0.096**	0,024	0.185**	-0.070**	0.160**	-0.123**	-0.060*	-0,014	0.089**	0,046	0.385**

Supplemental Table (SI5), continued

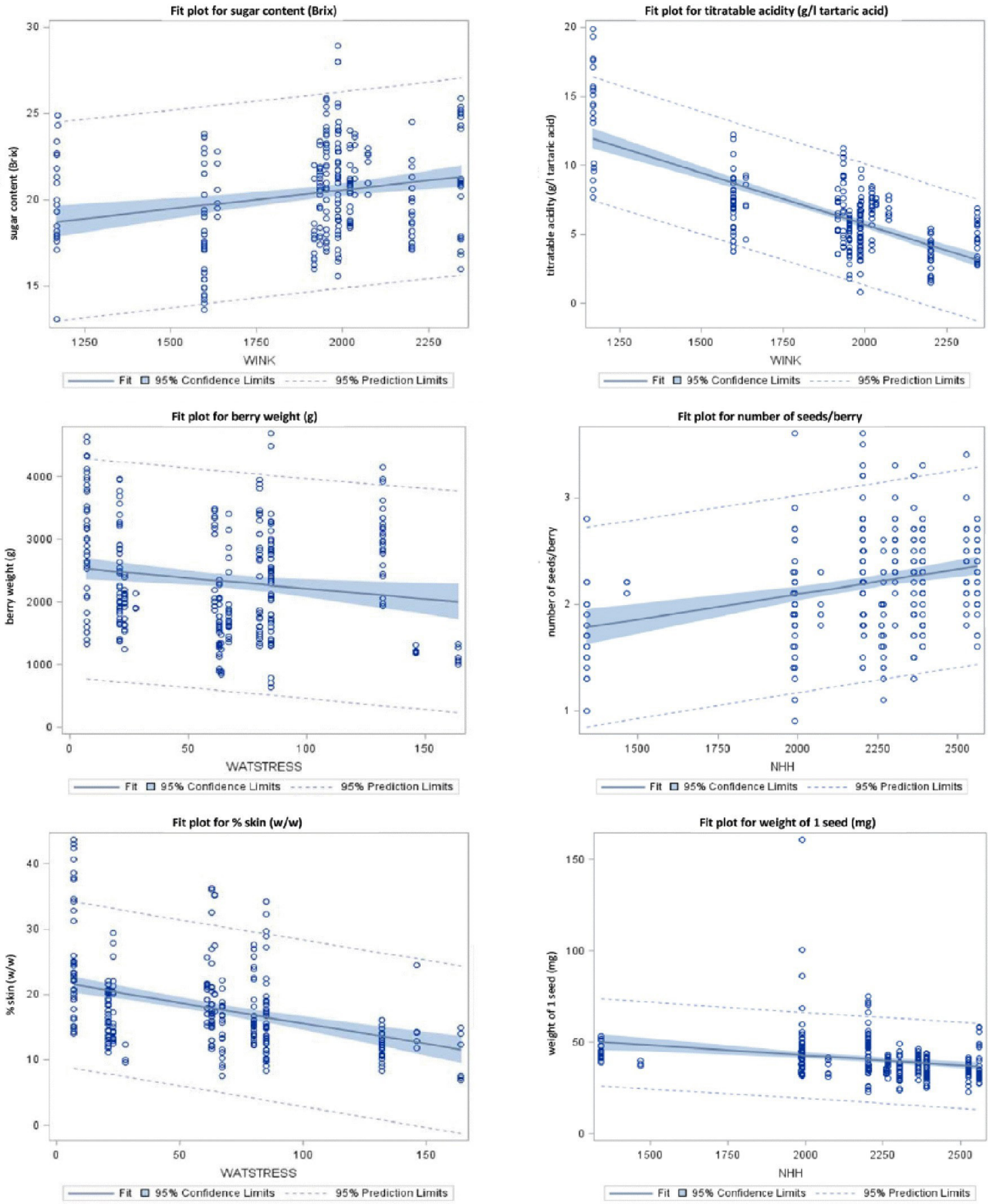
	Anthocyanins (mg·berry^{-1})	Anthocyanins (mg·g^{-1} of skin)	skin phenolic (mg·kg^{-1} of grapes)	skin phenolic (mg·berry^{-1})	skin phenolic (mg·g^{-1} of skin)	seed phenolic (mg·kg^{-1} of grapes)	seed phenolic (mg·berry^{-1})	seed phenolic (mg·g^{-1} of seed)	seed phenolic (µg·seed^{-1})	skin phenolics (%)	seed phenolics (%)	total phenolics (mg·kg^{-1} of grape)	total phenolics (mg·berry^{-1})
Bunch weight (g)	0,013	-0,065	-0.210**	0,017	-0,036	-0.137**	-0,032	-0.079**	-0,055	-0,048	0,048	-0.216**	0,013
Berry length (mm)	-0,037	-0.250**	-0.292**	0.095**	-0.185**	-0.275**	-0,018	-0.115**	0,005	0.065*	-0.065*	-0.335**	0.088**
Berry width (mm)	-0.089*	-0.257**	-0.250**	0.098**	-0.143**	-0.237**	0,002	-0.083**	0,013	0,040	-0,040	-0.285**	0.096**
Length/width	0.099**	-0,044	-0.142**	0,038	-0.125**	-0.158**	-0,040	-0.095**	-0,016	0.066*	-0.066*	-0.174**	0,024
Sugar content (Brix)	0.185**	0.131**	0.323**	0.189**	0.163**	0.090**	0,029	0,019	0,035	0.121**	-0.121**	0.300**	0.185**
Titratable acidity (g·L^{-1} tartaric acid)	0.075*	-0,007	-0.076**	-0.069**	-0.141**	0,004	0,024	-0,020	0,010	-0.060*	0.060*	-0.067**	-0.070**
Berry weight (g)	0.069*	-0.160**	**-0.398****	0.145**	-0.178**	-0.295**	0.073**	-0.070**	0.077**	0,017	-0,017	**-0.432****	0.160**
% Skin (w/w)	0,024	-0.253**	0.093**	-0.058*	**-0.387****	-0.083**	-0.213**	-0.211**	-0.200**	0.204**	-0.204**	0.052*	-0.123**
% Seed (w/w)	-0,005	0.114**	0.343**	-0.057*	0.123**	0.277**	-0,030	-0.132**	-0.156**	-0,016	0,016	**0.382****	-0.060*
1 Skin weight (g)	0,034	-0.337**	-0.226**	0,039	**-0.475****	-0.297**	-0.160**	-0.246**	-0.154**	0.190**	-0.190**	-0.289**	-0,014
Number of seeds/berry	0.105**	0.084**	0,033	0.092**	0,031	-0.048*	-0,035	-0.250**	-0.323**	0,017	-0,017	0,022	0.089**
Weight of 1 seed (mg)	0,019	-0.152**	-0.213**	0,037	-0.207**	-0.173**	0,027	-0.157**	0.116**	0,000	0,000	-0.237**	0,046
Anthocyanins (mg·kg^{-1} of grapes)	**0.835****	**0.831****	**0.623****	**0.449****	**0.457****	0,052	-0.112**	-0.077**	-0.106**	0.298**	-0.298**	**0.545****	**0.385****
Anthocyanins (mg·berry^{-1})	1	**0.792****	**0.454****	**0.632****	**0.411****	-0.122**	-0.120**	-0.147**	-0.127**	**0.369****	**-0.369****	**0.342****	**0.553****
Anthocyanins (mg·g^{-1} of skin)	0.792**	1	**0.447****	**0.399****	**0.610****	0.078**	-0,024	0,014	-0,027	0.140**	-0.141**	**0.406****	**0.368****
Skin phenolic (mg·kg^{-1} of grapes)	0.454**	0.447**	1	**0.746****	**0.786****	0.307**	0.069**	0.140**	0.057*	0.323**	-0.323**	**0.946****	**0.706****
Skin phenolic (mg·berry^{-1})	0.632**	0.399**	0.746**	1	**0.685****	0,016	0.090**	0,046	0.063**	**0.414****	**-0.414****	**0.634****	**0.945****
Skin phenolic (mg/g of skin)	0.411**	0.610**	0.786**	0.685**	1	0.320**	0.184**	0.267**	0.175**	0.168**	-0.168**	**0.770****	**0.688****
Seed phenolic (mg·kg^{-1} of grapes)	-0.122**	0.078**	0.307**	0,016	0.320**	1	**0.759****	**0.774****	**0.663****	**-0.625****	**0.625****	**0.598****	0.264**
Seed phenolic (mg·berry^{-1})	-0.120**	-0,024	0.069**	0.090**	0.184**	0.759**	1	**0.842****	**0.876****	**-0.724****	**0.724****	0.315**	**0.410****
Seed phenolic (mg·g^{-1} of seed)	-0.147**	0,014	0.140**	0,046	0.267**	0.774**	0.842**	1	**0.901****	**-0.654****	**0.654****	**0.381****	0.318**
Seed phenolic (µg·seed^{-1})	-0.127**	-0,027	0.057*	0.063**	0.175**	0.663**	0.876**	0.901**	1	**-0.661****	**0.661****	0.273**	0.345**
Skin phenolics (%)	0.369**	0.140**	0.323**	0.414**	0.168**	-0.625**	-0.724**	-0.654**	-0.661**	1	**-10.000****	0.059*	0.137**
Seed phenolics (%)	-0.369**	-0.141**	-0.323**	-0.414**	-0.168**	0.625**	0.724**	0.654**	0.661**	-10.000**	1	-0.059*	-0.137**
Total phenolics (mg·kg^{-1} of grape)	0.342**	0.406**	0.946**	0.634**	0.770**	0.598**	0.315**	0.381**	0.273**	0.059*	-0.059*	1	**0.686****
Total phenolics (mg·berry^{-1})	0.553**	0.368**	0.706**	0.945**	0.688**	0.264**	0.410**	0.318**	0.345**	0.137**	-0.137**	0.686**	1

Supplemental Table (SI6)

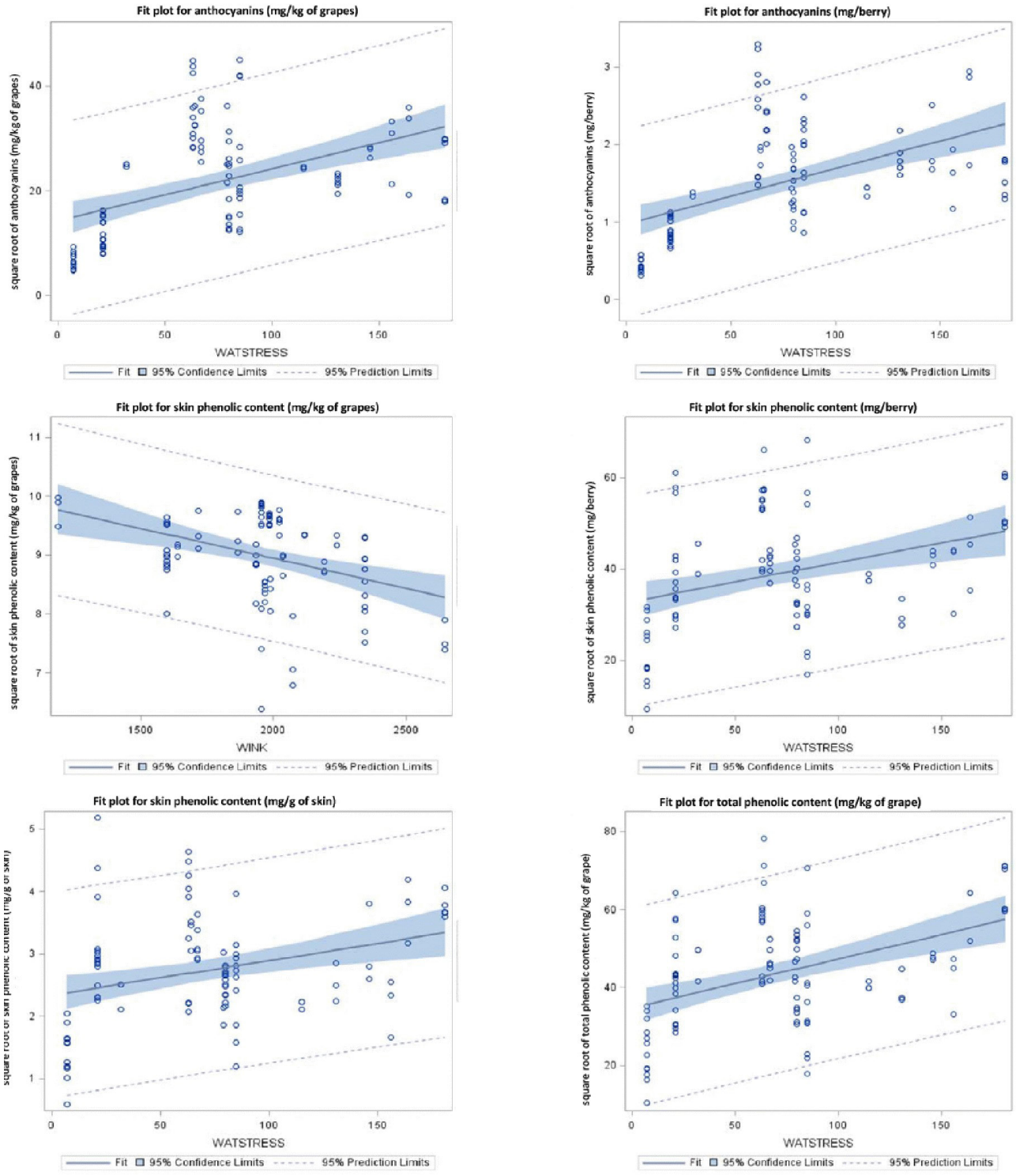
Comparison of models involving climatic indexes (A and B) against a model without them but with categorical site and year information interaction (C)
Model (A): y = site + year + cultivar + Winkler + NHH + Precipitation Index + Water Stress + error term
Model (B): y = cultivar + single_climatic_index + cultivar * single_climatic_index + error term
Model (C): y = site + year + cultivar + site * year + site * cultivar + cultivar * year + error term
Significance levels: *** = <0.001; ** = < 0.01; * = < 0.05; ns = not significant

All cultivars		Sugar content (Brix)	Titratable acidity ($g \cdot L^{-1}$ tartaric acid)	Berry weight (mg)	% Skin (w/w)	Number of seeds·berry^{-1}	Weight of 1 seed (mg)
GLM model (A)	r2 model with all climatic indexes	0.578	0.835	0.823	0.626	0.419	0.495
GLM model (A)	Significance level	***	***	***	***	***	***
GLMSELECT model (A)	First retained climatic index	Winkler	Water Stress	NHH	Winkler	NHH	not retained
GLMSELECT model (A)	r2 model with first climatic index	0.490	0.817	0.809	0.608	0.086	--
GLMSELECT model (A)	Significance level	**	***	***	**	ns	--
GLM model (B)	r2 First retained climatic index in (A)	0.608	0.573	0.770	0.590	0.502	--
GLM model (B)	Significance level climatic index	*	ns	ns	*	*	--
GLM model (B)	Significance level cultivar * climatic index	***	***	***	***	***	--
GLM model (C)	r2 model without climatic indexes w/ interactions	0.860	0.939	0.941	0.827	0.694	0.686
GLM model (C)	Significance level	***	***	***	***	***	***

Red, black, blue black, dark red, violet cultivars		Anthocyanins ($mg \cdot kg^{-1}$ of grapes)	Anthocyanins ($mg \cdot g^{-1}$ of skin)	Skin phenolics (%)	Skin phenolics ($mg \cdot kg^{-1}$ of grapes)	Skin phenolics ($mg \cdot g^{-1}$ of skin)	Total phenolics ($mg \cdot kg^{-1}$ of grape)
GLM model (A)	r2 model with all climatic indexes	0.837	0.793	0.662	0.836	0.784	0.870
GLM model (A)	Significance level	***	***	***	***	***	***
GLMSELECT model (A)	First retained climatic index	Water stress	Water stress	Winkler	Water stress	Water stress	Water stress
GLMSELECT model (A)	r2 model with first climatic index	0.707	0.726	0.341	0.785	0.727	0.855
GLMSELECT model (A)	Significance level	**	***	***	***	***	**
GLM model (B)	r2 First retained climatic index in (A)	0.494	0.354	0.398	0.481	0.500	0.584
GLM model (B)	Significance level climatic index	***	***	**	**	*	***
GLM model (B)	Significance level cultivar * climatic index	***	ns	ns	*	ns	**
GLM model (C)	r2 model without climatic indexes w/ interactions	0.941	0.920	0.886	0.934	0.892	0.948
GLM model (C)	Significance level	***	***	***	***	***	***



Supplemental Figure (SI7): Regressions between climatic variables and traits, according to the simplest variance model (B): y = Single climatic index + error term. 3A: All cultivars; 3B: Red, black, blue black, dark red violet cultivars.

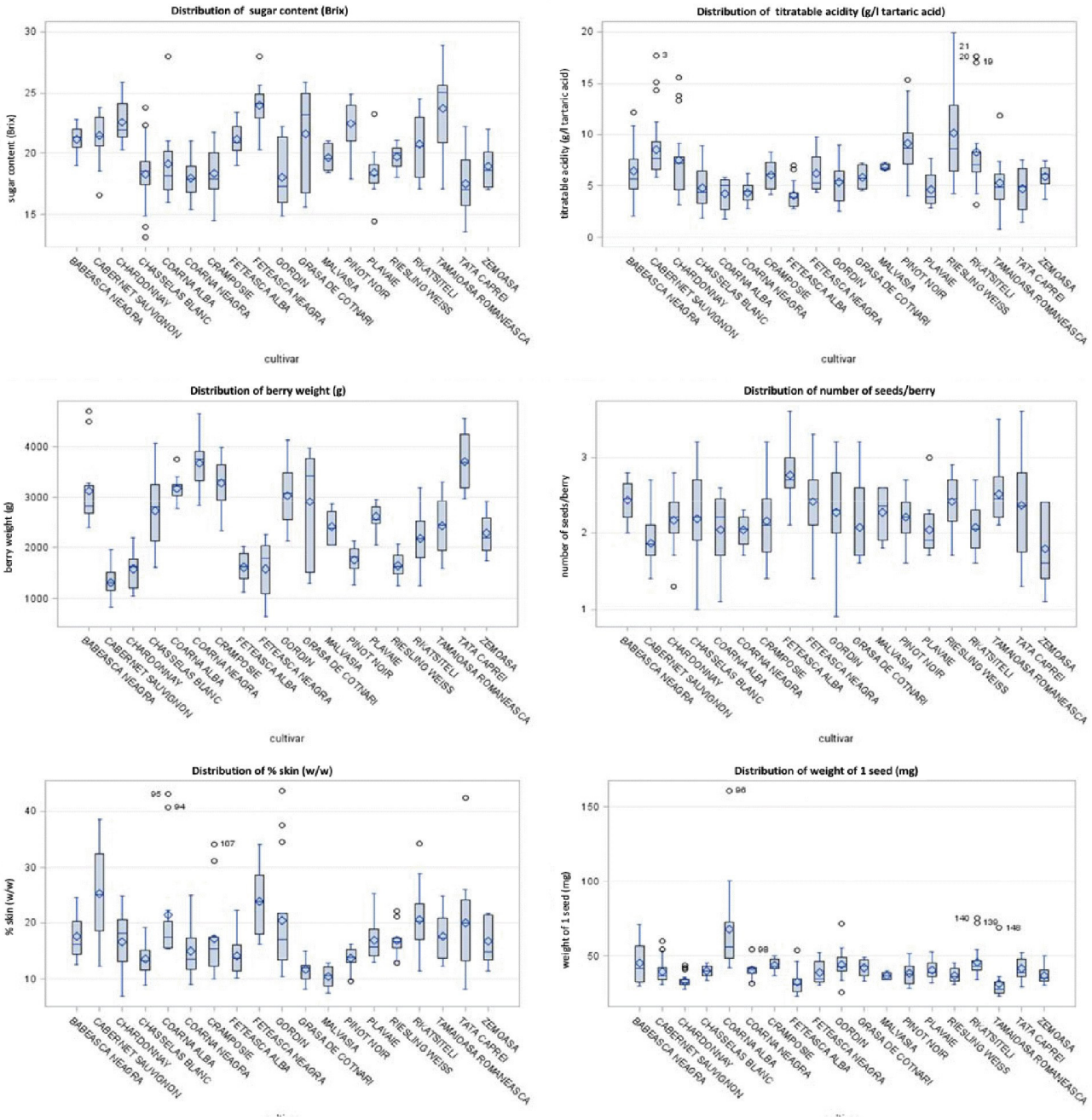


Supplemental Figure (SI7), contiued: Regressions between climatic variables and traits, according to the simplest variance model (B): y = Single climatic index + error term. 3A: All cultivars; 3B: Red, black, blue black, dark red violet cultivars.

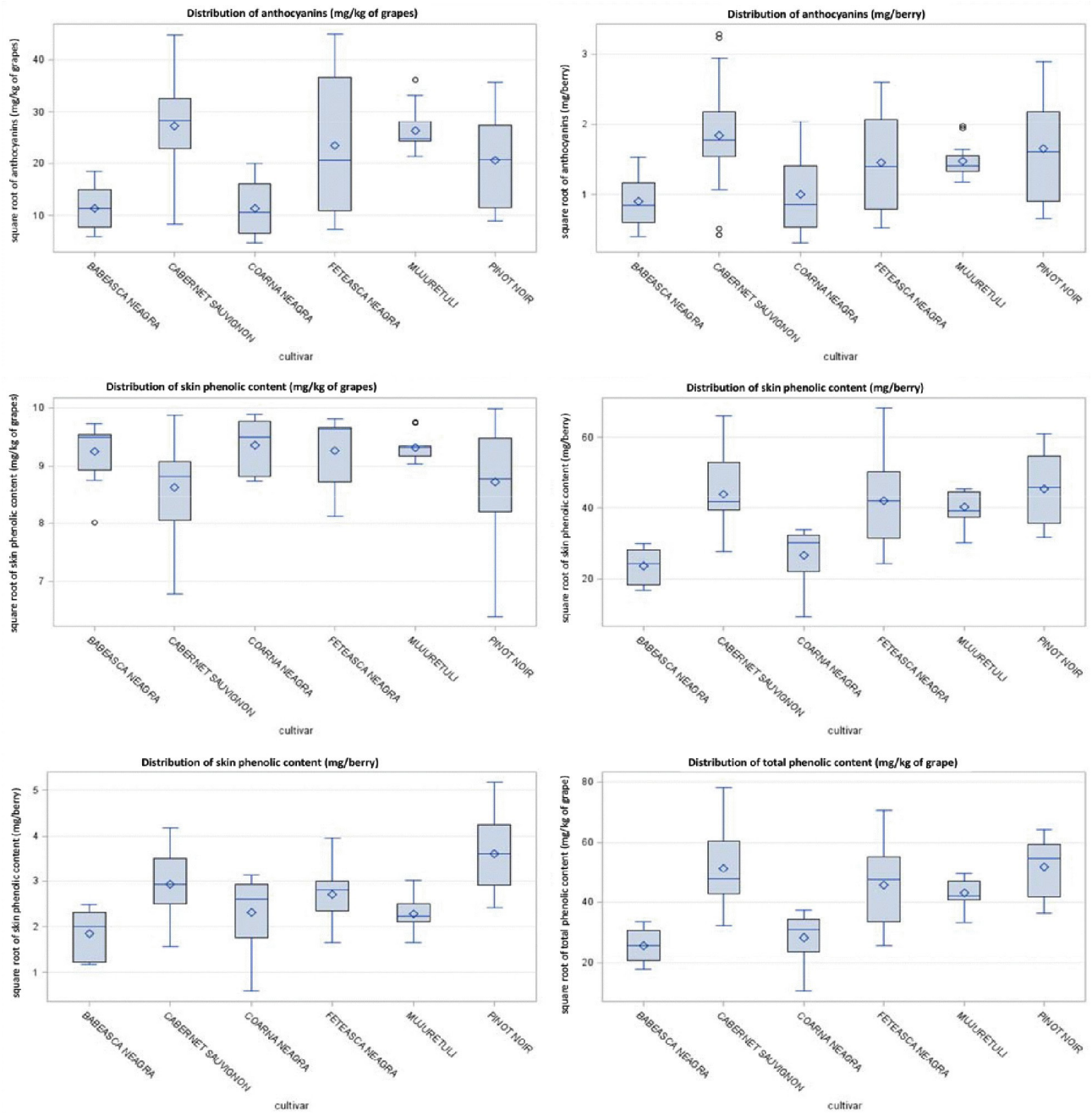
Supplemental Table (SI8)

Significance of the effects according to the complete mixed model with interactions.
Model (C): y = site + year + cultivar + site * year + site * cultivar + cultivar * year + error term

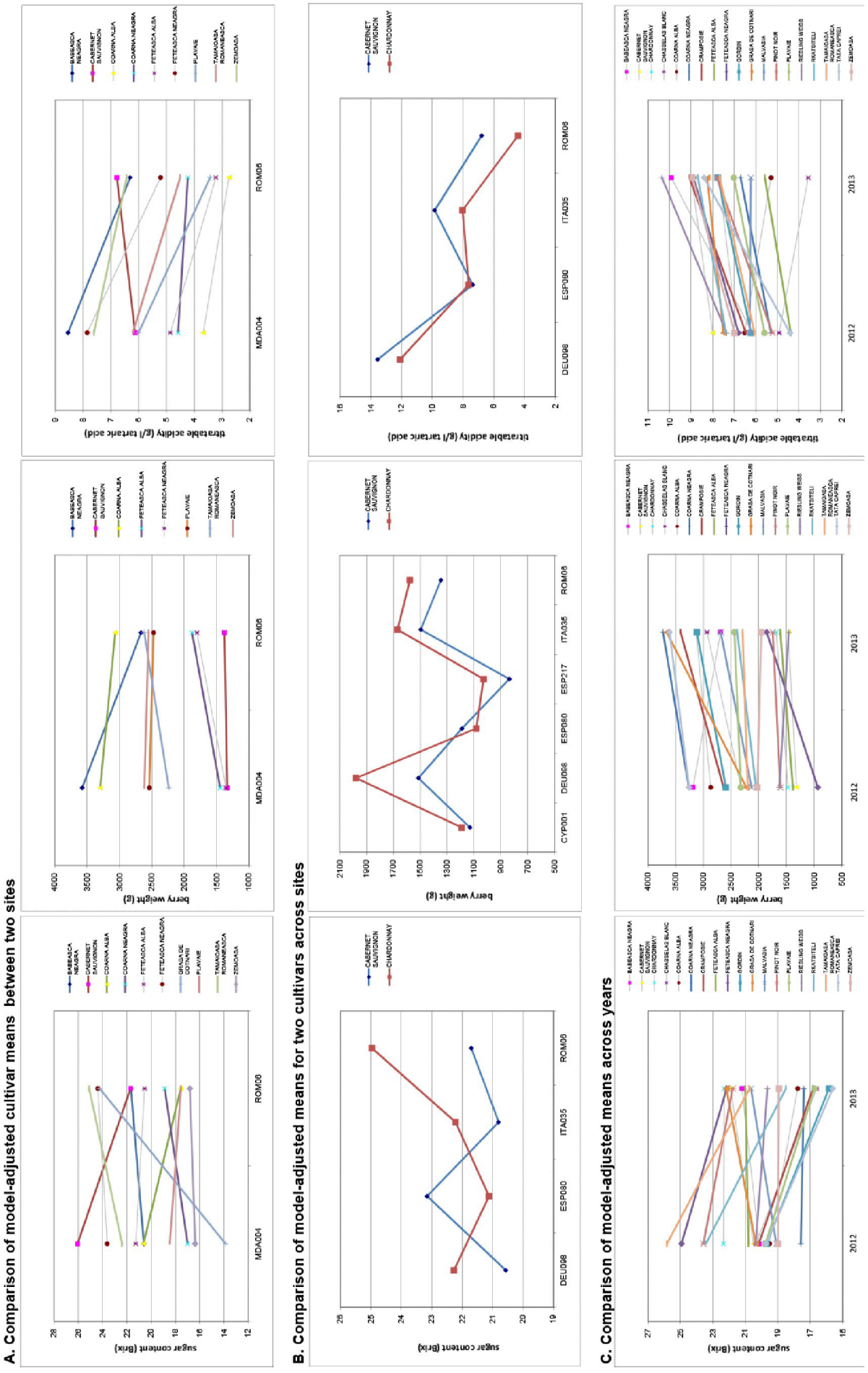
All cultivars		Sugar content (Brix)		Titratable acidity ($g \cdot L^{-1}$ tartaric acid)		Berry weight (mg)		% Skin (w/w)		Number of seeds·berry^{-1}		Weight of 1 seed (mg)	
	DF	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*
Whole model	76	15.87	<.0001	39.8	<.0001	40.92	<.0001	12.3	<.0001	5.86	<.0001	5.62	<.0001
Site	6	3.27	*0.0043*	42.25	*<.0001*	10.14	*<.0001*	28.08	*<.0001*	4.64	*0.0002*	7.77	*<.0001*
Cultivar	18	**23.89**	*<.0001*	26.25	*<.0001*	71.05	*<.0001*	20.31	*<.0001*	6.02	*<.0001*	9.65	*<.0001*
Year	1	9.16	*0.0028*	39.09	*<.0001*	19.91	*<.0001*	15.78	*<.0001*	1.76	*0.1865*	0.08	*0.7815*
Site*cultivar	27	8.19	*<.0001*	6.19	*<.0001*	8.58	*<.0001*	4.05	*<.0001*	4.78	*<.0001*	2.46	*0.0002*
Cultivar*year	18	5.21	*<.0001*	5.47	*<.0001*	7.18	*<.0001*	8.54	*<.0001*	3.02	*<.0001*	2.9	*0.0001*
Site*year	6	16.97	*<.0001*	14.67	*<.0001*	16.69	*<.0001*	11.82	*<.0001*	4.02	*0.0008*	1.82	*0.0962*
red, black, blue black, dark red, violet cultivars		anthocyanins ($mg \cdot kg^{-1}$ of grapes)		Anthocyanins ($mg \cdot g^{-1}$ of skin)		Skin phenolics (%)		Skin phenolics ($mg \cdot kg^{-1}$ of grapes)		Skin phenolics ($mg \cdot g^{-1}$of skin)		Total phenolics ($mg \cdot kg^{-1}$ of grape)	
	DF	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*	F Value	*Pr > F*
Whole model	31	36.22	<.0001	26.08	<.0001	17.54	<.0001	32.26	<.0001	18.76	<.0001	41.46	<.0001
Site	6	27.41	*<.0001*	21.56	*<.0001*	22.77	*<.0001*	29.88	*<.0001*	15.23	*<.0001*	29.01	*<.0001*
Cultivar	18	39.43	*<.0001*	11.82	*<.0001*	29.58	*<.0001*	47.78	*<.0001*	13.92	*<.0001*	61.17	*<.0001*
Year	1	11.43	*0.0012*	9.69	*0.0027*	2.13	*0.1494*	36.95	*<.0001*	17	*0.0001*	54.85	*<.0001*
Site*cultivar	27	5.09	*0.0002*	8.3	*<.0001*	11.38	*<.0001*	10.61	*<.0001*	7.5	*<.0001*	9.28	*<.0001*
Cultivar*year	18	18.57	*<.0001*	10.29	*<.0001*	5.59	*0.0006*	13.37	*<.0001*	8.42	*<.0001*	15.94	*<.0001*
Site*year	6	11.56	*<.0001*	17.75	*<.0001*	25.9	*<.0001*	9.13	*<.0001*	10.78	*<.0001*	7.85	*<.0001*



Supplemental Figure (SI9): Distribution of the means, for each variety studied on multiple sites and years, adjusted by the complete model of variance analysis, with interactions. Model (C): y = site + year + cultivar + site * year + site * cultivar + cultivar * year + error term. 4A: All cultivars; 4B: Red, black, blue black, dark red violet cultivars.



Supplemental Figure (SI9), continued: Distribution of the means, for each variety studied on multiple sites and years, adjusted by the complete model of variance analysis, with interactions. Model (C): y = site + year + cultivar + site * year + site * cultivar + cultivar * year + error term. 4A: All cultivars; 4B: Red, black, blue black, dark red violet cultivars.



Supplemental Figure (SI10): Example of site x cultivar interaction for the variable "sugar content". Complete model of analysis of variance. Model (C): y = site + year + cultivar + site * year + site * cultivar + cultivar * year + error term.