



Institute for Grapevine Breeding Geilweilerhof

Breeding for Resistance in Grapevine

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1. Grapevine Breeding

- Breeding resistant varieties with very high wine quality
- Breeding research (genome analysis, gene identification, functional gene analysis)

2. Genetic Ressources

- Collection and conservation (and usage)
- Vitis International Variety Catalogue (VIVC)
- EU Vitis database
- Deutsche Genbank Reben

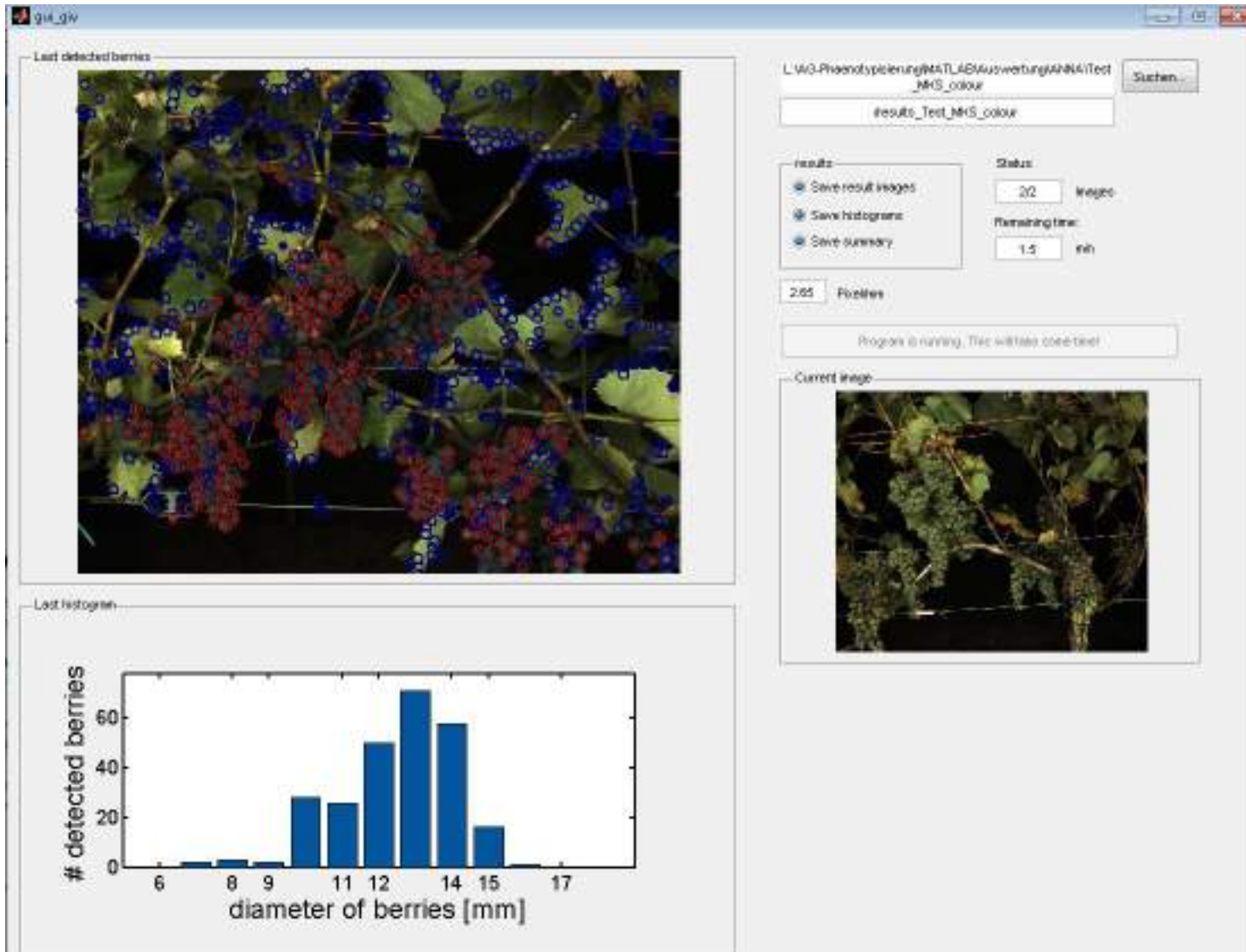
- Literature database Vitis VEA (Vitis Viticulture Enology Abstracts)
- Publisher of the journal VITIS

Institute for Grapevine Breeding
Geilweilerhof
&
Institute for Plant
Crops and
Viticulture
(Dossenheim)

3. Phenotyping



3. Phenotyping



3. Phenotyping 2.0



Downy mildew (*Plasmopara viticola*)



Powdery mildew (*Erysiphe necator*)



Origin of the main grapevine pests



Powdery mildew

Phylloxera

Downy mildew

Principle of breeding for resistance



Vitis vinifera

Susceptible
High Quality

X

Wild *Vitis* species



Hohe Resistance
Low Quality

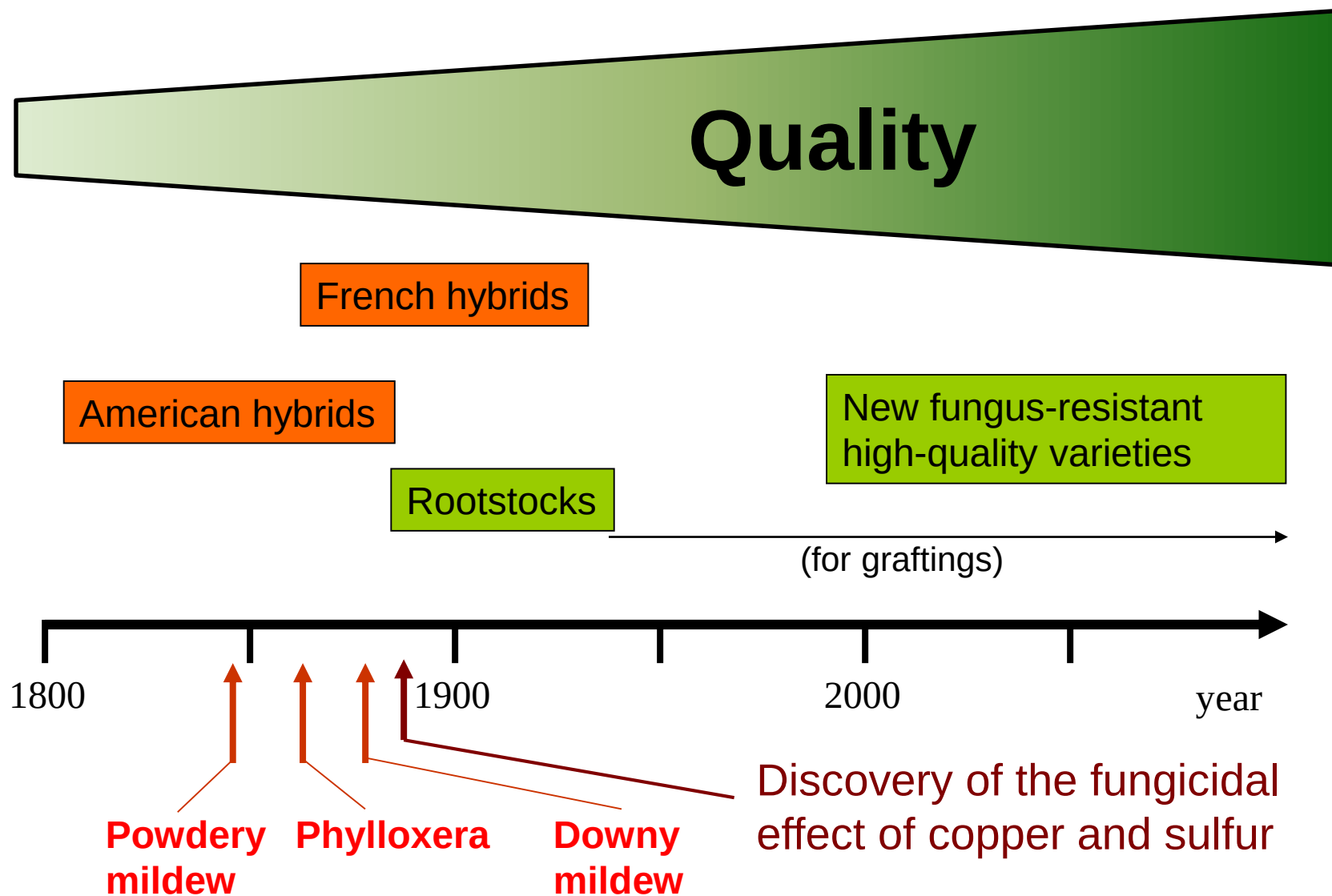
F1

pBC1

New variety



Milestones in grapevine breeding



Crossing

Emasculation:

Short time frame:

7 – 10 days beginning of june



Ca. 2000 bunches per year

+1000 female bunches



Process of crossing

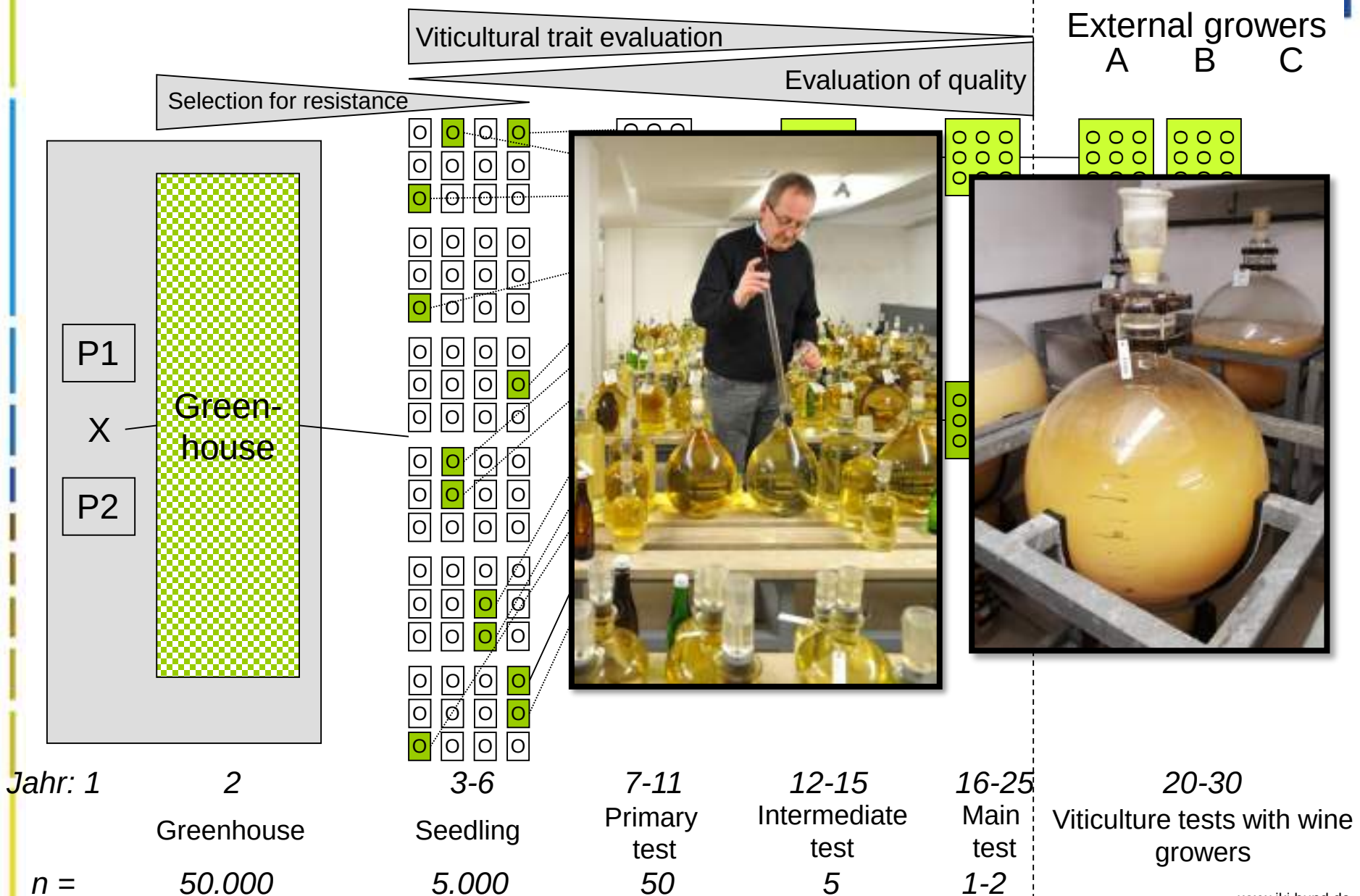




Washing out the seeds



Time frame of breeding for resistance





How to select the right seedlings?



Artificial inoculation with downy mildew



Powdery mildew

Natural infection in hoop house



Marker Assisted Selection (MAS)

Genetic identification of a resistance



Mother (resistant)

A
B
C
D
E
F

X



Father (susceptible)

a
b
c
d
e
f

Progeny:

A
B
C
d
e
f

A
b
c
d
e
F

a
b
C
D
E
F

a
B
C
D
e
f

A
B
c
d
e
f

a
b
c
d
E
F

Test for resistance:



Genetic identification of a resistance

Resistant progeny:

A	a	a
B	b	B
C	C	C
d	D	D
e	E	e
f	F	f



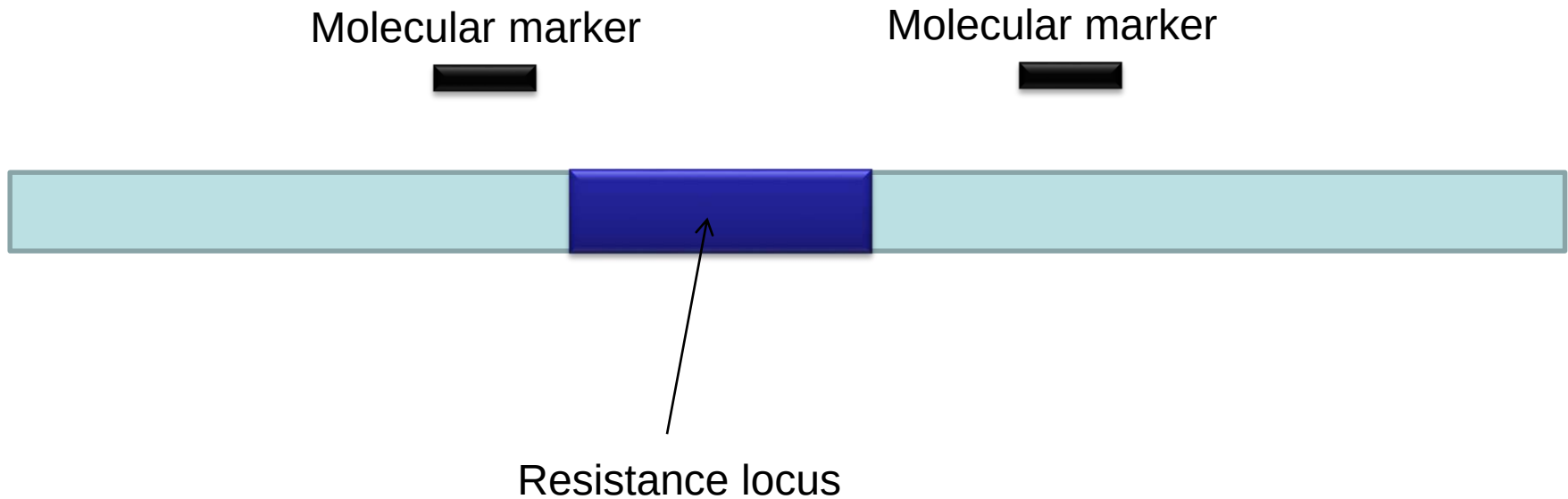
Susceptible progeny:

A	A	a
B	b	b
c	c	c
d	d	d
e	e	E
f	F	F

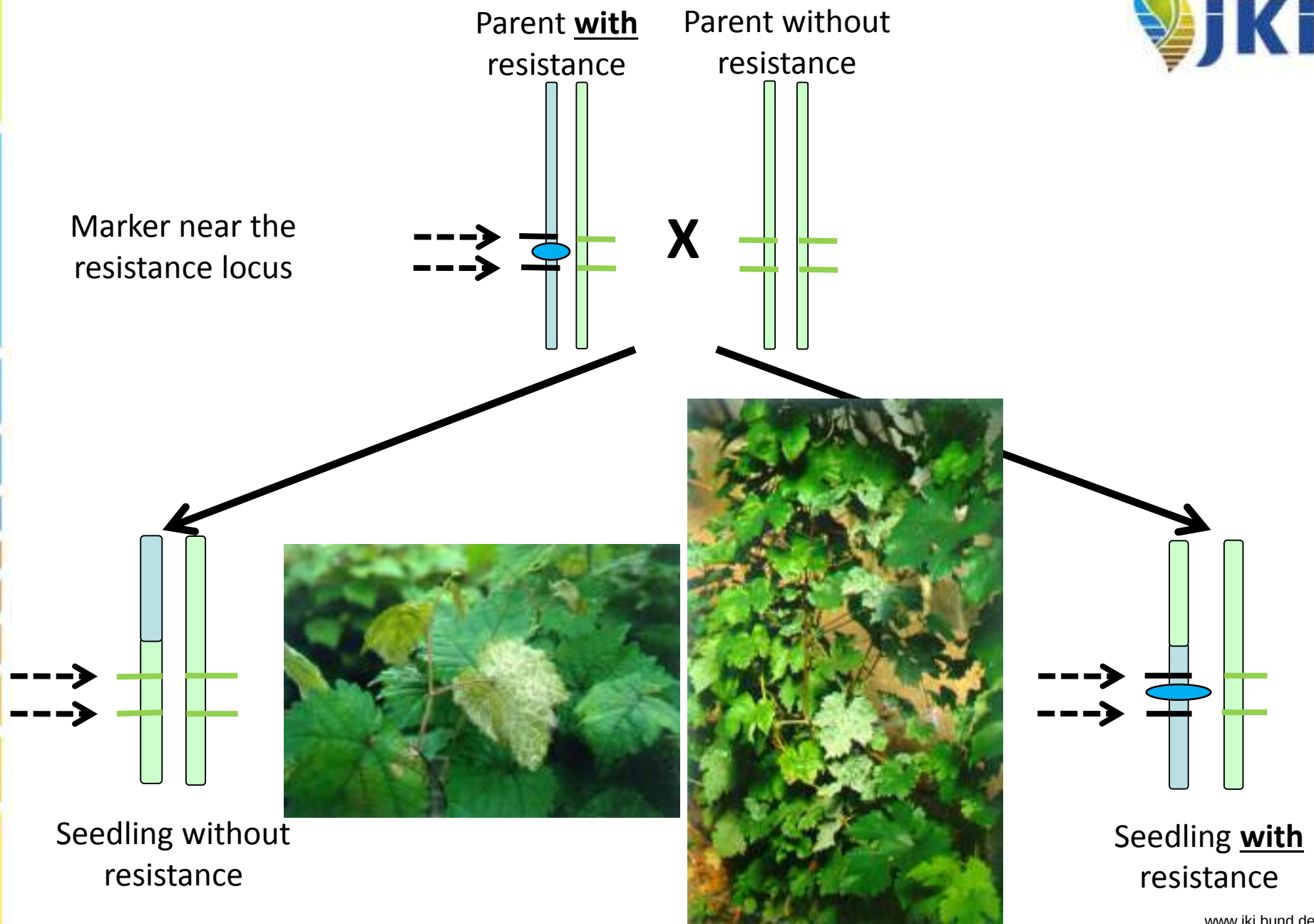


→ Genetic area C correlates with resistance (= „resistance locus“)

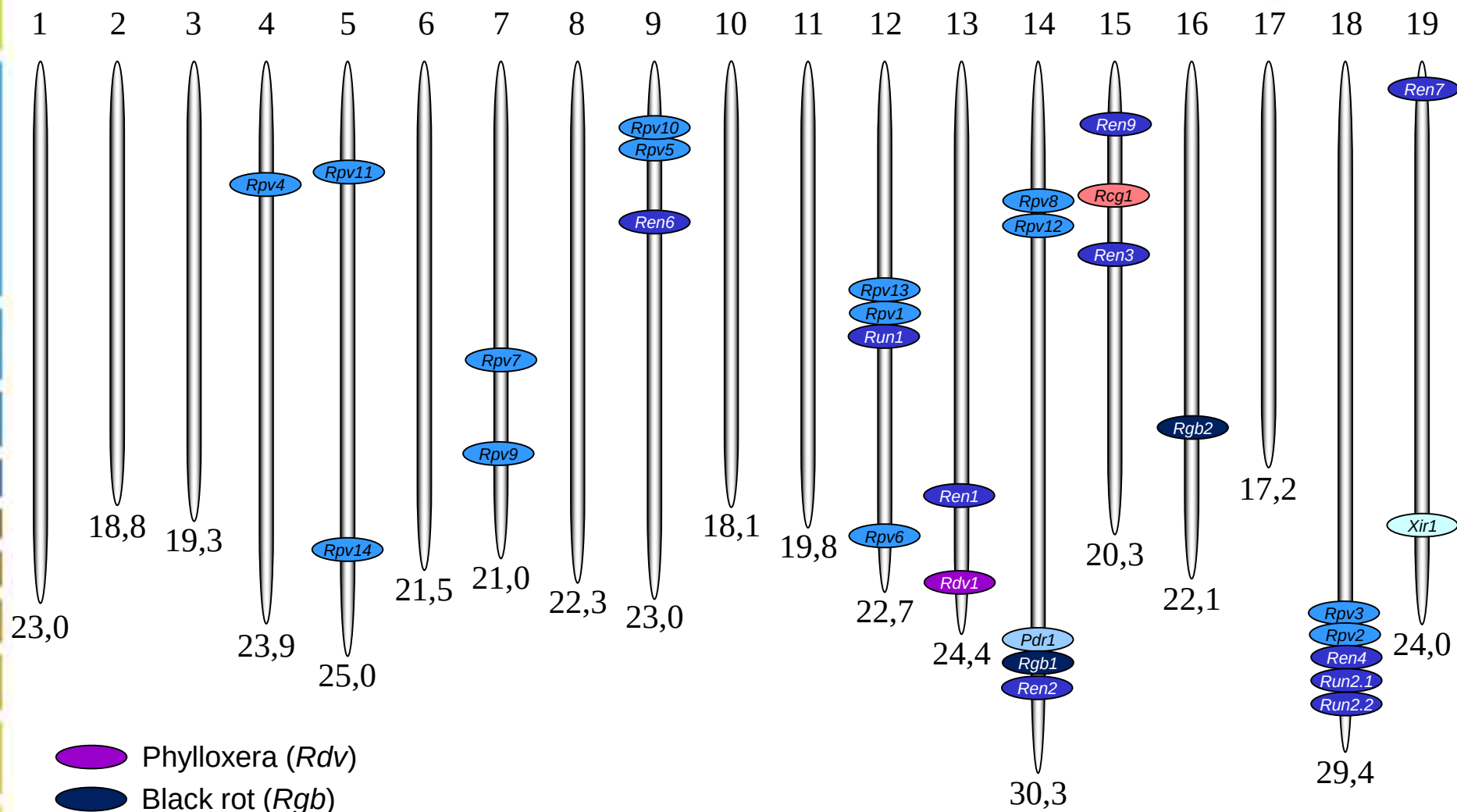
Molecular marker



Marker Assisted Selection



Identified resistance loci in *Vitis*

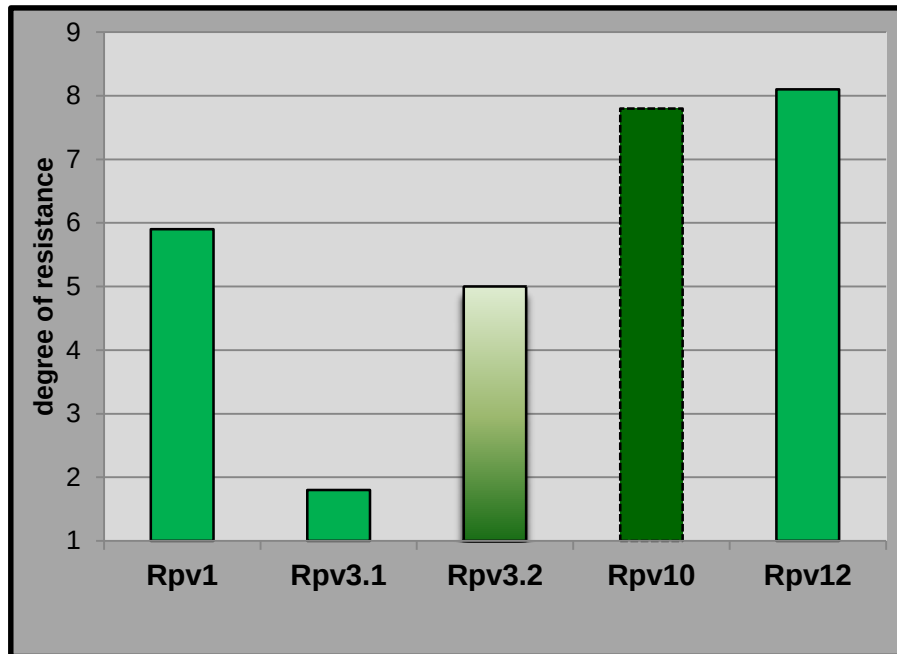


-  Phylloxera (*Rdv*)
-  Black rot (*Rgb*)
-  Powdery mildew (*Ren*, *Run*)
-  Downy mildew (*Rpv*)
-  Pierce's Disease (*Pdr*)

-  Nematodes (*Xir1*)
-  Agrobacterium (*Rcg1*)

The most important resistances for breeding

Downy mildew (several experiments 2016):



Powdery mildew	
Ren3	5 (medium)
Ren1	8 (high – very high)
Run1	9 (very high)
Ren4	9 (very high)

Durability of resistances – occurrence of fungicide resistances



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

Fungicide class	First occurrence of resistance	Years to resistance	Pest
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>

Combination of resistances?

MAS for two loci

Parent with
locus A

X

Parent with
locus B

Phenotypic discrimination may be difficult

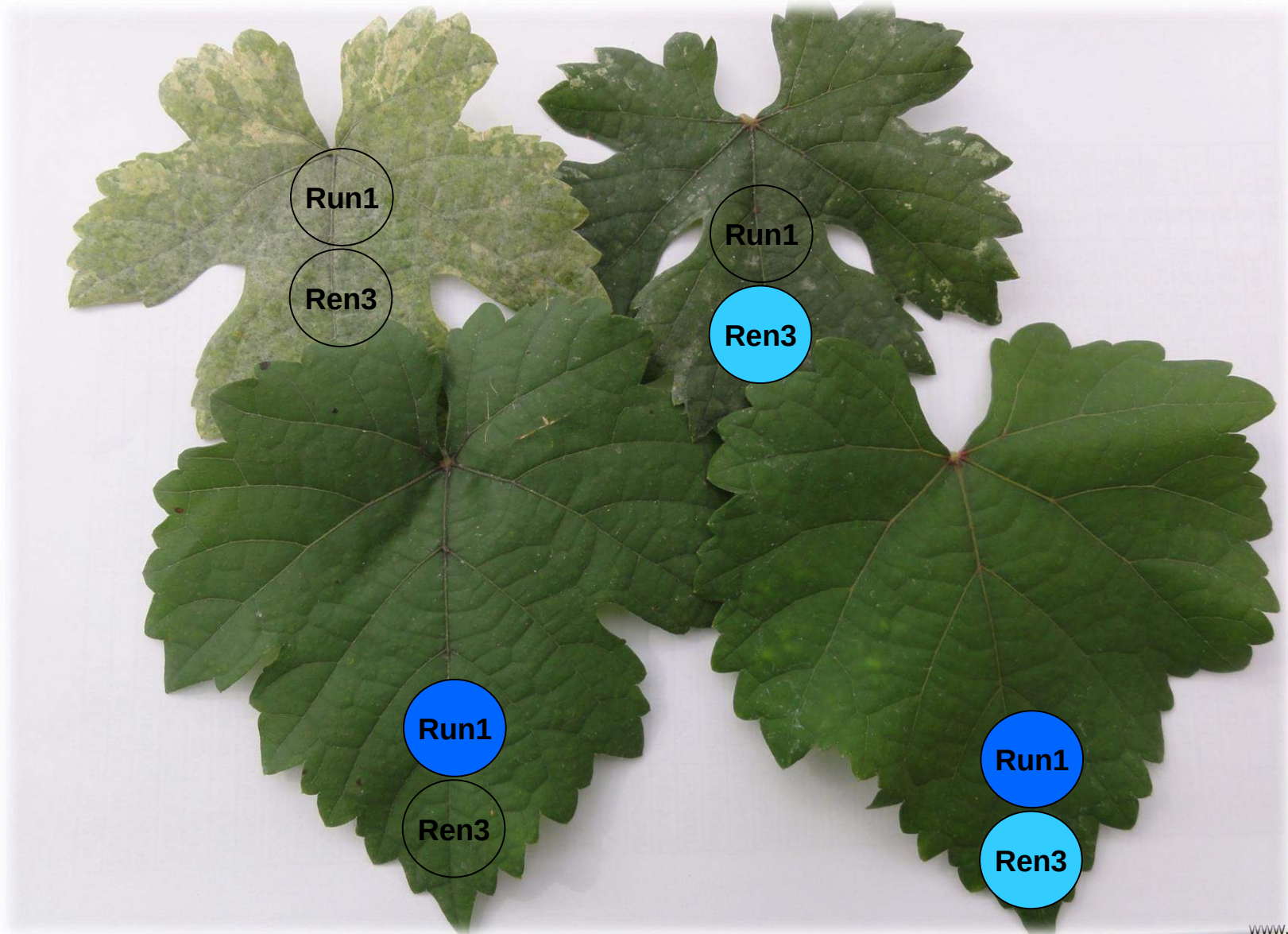
Seedling without
resistance

Seedling with
locus A

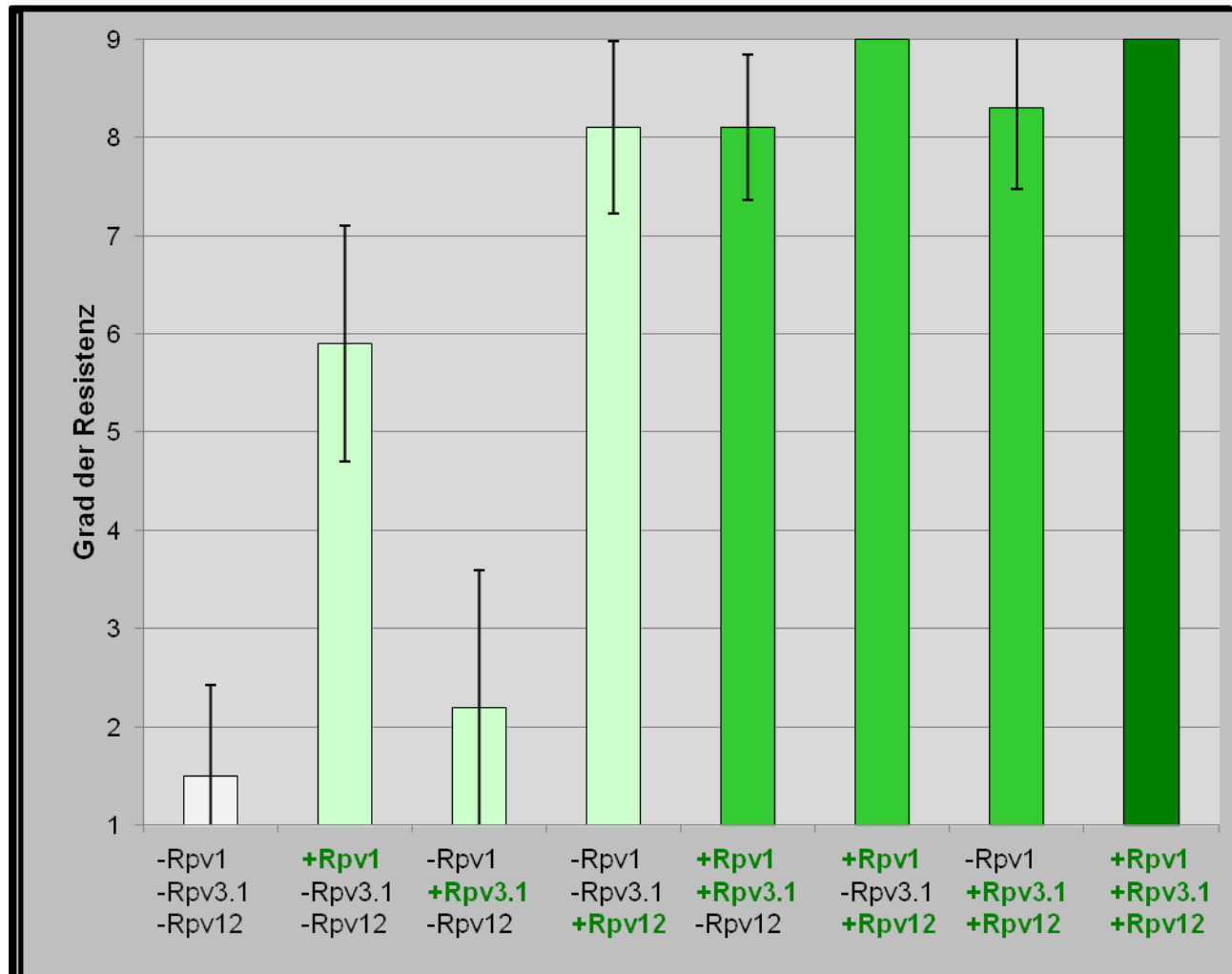
Seedling with
locus B

Seedling with
loci A+B

Powdery mildew resistance in a pop. of MTP 3082-1-42 **Run1** x Regent **Ren3**



Downy mildew: Combining different resistances and their degree of resistance



Calardis Blanc

Calardis Musqué (Bacchus x Seyval) x Seyve Villard 39-639



Rpv3-1

Rpv3-2

Ren3

Ren9

Rgb

Botrytis

Development

1993: Crossing

2018: Variety protection in GER

2019: Variety protection in the EU

~2020: Classification GER

Reduction of plant protection measures of at least 2/3 possible

Viticultural characteristics:

- Loose bunches→ good resistance against botrytis (gray mold)
- Upright growth
- Flowering and harvest time one week before Riesling

Wine:

Perfect light summer wine with a very nice and tangy acidity and light aromatic bouquet.

Calardis Blanc

Ø years 2009-2018

Yield		
	t/ha	%
Müller-Thurgau	18,0	100
Calardis Blanc	14,4	80

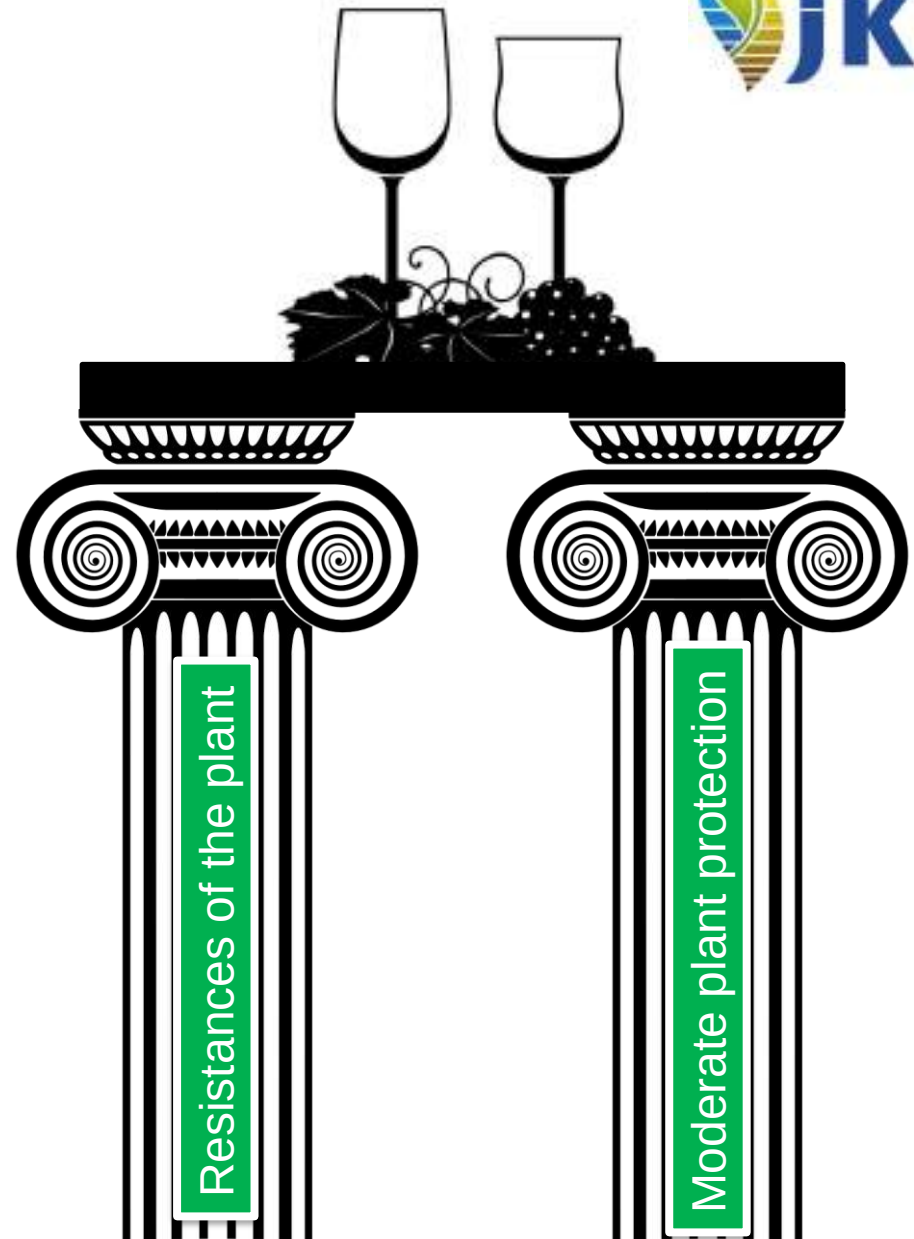
Must weight		
	°Oe	%
Müller-Thurgau	76	100
Calardis Blanc	82	108

Acidity		
	g/l	%
Müller-Thurgau	7,4	100
Calardis Blanc	7,1	96



Reduction of fungicides

- $>2/3$ of the plant protection treatments can be saved
- Still plant protection needed (2-3 treatments ?)
- Important for the durability of the resistances
- Important for the protection of other pathogens (e.g. black rot)



Thank you for your attention!



Calardis Blanc



Calardis Musqué