Molecular analysis of bunch architecture in grapevine

Eva Zyprian\textsuperscript{a}, Robert Richter\textsuperscript{a}, Susanne Rossmann\textsuperscript{b}, Klaus Theres\textsuperscript{b}, Reinhard Töpfer\textsuperscript{a}

\textsuperscript{a} Julius Kühn-Institut, Institute for Grapevine Breeding Geilweilerhof, 76833 Siebeldingen, Germany

\textsuperscript{b} Max Planck Institute, 50829 Cologne, Germany

GBG 2018, Bordeaux, France, July 15-20, 2018
Why study bunch architecture?

Loose clusters

- Dry off quickly
- Don´t squeeze each other
- Have less micro cracks
- Have intact wax layers
- Are better covered by protective sprays
- Are more resilient to *Botrytis* bunch rot and other infections
- Represent a physical factor of resistance

Zyprian et al., GBG 2018, Bordeaux, France, July 15-20, 2018
QTL Analysis in population GF.GA-47-42 x `Villard blanc´

• 150 F₁ individuals with considerable (transgressive) segregation of cluster architecture traits
• genetic map available (Zyprian et al., 2016)
• eight vines per genotype
• 46 females, 104 hermaphrodite plants
QTL Analysis in population
GF.GA-47-42 x `Villard blanc´

Sampling:
6 basally inserted clusters at 6 different trunks

BBCH81 – BBCH87
Phenotyping of cluster architecture sub-traits, over two to four years

- Image based assessment of sub-traits using
  - BAT software for volume (Kicherer et al. 2013)
  - ImageJ for length parameters

- Reference measurements: volume, weight

- in total 19 ampelometric measurements
## Cluster architecture sub-traits

<table>
<thead>
<tr>
<th>Sub-trait [Unit]</th>
<th>Notation</th>
<th>2013 n=12</th>
<th>2014 n=3</th>
<th>2015 n=6</th>
<th>2016 n=6</th>
<th>2017 n=6</th>
</tr>
</thead>
<tbody>
<tr>
<td>berry number per bunch</td>
<td>BN</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>sugar content of juice [°Bx]</td>
<td>Brix</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>berry weight [g]</td>
<td>BW</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>berry weight/rachis weight</td>
<td>BW/RW</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cluster weight [g]</td>
<td>CW</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean single berry volume [cm³]</td>
<td>MBV</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>compactness</td>
<td>OIV204</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>pedicel length [cm]</td>
<td>PED</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>peduncle length [cm]</td>
<td>PL</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>length 1st internode of rachis [cm]</td>
<td>L1I</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>length 2nd internode of rachis [cm]</td>
<td>L2I</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>length 3rd internode of rachis [cm]</td>
<td>L3I</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>diameter 2nd internode of rachis [cm]</td>
<td>RD</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>rachis length [cm]</td>
<td>RL</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rachis weight</td>
<td>RW</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>shoulder length</td>
<td>SL</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>total berry volume</td>
<td>TBV</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total length of laterals</td>
<td>TLL</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>presence/ absence of a “shoulder”</td>
<td>Wing</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

### Sub-trait with large effect on CA (OIV204) after statistical evaluation and modeling

Zyprian et al., GBG 2018, Bordeaux, France, July 15-20, 2018
Flower sex affects cluster architecture: Females are more loose!
23 QTLs for large effect sub-traits in eight clusters
newly identified QTL region

Markers flanking QTL clusters are available

Fanizza et al. 2005 table grape
Cabezas et al. 2006 table grape
Costantini et al. 2008 table grape
Marguerit et al. 2009 hybrid cross
Doligez et al. 2013 table/wine
Correa et al. 2014 table grape
Expression Analysis in `Pinot noir´

**Origin**
- French P.noir gene pool

**Trait**
- compact
- mixed berries
- loose

**Group**
- INRA / France
- Frank / Baden
- Geisenheim / Hessen
- Freiburg / Baden
- M-/L-type Wädenswil
- Geisenheim / Hessen

**Clones**
- ENTAV 777
- Frank Charisma
- Frank Classic
- Gm-20-13
- Fr1801
- WE-171
- Fr12-L/13-L
- Gm-1-86
- PN 40024

*Foto: Antes
Foto: E. Wennesheimer Worms
Foto: R. Richter, JKI Geilweilerhof*

Zyprian et al., GBG 2018, Bordeaux, France, July 15-20, 2018
Plants in three different locations

Antes Heppenheim
1995
125AA/1.8m²

JKI Siebeldingen
2005
125AA/1.8 m²

Sibbus Jechtingen
1997
125AA/2.2m²

Sampling harmonized according to degree/days (Molitor, 2014)

Zyprian et al., GBG 2018, Bordeaux, France, July 15-20, 2018
Phenotyping in ‘Pinot noir’

• Eight of 20 sub-traits show significant differences between clones
• Grouping in loose and compact clustered clones reveals four sub-trait as significantly different

Variance analysis (ANOVA) indicates
• Berry volume
• Pedicel length
• Rachis length
• Total berry volume as determinants of CA
Investigation of rachis elongation

Measurement of rachis length at Geilweilerhof each week from May to August 2015 and 2016 at the same bunch (n = 16)
RNA-Seq, RT-qPCR: Candidate gene expression in ‘Pinot noir’ clones

2015/ 2016/ 2017

A candidate gene is consistently higher expressed in loose PN clones over three years and three locations.

Zyprian et al., GBG 2018, Bordeaux, France, July 15-20, 2018
Conclusions

- Eight QTL regions contain genetic determinants of cluster architecture in GF.GA.47-42 x `Villard blanc´.
  Markers from these regions may now be tested for transferability of their linkage to the trait in extended breeding material.
- Two candidate genes are differentially expressed in loose versus compact `Pinot noir´ clones, over three locations.
Thank you for your attention!

Thanks to…

Grapevine nursery Antes, Heppenheim

Grapevine nursery Sibus, Jechtingen

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