



Pre-harvest temperature effects on internal berry quality

**International Black Currant Association
Waldenburg 4th to 6th June 2013**



Many thanks

to all people supporting the blackcurrant trials at Geisenheim:

in the field: Institute of Pomology

in the lab: Institute of Wine Analytic and Beverage Technology

Hochschule Geisenheim University

**Located:
in the Rhine valley, west of Frankfurt**



Comparison of 23 varieties in 2003 to 2005

Correlation coefficients between TEAC value, total phenols, total anthocyanins and ascorbic acid with yield, berry weight and temperature units

	Yield	Berry weight	Sum of temperature units ¹
TEAC	-0.34**	-0.43**	0.36**
Total phenols	-0.34**	-0.48**	0.33*
Total anthocyanins	ns	-0.38**	0.51**
Ascorbic acid	ns	ns	ns

¹) temperature units calculated according the scheme of Lantin (1986) – period color change until harvest

Krüger et al. 2011, J. Appl. Bot and Food Qual.

Comparison of 23 varieties in 2003 to 2005

Principal component analysis (PCA) showed the following factor loadings

	PC 1	PC 2
Cultivar	- 0.437	0.263
Ascorbic acid	0.347	- 0.719
Total phenols	0.899	- 0.021
Total anthocyanins	0.693	0.432
TEAC	0.876	0.098
Yield	- 0.448	0.305
Berry weight	- 0.635	0.272
Sum of temperature units ¹	0.436	0.705
Variance explained by PC (%)	39.5	18.1

¹) temperature units calculated according the scheme of Lantin (1986) – period color change until harvest

How is the influence of temperature in a long time experiment

- on phenological data like time of flowering, beginning of ripening and harvest?

How is the effect of pre-harvest temperature in a long time experiment

- on internal fruit quality parameters?

- **Years of evaluation:** 2002 - 2012
- **Varieties:** Tiben (9 years), Tisel (10 years), Tsema (8 years)

- **Pre-harvest temperature parameters:**
 - Period full bloom until harvest
 - Period color change of the berries (from green to first coloring) until harvest
 - ❖ Sum of heat units according to Lantin, 1986
 - ❖ Sum of daily mean temperature
 - ❖ Mean temperature

- **Harvest:** Fruits were harvested when the majority of the berries were sound, fully ripe and regarded as commercially ripe



Temperature transformation to heat units according to Lantin (1986)

- a scheme gives to values for every daily minimum and maximum temperature, which have to be summarized to the daily heat unit

- **Example**

- minimum temperatur of 7 °C becomes a value of 1.3
- maximum temperature of 18 °C becommes a value of 1.8
- both values are summarized to a heat unit of 3.1

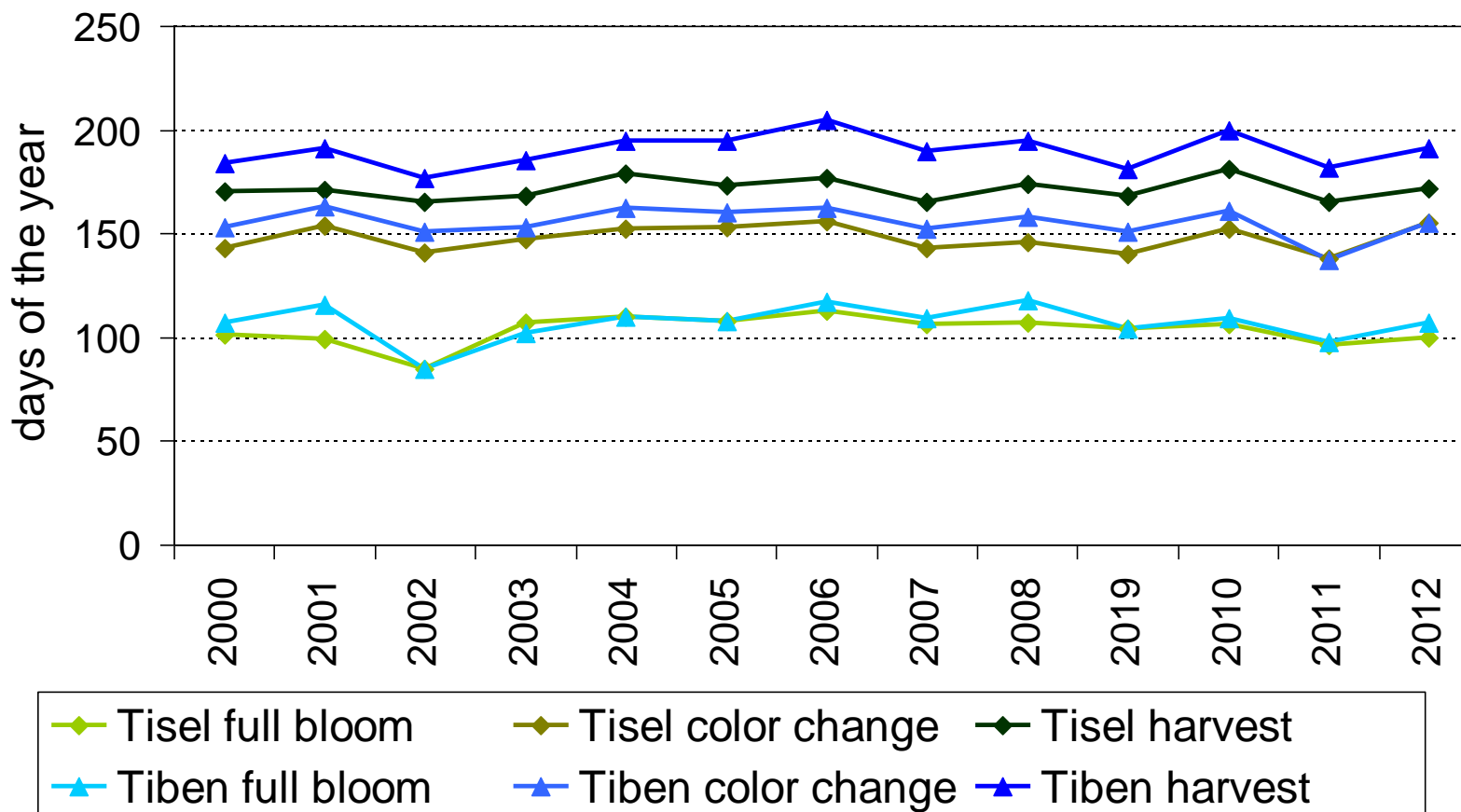
Juice processing

- Fruits were stored at -20°C until analyses
- 5 kg of fruits per variety were crushed in a disc-mill, heated to 50°C ;
- Mash enzyme was added for a better degradation of pectin
- After 2 h, the mash was pressed, and juice was filled in brown bottles after pasteurisation (90°C)

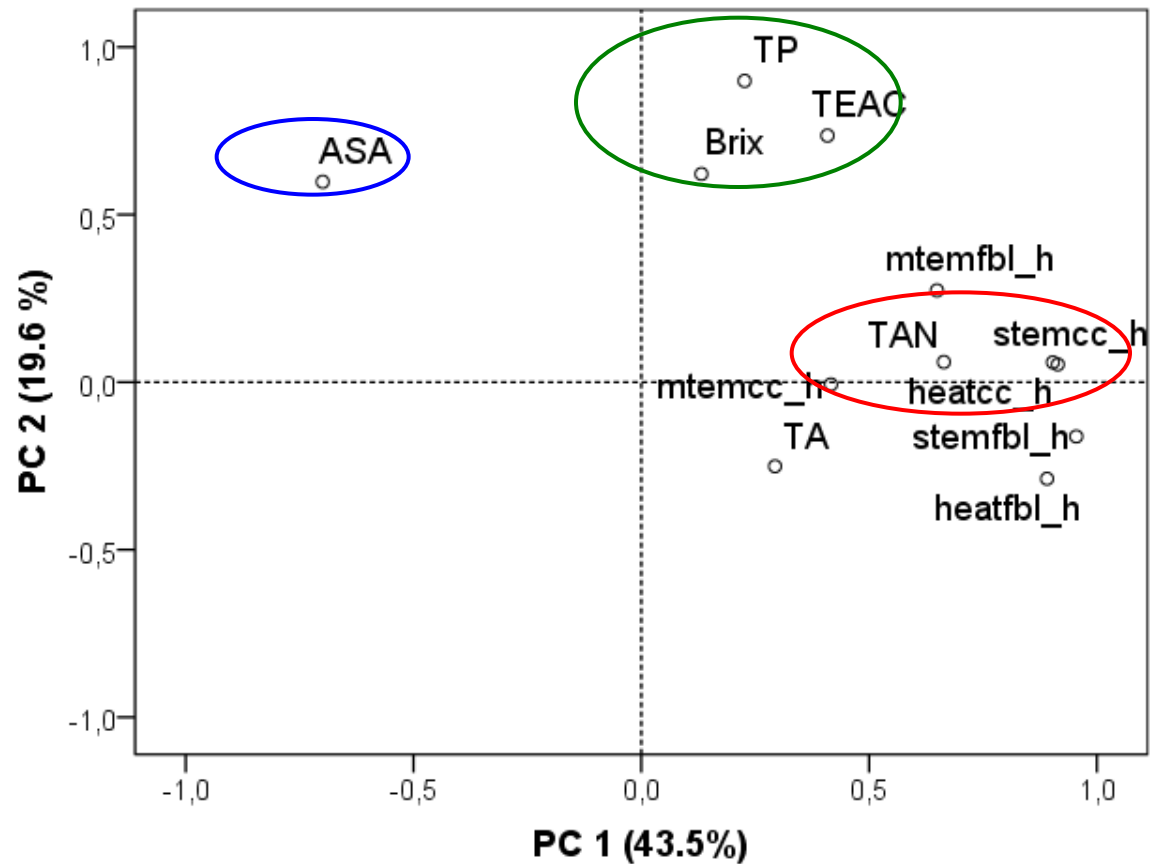
Chemical analyses

- Brix
- Total acidity (titration to pH.8.1; expressed as g/L citric acid)
- Total phenols (Folin-Ciocalteu method, expressed as g/L)
- Total anthocyanins (HPLC, expressed as g/L)
- Ascorbic acid (potentiometrically according IFU method 17, expressed as g/L)
- TEAC (according to Re, 1999 as Trolox equivalent, expressed in mmol/L)

Phenological data in the years 2000 to 2012



Principal component analysis



Long time experiment - Results

Correlation coefficients between TEAC value, total phenols, total anthocyanins and ascorbic acid with pre-harvest temperature parameters, **all three cultivars**

	Total Anthocyanins	Ascorbic acids
Heat units full bloom to harvest	0.553**	-0.803**
Heat units color change to harvest	0.539**	-0.546**
Sum of temp. full bloom to harvest	0.525**	-0.745**
Sum of temp. color change to harvest	0.466**	-0.526**
Mean temp. full bloom to harvest	ns	ns
Mean temp. color change to harvest	ns	ns

No significant correlation of Brix, total acidity, total phenols and TEAC with temperature parameters

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Long time experiment - Results

		2002	2003	2004	2005	2006	2008	2009	2010	2011	2012
April	sec	8.7	11.2	10.8	11.5	10.2	8.0	14.9	10.2	11.6	8.3
	third	12.1	15.3	14.5	12.3	12.0	12.5	12.7	13.3	16.8	12.7
May	first	12.9	16.1	11.5	12.6	16.6	15.4	14.1	9.9	15.	15.1
	sec	16.5	13.1	15.2	12.1	16.1	17.3	14.9	10.2	15.6	13.2
	third	14.9	17.7	13.2	18.5	12.9	19.3	17.8	16.0	17.2	20.6
June	first	17.6	22.2	18.2	15.3	14.3	20.2	14.7	18.8	18.9	15.2
	sec	21.2	21.2	16.3	18.4	21.7	15.4	16.6	16.7	16.7	16.8
	third	18.9	21.6	17.7	23.5	20.5	20.6	19.3	20.1	19.1	18.7
July	first	18.2	18.4	16.8	18.1	23.5	19.7	20.0	23.6	18.5	19.3
∅		15.7	17.4	14.9	15.8	16.4	16.5	16.1	15.4	16.6	15.5

Long time experiment - Results

Correlation coefficients between TEAC value, total phenols, total anthocyanins and ascorbic acid with pre-harvest temperature parameters, **cv. Tsema**

	Total acidity
Heat units full bloom to harvest	-0.843**
Heat units color change to harvest	ns
Sum of temp. full bloom to harvest	-0.894**
Sum of temp. color change to harvest	ns

No significant correlation of Brix, total phenols, total anthocyanins, ascorbic acid and TEAC with temperature parameters

Long time experiment - Results

Correlation coefficients between TEAC value, total phenols, total anthocyanins and ascorbic acid with pre-harvest temperature parameters, **cv. Tiben**

	Brix	Total acidity
Heat units full bloom to harvest	ns	ns
Heat units color change to harvest	0.769*	ns
Sum of temp. full bloom to harvest	ns	-0.754*
Sum of temp. color change to harvest	ns	ns

No significant correlation of total phenols, total anthocyanin, ascorbic acid and TEAC with temperature parameters

No significant correlation between Brix, total acidity, ascorbic acid, total phenols, total anthocyanins and TEAC with pre-harvest temperature parameters for **cv. Tisel**

For the analysed data set:

- there is no indication that the time for full bloom, color change of the berries and harvest has changed in the last decade
- pre-harvest temperature affects the content of total anthocyanins (pos.) and ascorbic acid (neg.) in the berries
- no effects on total phenols and TEAC as in the previous publication
- reason for this: greater variation in pre-harvest temperature in the previous publication than in the long time experiment
- in general: best correlation when heat units for the period change of berry color until harvest was used
- however, an increase of pre-harvest temperature of 2 °C (as predicted by climate change models) will enhance the content of anthocyanins in the berries, and probably also their content of phenols and the values of TEAC, and decrease their content of ascorbic acid
- what about Brix and total acidity?
- differences between the varieties: evidence of variety-dependent reaction on raising temperature?