



*Grapevine genetic
resources: evaluation and
pre-breeding at the
European level
rapevine Breeding*

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Grapevine Databases at JKI



- the only literature DB for viticulture and oenology
- currently 74.000 documents (since 1969)
- bibliographical information, abstracts, DOI, full text
- since 1994 technical journals in German
- ~ 2.500 visitors/month with 30.000 accesses
- co-funding with Rheinland-Pfalz
- Editor of VITIS (since 1957)
- www.vitis-vea.de



- begin 1983 – since 1996 on internet
- **cultivar-related**
- > 20.000 cultivars, breeding strains and wild species
- passport-, resistance- and marker data
- ca. 7.000 accesses/month
- www.vivc.de



- since 1997 on internet
- **accession-related**
- maintained by curators of European repositories online
- ~ 40.000 accessions
- characterisation-, evaluation-, marker data, photos
- ca. 1.300 accesses/month
- www.eu-vitis.de



- since 2010 on internet
- **accession-related**
- 4224 accessions from 7 collections in Germany*)
- www.deutsche-genbank-reben.de

*) ~ 3800 accessions at JKI

Start of grapevine maintenance activities in Europe



1982: First official agreements on important measures

- IBPGR-working group „*Vitis* Genetic Resources“
Thessaloniki, Greece, 29 April – 1 May, 1982
Chair: Prof. G. Alleweldt
 - Inventory of maintenance activities in Europe
 - Collection of old neglected cultivars
 - Description of cultivars for identification of synonymy through
 - Utilization of morphological descriptors (21 characteristics)
- OIV-expert group „Vine selection“
Adoption of resolution N° 2/82 recommending
 - Collection in centers of high genetic diversity
 - Maintenance of *Vitis*-species, cultivars and clones in repositories
 - Development of international collaboration between repositories
 - Free exchange of grape material

Start of grapevine maintenance activities in Europe



One of the first steps:

→ implementation of a worldwide inventory of germplasm

Objectives:

- Documentation of worldwide existing collections
- Documentation of the therein maintained accessions

Results:

- Répertoire mondial des collections de *Vitis* (OIV 1987)
- Establishment of the *Vitis* International Variety Catalogue (VIVC, since 1984)

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- About VIVC >
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History of the database

In 1984 the establishment of the *Vitis* International Variety Catalogue (VIVC) took place at the Institute for Grapevine Breeding Geilweilerhof. The concept of a database on grapevine genetic resources was supported by IBPGR (today called Bioversity) and the International Organisation of Vine and Wine (OIV). Today VIVC is an encyclopedic database with around 23000 cultivars, breeding lines and *Vitis* species, existing in grapevine repositories and/or described in bibliography. It is an information source for breeders, researchers, curators of germplasm repositories and interested wine enthusiasts. Besides cultivar specific passport data, SSR-marker data, comprehensive bibliography and photos are to be found.

[History »](#)

Since 1996: Web presence of VIVC

***Vitis* International Variety Catalogue (VIVC)**



Main objectives

- Registration of the worldwide existing and/or documented grape germplasm
- Comprehensive description of grape germplasm
- Solution of synonymy, homonymy and misnaming
- Contribution in monitoring endangered germplasm preservation
- Recording of cultivar describing bibliography

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- Relationships based on nine microsatellites
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Relationships based on nine microsatellites

Potential uses: although nine markers are not enough to ascertain a putative kin relationship, this tool helps to find first-degree relationships, to check the reliability of the pedigree given by breeders and to explore genetic and geographic background of a variety.

Note

Paste your profile according to the given example. Replace missing data with md.

Example:

Insert your profile: 135 145 228 242 239 247 241 255 180 195 248 248 md md 196 204 237 249

Genetic profiles of 3457 cultivars are available.

Source of SSR-marker data	VVS2		VVM D5		VVM D7		VVM D25		VVM D27		VVM D28		VVM D32		VrZAG62		VrZAG79		Source of data
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	
Reference variety																			
CABERNET SAUVIGNON	139	151	234	242	239	239	239	249	176	190	234	236	240	240	188	194	247	247	view
CHARDONNAY BLANC	137	143	236	240	239	243	239	255	182	190	218	228	240	272	188	196	243	245	view
MUSCAT A PETITS GRAINS BLANCS	133	133	230	238	233	249	241	249	180	195	246	268	264	272	186	196	251	255	view
PINOT NOIR	137	151	230	240	239	243	239	249	186	190	218	236	240	272	188	194	239	245	view

Insert your profile:

Search

Reset

Indication

In case of use of the genetic profiles generated at Institute for Grapevine Breeding Geilweilerhof the source has to be mentioned as: Maul, E.; Röckel, F. 2015: "variety name" Vitis International Variety Catalogue (www.vivc.de)

Genetic profiles for 3457 prime names are currently available

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The outcome of European wide cooperation (4 projects) to solve *synonymy, homonymy and misnaming* of grapevine by using SSRs:

- Genres081 (1997 – 2002)
- Black Sea project (2003 – 2007)
- GrapeGen06 (2007 – 2011)
- COST Action FA1003 (2010 – 2014)

Genetic profiles for 3457 prime names are currently available

The European *Vitis* Database



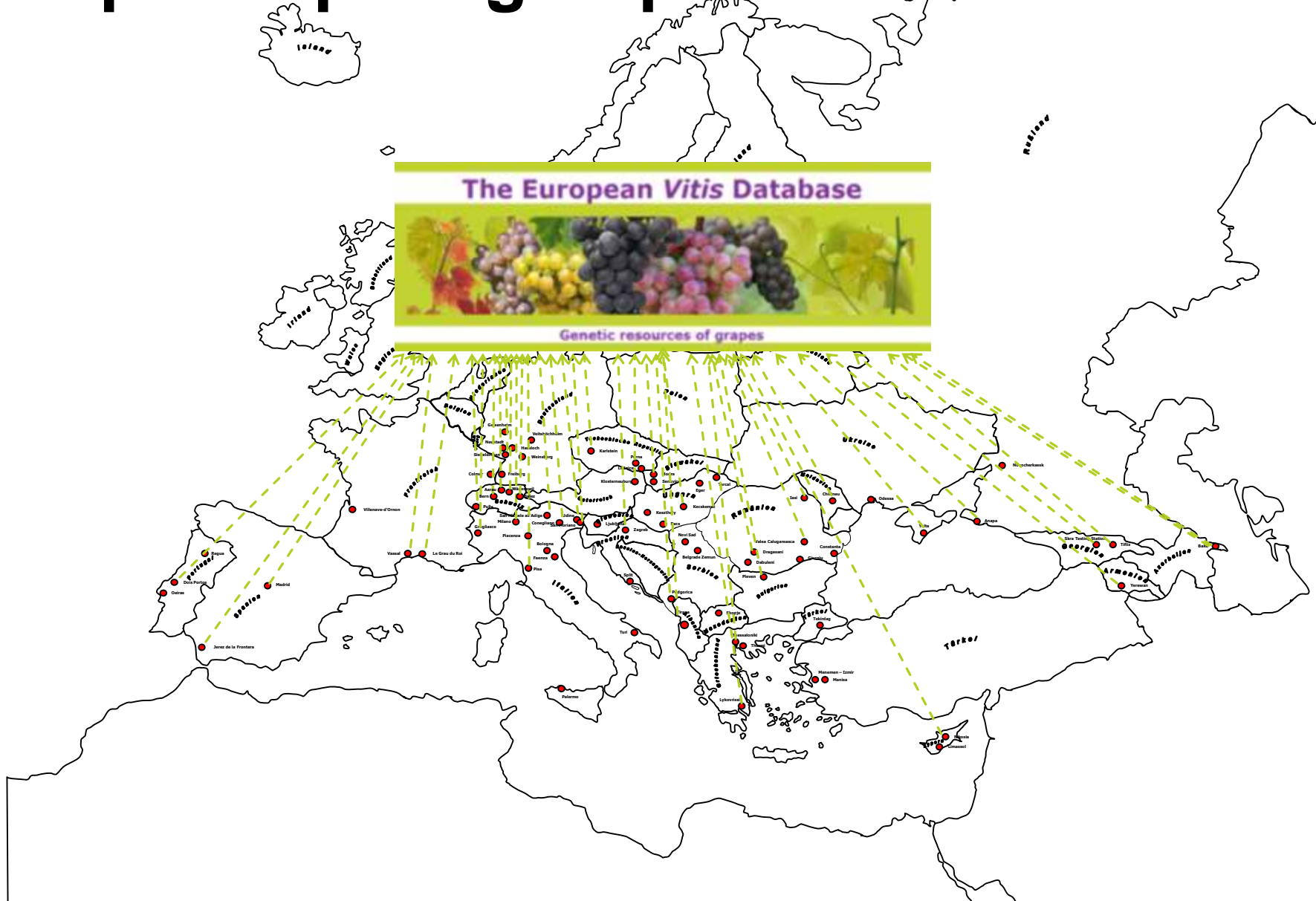
Genetic resources of grapes

[Register for SSR-marker data admission via public access](#)

The European *Vitis* Database is being maintained since 2007 by the
©Julius Kühn-Institut - Federal Research Centre for Cultivated Plants (JKI), Institute for Grapevine Breeding Geilweilerhof, Siebeldingen, Germany.
The establishment of the European *Vitis* Database with free access via Internet has been carried out in the scope of the European Project Genres081. The follow up
and enlargement will be accomplished within GrapeGen06 and by the European Cooperative Programme for Plant Genetic Resources (ECPGR).

Members of the European Cooperative Programme for Plant Genetic Resources (ECPGR) *Vitis* Working Group ©JKI 2007
Last modified: November, 2016

56 participating Repositories:



The European *Vitis* Database



Data import and management by curators of repositories:



Data check during data import

To modify your MCPD data please see the three options below:

- 1. Adjustment:** Click on the "error" message (e.g. BERRY_COLOR) to adjust and to save your data. Your data set will be checked again.
- 2. Deletion of an accession:** Click on the icon in front of the row to delete the complete accession. **Attention:** Any record (data, photos) linked to the accession will be deleted as well.
- 3. Abort of import:** If too many data sets have to be adjusted you may want to stop the import and revise the MCPD data in your excel file. Click on the button 'cancel import' below.

cancel import

All "errors" need to be adjusted to pass to the next step.


Row	ACCENUMB
 10	DEU098-1980-117
 22	DEU098-1980-312
 31	DEU098-1988-063
 33	DEU098-1993-133
 3	DEU098-2006-090
 4	DEU098-2006-091
 9	DEU098-2006-094
 2	DEU098-2006-148
 5	DEU098-2006-149

MOVE CLOSE

Please correct the LATITUDE

LATITUDE has max. 7 characters in database
 Format: Degree (2 digits) minutes (2 digits) seconds (2 digits) N (North) or S (South),
 Example: 011530N or 4531--S

correct all with same error
 transfer the information to **remarks** field



INSTCODE: DEU099
 BERRY_COLOR: R
 COUNTRY_OF_ORIGIN_OF_THE_VARIETY: HUNg
 COLLSRC: 19

Riesling

Weisser Heunisch x (*Vitis vinifera* ssp. *silvestris* x Traminer) ?

First mentioning:

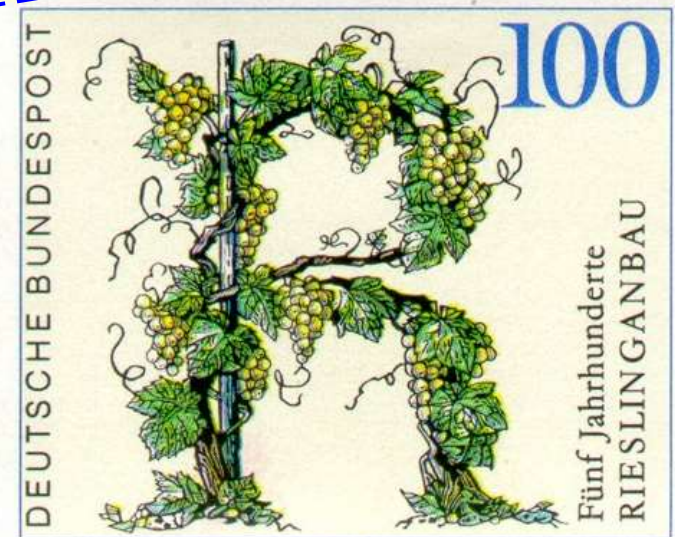
1435 Rüsselsheim: bill for plants

**Grapevine cultivars are used for centuries
Grapevine is vegetatively propagated**

1453 Diebach: vines in a vineyard

1464/1465 Trier: plants for cultivation

1490 First documented
mentioning of a vineyard
("Ruslingwingart") near Worms.





powdery mildew



downy mildew

Available Resistance Loci within Wine Grapes

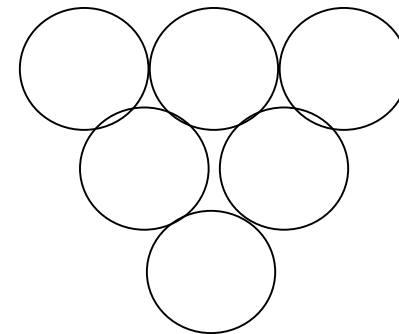
Downy mildew

none

Powdery mildew

none

in **traditional** cultivars:



0&0

Principal of Grapevine Breeding

cultivated *Vitis vinifera*

- High quality
- No mildew resistance



e.g. 'Müller-Thurgau'

Vitis wild species

- Poor quality
- High mildew resistance



e.g. *Vitis amurensis*

Repetitive pseudo
backcrosses using
various
V. vinifera cultivars

New cultivars

- High quality
- High mildew resistance



e.g. 'Solaris'

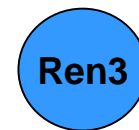
Available Resistance Loci within French and American Hybrids

Downy mildew



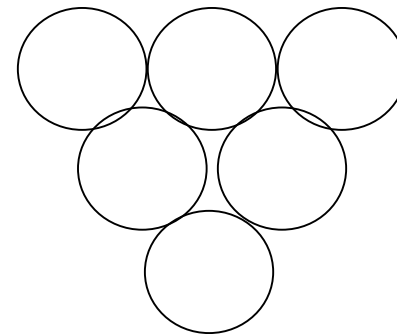
...

Powdery mildew



...

in **traditional** cultivars:



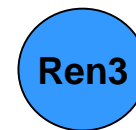
O&O

Available Resistance Loci within French and American Hybrids and from Introgressions

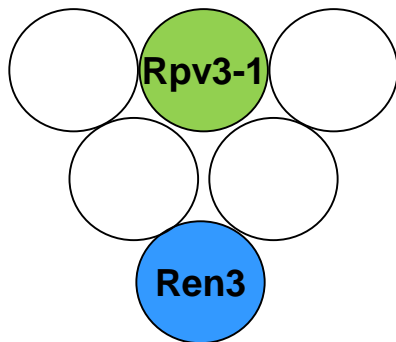
Downy mildew



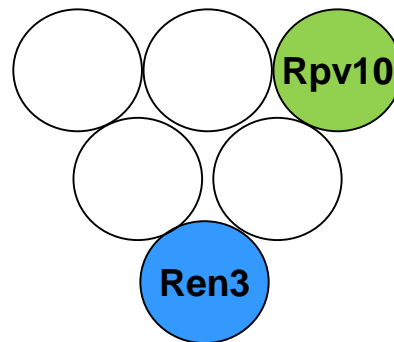
Powdery mildew



in **current resistant** cultivars:

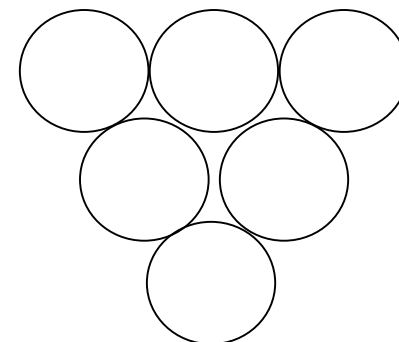


1&1



1&1

in **traditional** cultivars:



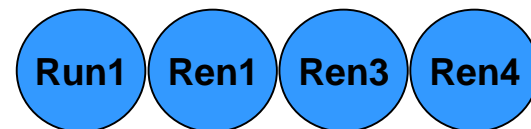
0&0

Available Resistance Loci in Advanced Genetic Background

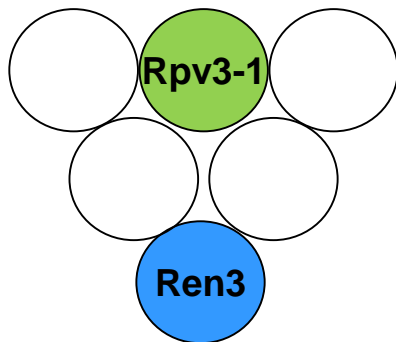
Downy mildew



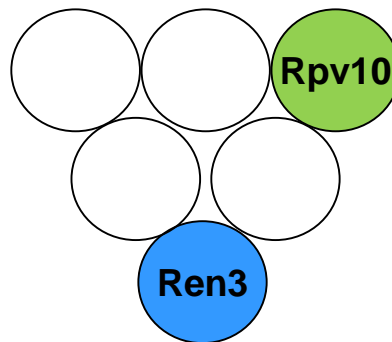
Powdery mildew



in **current resistant** cultivars:

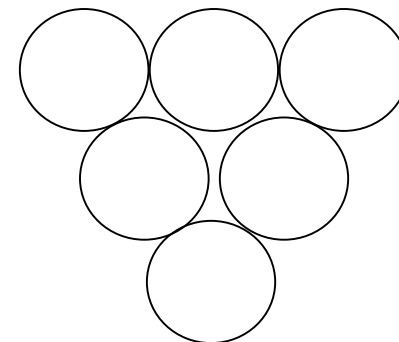


1&1



1&1

in **traditional** cultivars:



0&0

Regent

Cross 1967

Variety protection 1994

Classification 1996



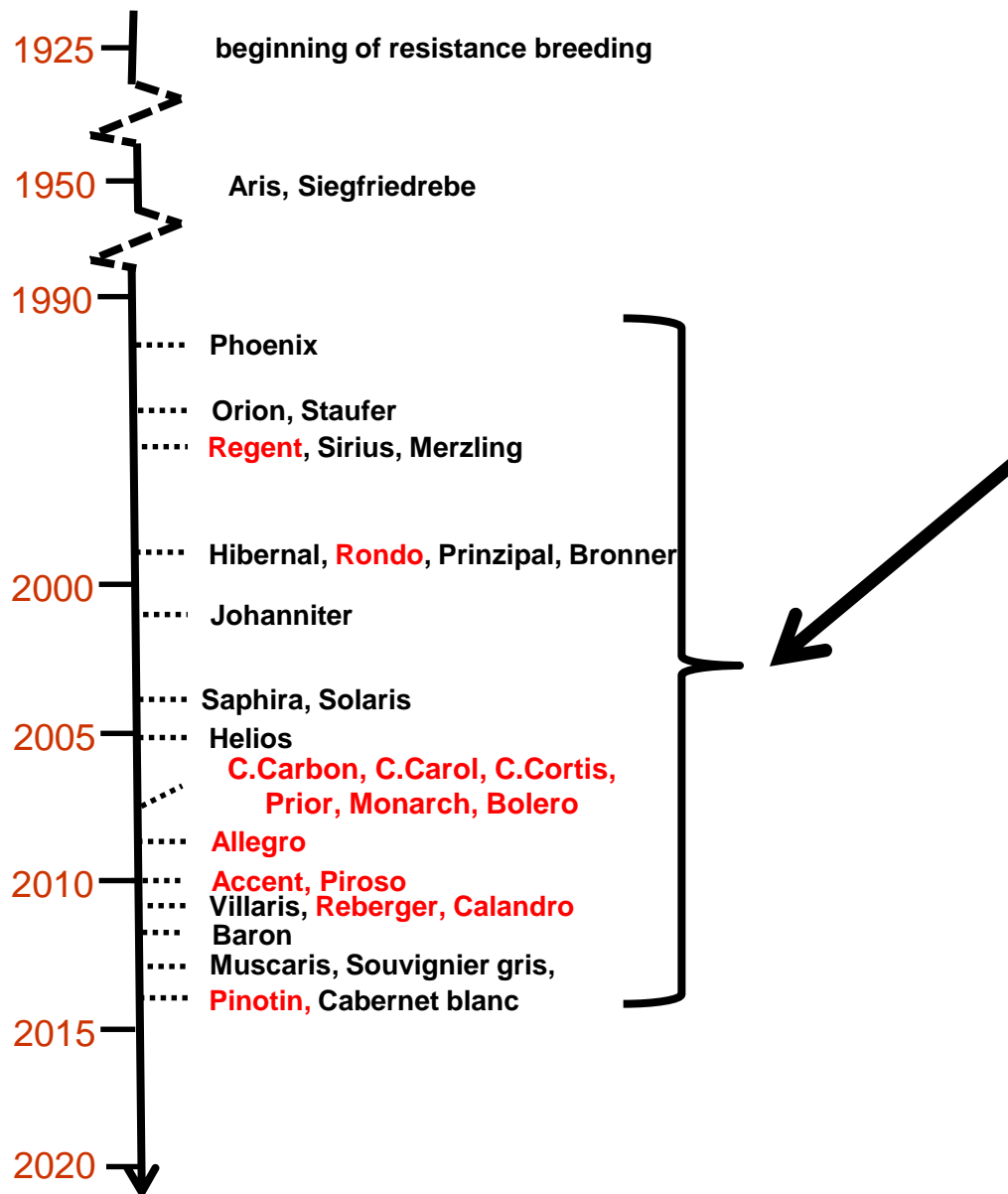
Occurrence of Fungicide Resistances



(according to HG Hewitt (1998) Fungicides in Crop Protection, modified by Deising et al.)

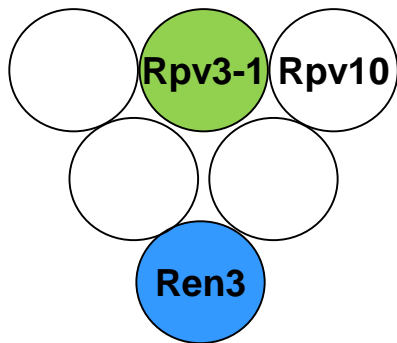
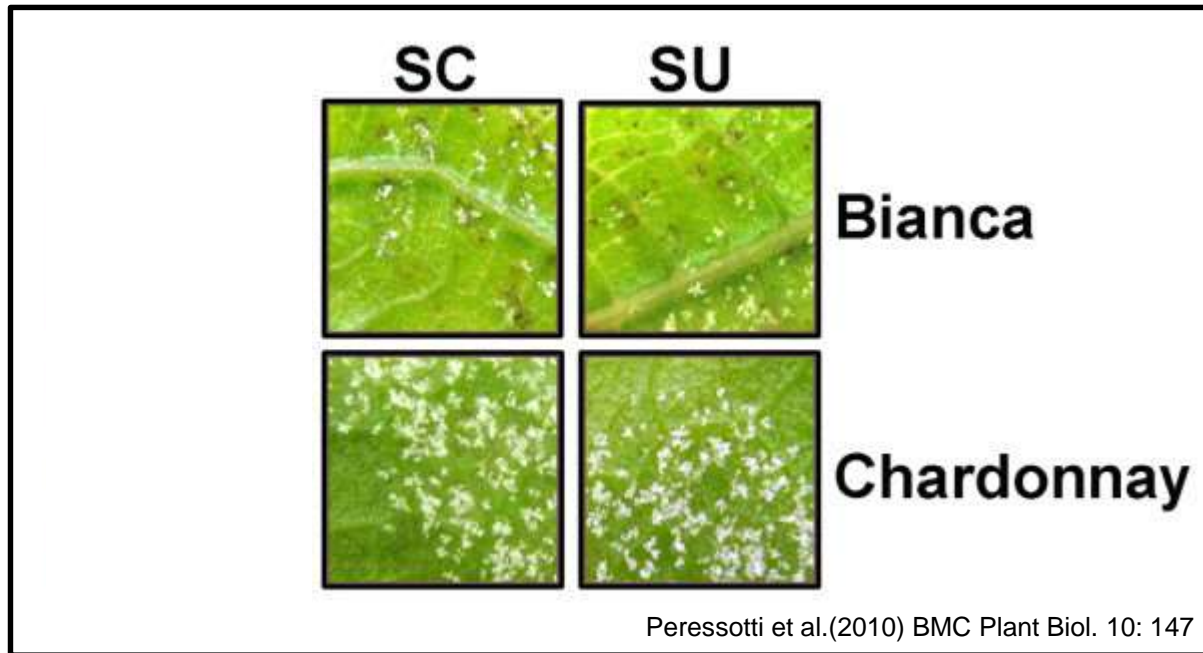
Class of Fungicides	First occurrence of resistance	Years prior to occurrence of resistance	Pathogen
Organic mercury	1964	40	<i>Pyrenophora avenae</i>
Benzimidazole	1970	2	<i>Venturia inaequalis</i> , <i>Botrytis cinerea</i>
Phenylamide	1980	2	<i>Phytophthora infestans</i> , <i>Plasmopara viticola</i>
Dicarboximide	1982	5	<i>Botrytis cinerea</i>
DMIs	1982	4	<i>Blumeria graminis</i>
Carboxanilide	1986	14	<i>Ustilago nuda</i>
Morpholine	1994	34	<i>Blumeria graminis</i>
Strobilurine	1998	2	<i>Blumeria graminis</i> f.sp. <i>tritici</i>

Resistance Breeding in Germany

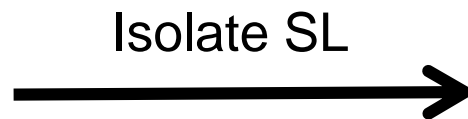


Durability of resistances

Plasmopara viticola
(downy mildew)
6 dpi

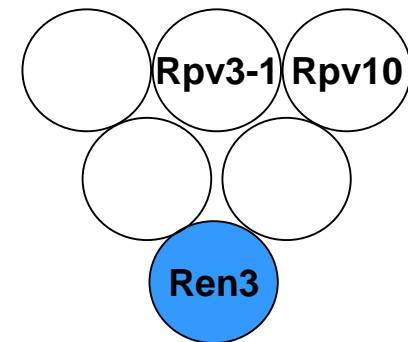


Bianca



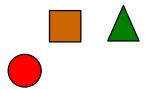
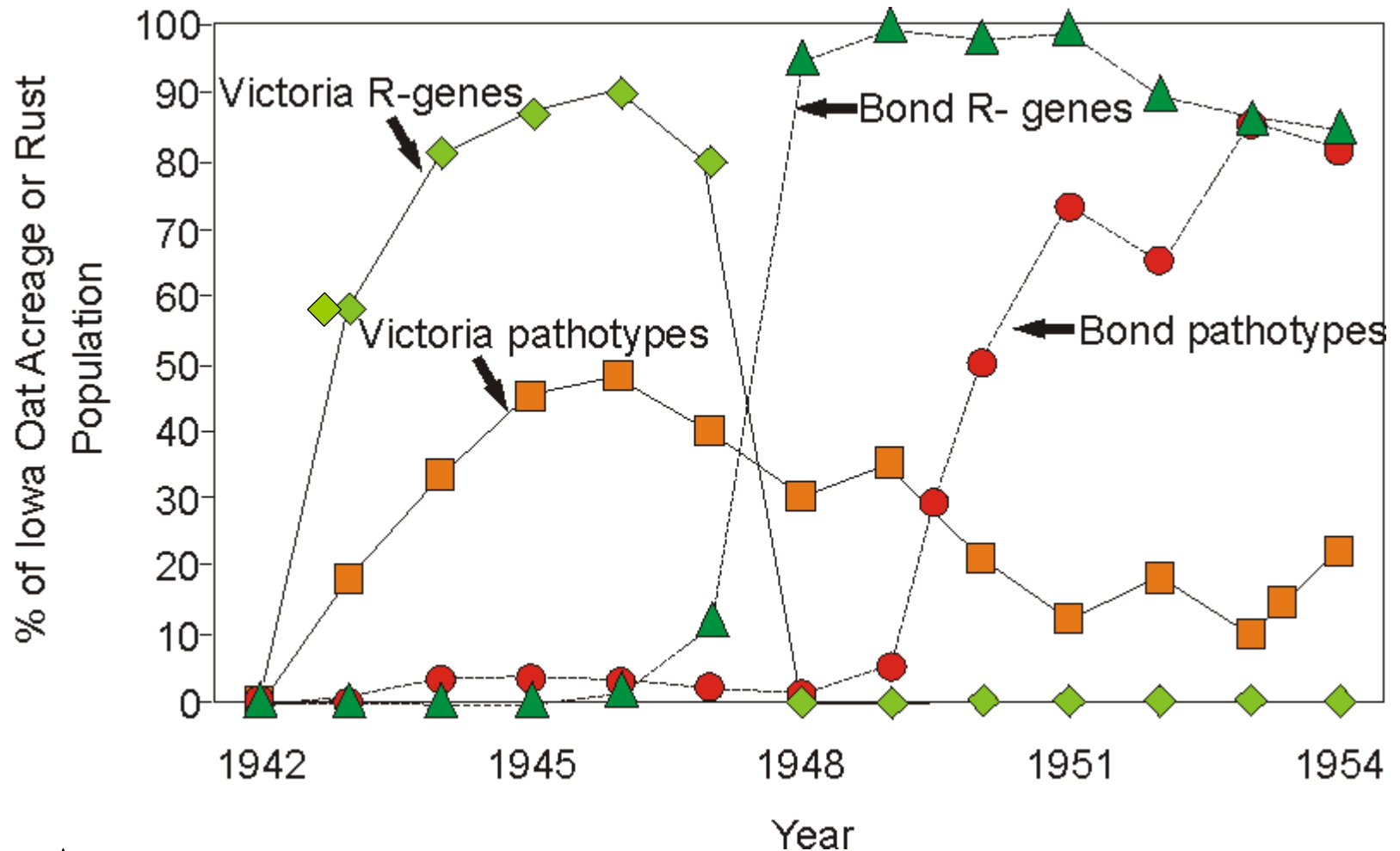
QTL Rpv3 disappears
applying isolate SL

→ formation of *P. viticola* races



Bianca

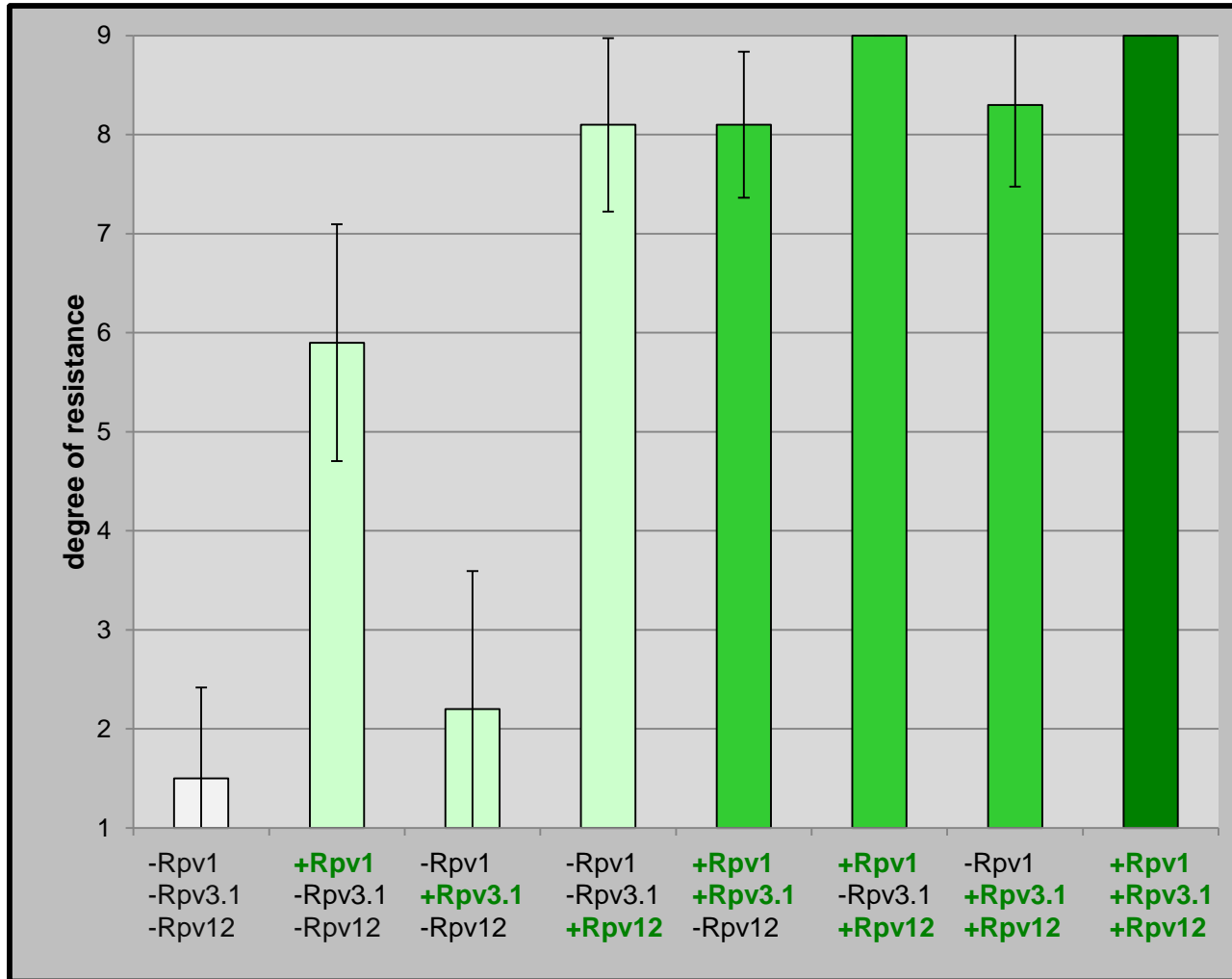
Classical Boom-and-Bust Cycle



Downy Mildew: Example III



Influence of individual resistance loci and their different combinations on degree of resistance

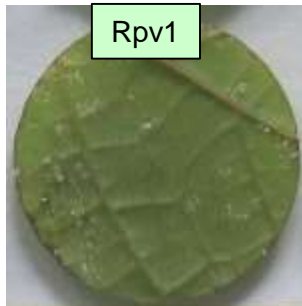


Downy Mildew

Leaf disc essays



no resistance locus



Rpv1



Rpv3.1



Rpv12

1 resistance locus



Rpv1+Rpv3.1



Rpv1+Rpv12



Rpv3.1+Rpv12

2 resistance loci

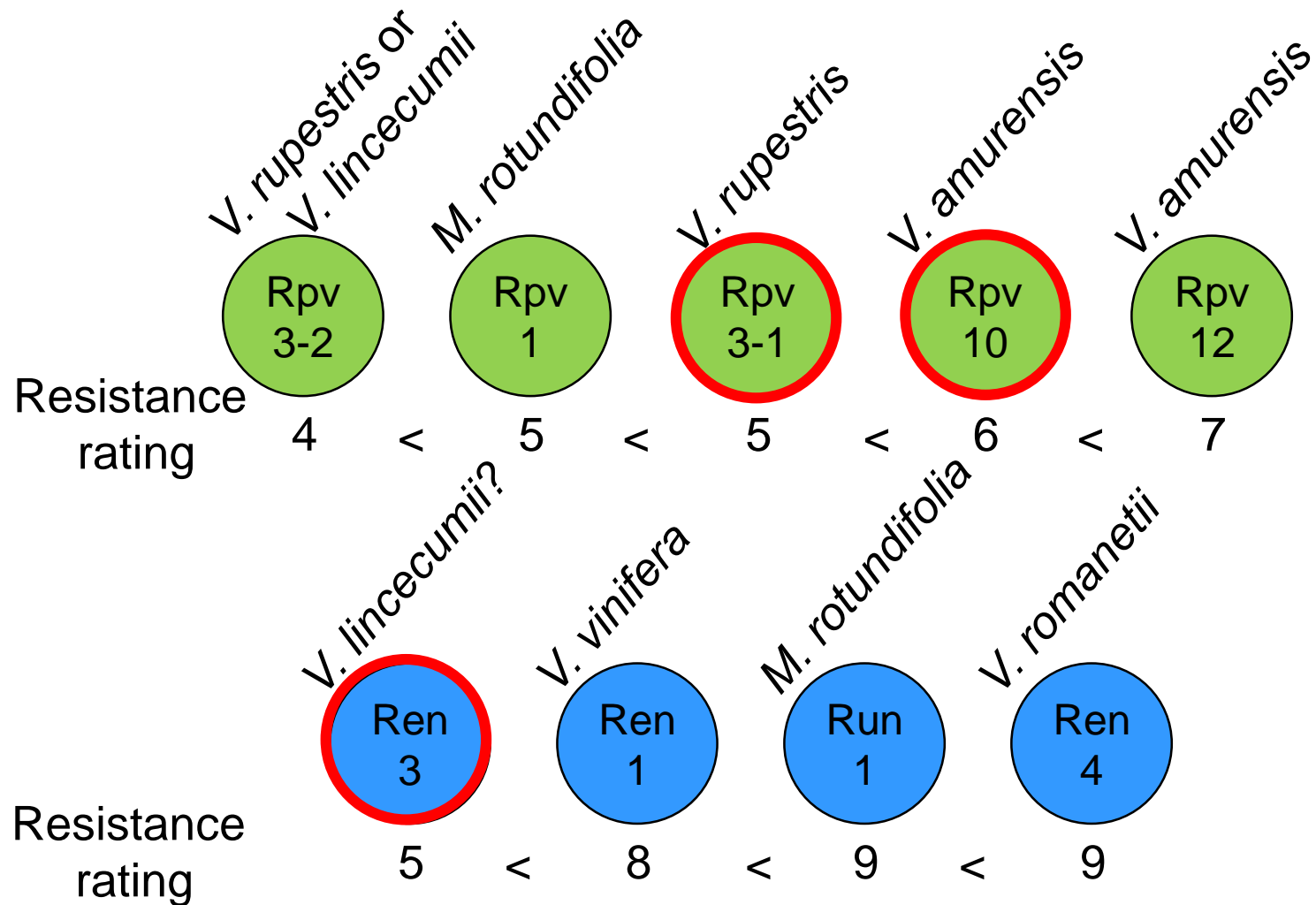


Rpv1+Rpv3.1+Rpv12

3 resistance loci

New breeding strategies/tools

Rating of resistance loci in elite background





Screening and characterization

Biotic stress

- Downy mildew
- Powdery mildew
- Black rot
- Phylloxera



Abiotic stress

- Heat
- Drought



Downy (DM) and Powdery Mildew (PM)

Partner	Genotype	sat/silv	Country	Region	OIV DM	OIV PM
UNIMI	NAKHIDURI 06	<i>V.vinifera silvestris</i>	Georgia	Caucasus	8,1	7,9
UNIMI	SKRA 01	<i>V.vinifera silvestris</i>	Georgia	Caucasus	6,9	9
UNIMI	GEOW31	<i>V.vinifera silvestris</i>	Georgia	Caucasus	7,2	8,7
UNIMI	BARISAKHO TURNING 01	<i>V.vinifera silvestris</i>	Georgia	Caucasus	7,3	8,2
UNIMI	Seura	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,5	9
UNIMI	Yaghoti white	<i>V.vinifera vinifera</i>	Iran	Central Asia	6,7	8,7
UNIMI	Chitistvala kakhuri (bobduri)	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,2	9
UNIMI	Dondghlabi Shavi	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,1	9
UNIMI	Adreuli tkhelkana	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,3	8,7
UNIMI	Alexandrouli	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6	9
UNIMI	Tsirkvalis tetri	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,1	8,9
UNIMI	Almura Tetri	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,7	8,1
UNIMI	Chesm gave	<i>V.vinifera vinifera</i>	Iran	Central Asia	6,4	8,4
UNIMI	Chesm gave	<i>V.vinifera vinifera</i>	Iran	Central Asia	6	8,8
UNIMI	Mskhvili Kurdzeni	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,9	7,8
INRA	Sciavtsitska	<i>V.vinifera vinifera</i>	Balkans	Balkans	6	8,7
UNIMI	TEDOTSMINDA 16	<i>V.vinifera silvestris</i>	Georgia	Caucasus	6,1	8,3
UNIMI	SAMEBIS SERI 02	<i>V.vinifera silvestris</i>	Georgia	Caucasus	6,4	7,8
UNIMI	Adreuli tkhelkana	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6	8
UNIMI	Ojaleshi lechkhumis (Orbeluri ojaleshi)	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6	8
UNIMI	Saperavi Khashmis	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6	8
UNIMI	Shavkapito	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6	7,7
INRA	KVELOURI	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,4	6,8
UNIMI	Kharistvala Meskhuri	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,8	6,3
UNIMI	NAKHIDURI 04	<i>V.vinifera silvestris</i>	Georgia	Caucasus	6	6,4
UNIMI	Khupishij	<i>V.vinifera vinifera</i>	Georgia	Caucasus	6,1	6,3



Black Rot (BR)

No	Accession Name	Type / Origin	Partner	# Tests	Level of Resistance	Comment
1	Börner	rootstock	PTE	6	9	
2	Csillám	Franko-American hybrids x Vvi_v	PTE	6	9	no symptoms
3	Seibel 7053	Franko-American hybrids	PTE	6	9	rotted berries
4	M. rotundifolia n.1	M. rotundifolia seedling	PTE	4	9	
5	Seyve-Villard 5276	Franko-American hybrids	PTE	6	7-9	superficial spots on berries
6	15-7-1	Vam x Vvi_v F2	PTE	2	9	mummies and rotted berries
7	5-10-6	Vam x Vvi_v F2	PTE	4	9	superficial spots on berries
8	5-11-6	Vam x Vvi_v F2	PTE	2	9	superficial spots on berries
9	5-16-3	Vam x Vvi_v F2	PTE	2	9	rotted berries
10	Teréz	Franko-American hybrids x Vvi_v	PTE	6	7	rotted berries
11	5-11-2	Vam x Vvi_v F2	PTE	6	7	few peeling spots on berries
12	Felicia	new variety	PTE	6	5-7	no symptoms
13	Malverina	Franko-American hybrids x Vvi_v	PTE	6	5-7	rotted berries
14	Merzling 13-12-9	new variety x Vvi_v	PTE	6	5-7	few peeling spots on berries
15	Villaris	new variety	PTE	6	5-7	
16	GM 318-57 239 F2	Franko-American hybrids x Vvi_v	PTE	6	5	rotted berries
17	Seyve-Villard 12375	Franko-American hybrids	PTE	6	5	mummies and rotted berries
18	Seyve-Villard 18315	Franko-American hybrids	PTE	4	5	mummies and rotted berries



Phylloxera (Dv)

No	Accession name	Species	Partner	# Tests	Level of Resistance	Comment
1	AESTIVALIS GF 02	Vae	JKI	1	1,0	
2	AESTIVALIS GF 04	Vae	JKI	1	1,0	
3	AESTIVALIS GF 06	Vae	JKI	1	1,0	
4	AESTIVALIS GF 07	Vae	JKI	1	1,0	
5	AESTIVALIS GF 11	Vae	JKI	1	1,0	
6	AESTIVALIS GF 12	Vae	JKI	1	1,0	
7	AESTIVALIS GF 13	Vae	JKI	1	1,0	
8	AESTIVALIS GF 14	Vae	JKI	1	1,0	
9	AESTIVALIS GF 17	Vae	JKI	1	1,0	
10	AESTIVALIS GF 18	Vae	JKI	1	1,0	
11	AESTIVALIS GF 19	Vae	JKI	1	1,0	
12	AESTIVALIS GF 22	Vae	JKI	1	1,0	
13	BOERNER	Vci, Vri	JKI	1	1,0	reference
14	AESTIVALIS GF 03	Vae	JKI	1	1,3	
15	AESTIVALIS GF 15	Vae	JKI	1	1,3	
16	AESTIVALIS GF 23	Vae	JKI	1	1,3	
17	AESTIVALIS GF 01	Vae	JKI	1	1,7	
18	AESTIVALIS GF 20	Vae	JKI	1	2,0	
19	GF.V3125	Vvi_v	JKI	1	2,4	reference
20	PINOT NOIR	Vvi_v	JKI	1	2,5	reference
21	AESTIVALIS GF 05	Vae	JKI	1	3,0	
22	AESTIVALIS GF 10	Vae	JKI	1	3,0	

1 = no nodosities
 2 = up to 10 nodosities
 3 = 11-30 nodosities
 4 = > 30 nodosities



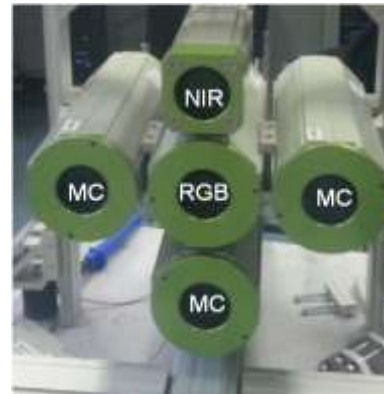
New breeding strategies/tools



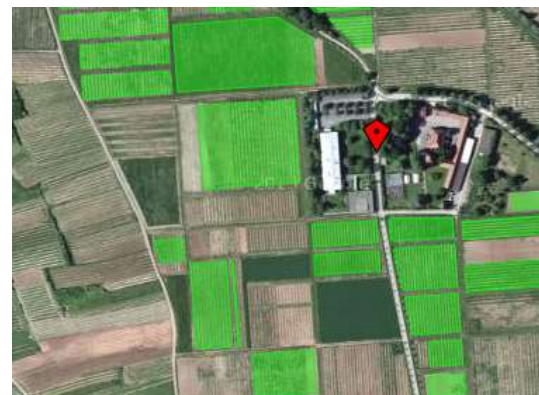
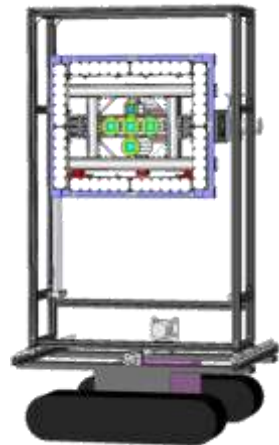
New breeding strategies/tools –

Automatic Phenotyping in the field:

- robotic platform & camera movement
- multi-camera-system & illumination
- geo-referenz of single vines (plant ID)



Kicherer *et al.* 2015a, Sensors



SENSORS FOR OBJECTIVE YIELD ADJUSTMENT

Multi-sensor field phenotyping platform: **PHENObot***

- Automated, synchrone image capture
- Georeference with high precision



* Kicherer, Herzog, Pflanz, Wieland, Rüger, Kecke, Kuhlmann, Töpfer (2015) **Sensors**, 15(3), 4823-4836.

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Disadvantages:

- slow speed
- image acquisition at night to ensure standardized light conditions



* Kicherer, Herzog, Pflanz, Wieland, Rüger, Kecke, Kuhlmann, Töpfer (2015) *Sensors*, 15(3), 4823-4836.

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Improved multi-sensor field phenotyping platform: **Phenoliner***

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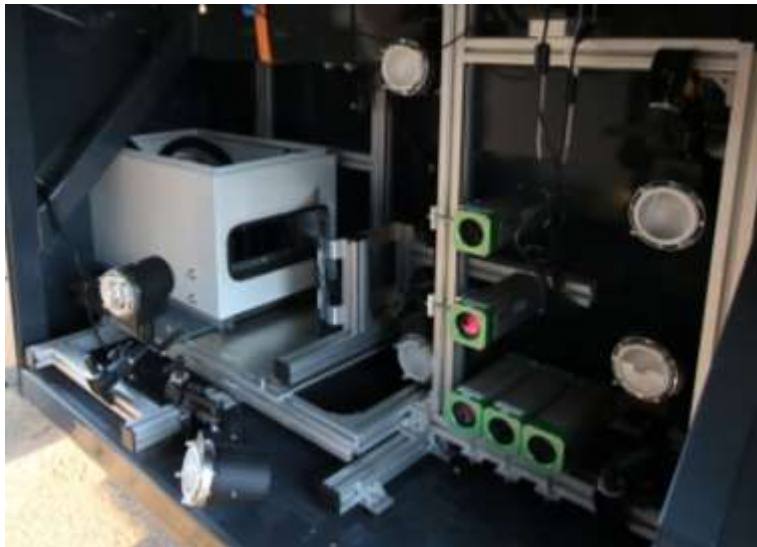


* Kicherer, Herzog, Bendel, Klück, Backhaus, Wieland, Rose, Klingbeil, Läbe, Kohl, Petry, Kuhlmann, Seiffert, Töpfer (2017) **Sensors**, in preparation

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Modern Grapevine Breeding needs to

- share work to save time → evaluation of genetic resources
- develop complementary pre-breeding programs → develop introgression lines
- exchange of grapevine genetic resources and breeding material

→ No single grapevine breeding program is faster than the evolution of the pathogen



**Thank you for your
attention**