

Institute for Grapevine Breeding Geilweilerhof

Grape breeding supported by molecular tools – what can we expect?

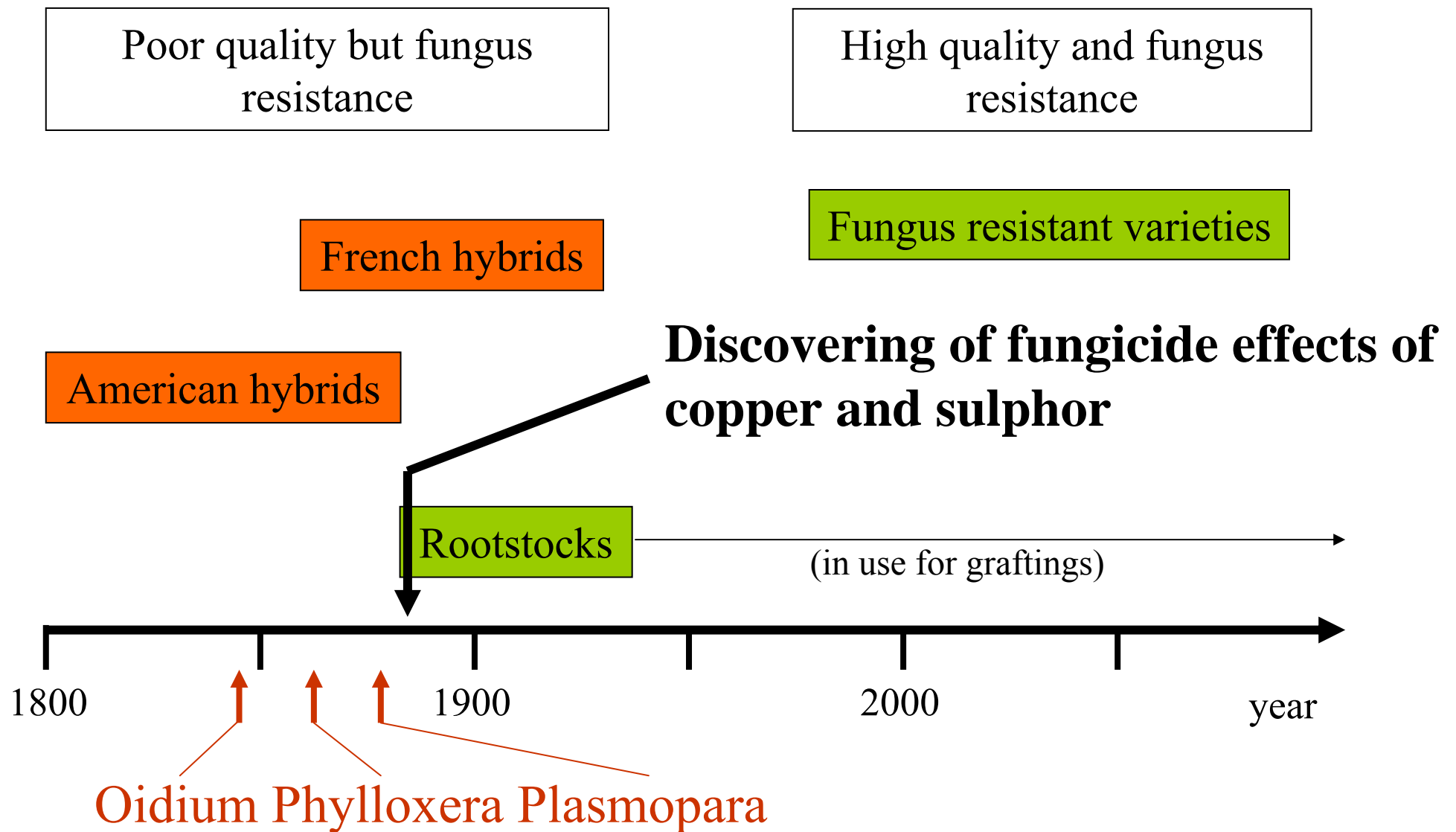
Rudolf Eibach, Reinhard Töpfer and Erika Maul

Lien de la vigne – Assemblée Générale du 13 Mars 2009

Traditional tools and goals of grapevine breeding:

- **clonal selection:** improving traditional cultivars for specific characters like flavor of wine or resistance against botrytis
- **cross breeding:**
 - new wine and table grape varieties:
improved abiotic and biotic resistance traits combined with high quality
 - new rootstock varieties:
phylloxera, adaptation to calcareous soils, etc.

Milestones in grapevine resistance breeding





powdery mildew



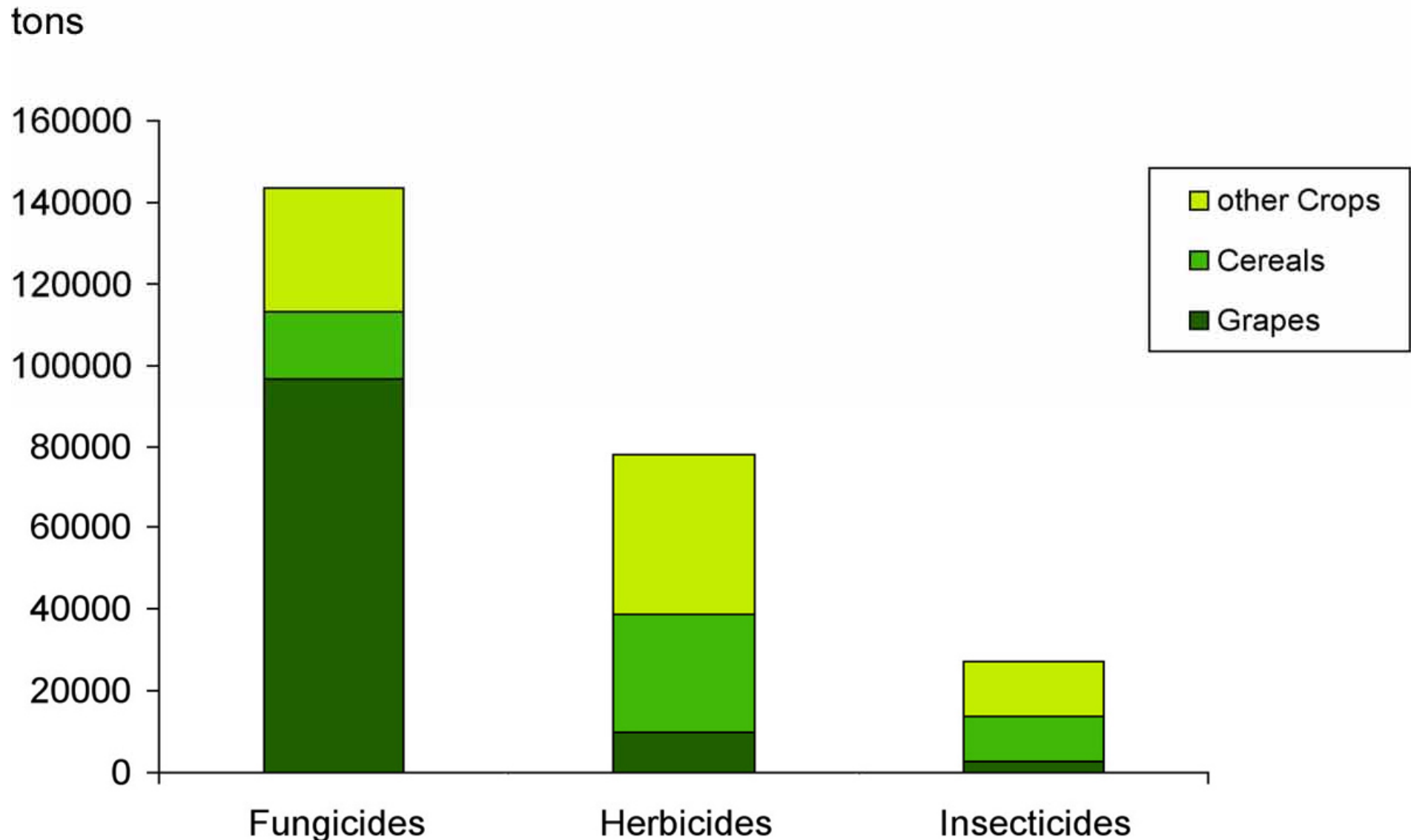
downy mildew



Lemberger with and without plant protection

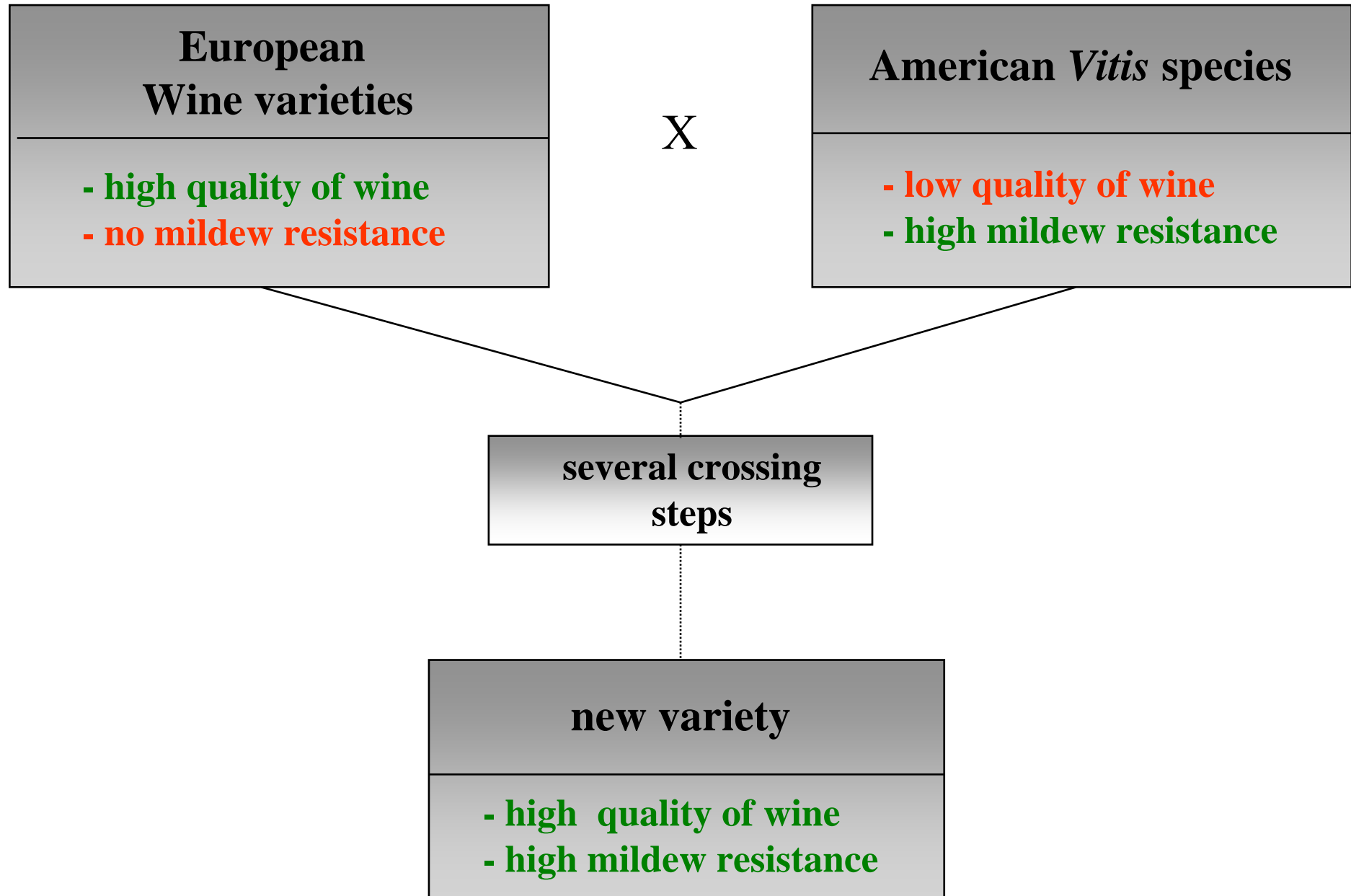
Application of Plant Protection Products in EU 15

(Average 1992 –1996)



Source: EU - Study on the Use of the Varieties of Interspecific Vines, 2003

Principles of resistance breeding





Phenotypical evaluation for mildew resistance



Evaluation of wine quality



History of variety Regent

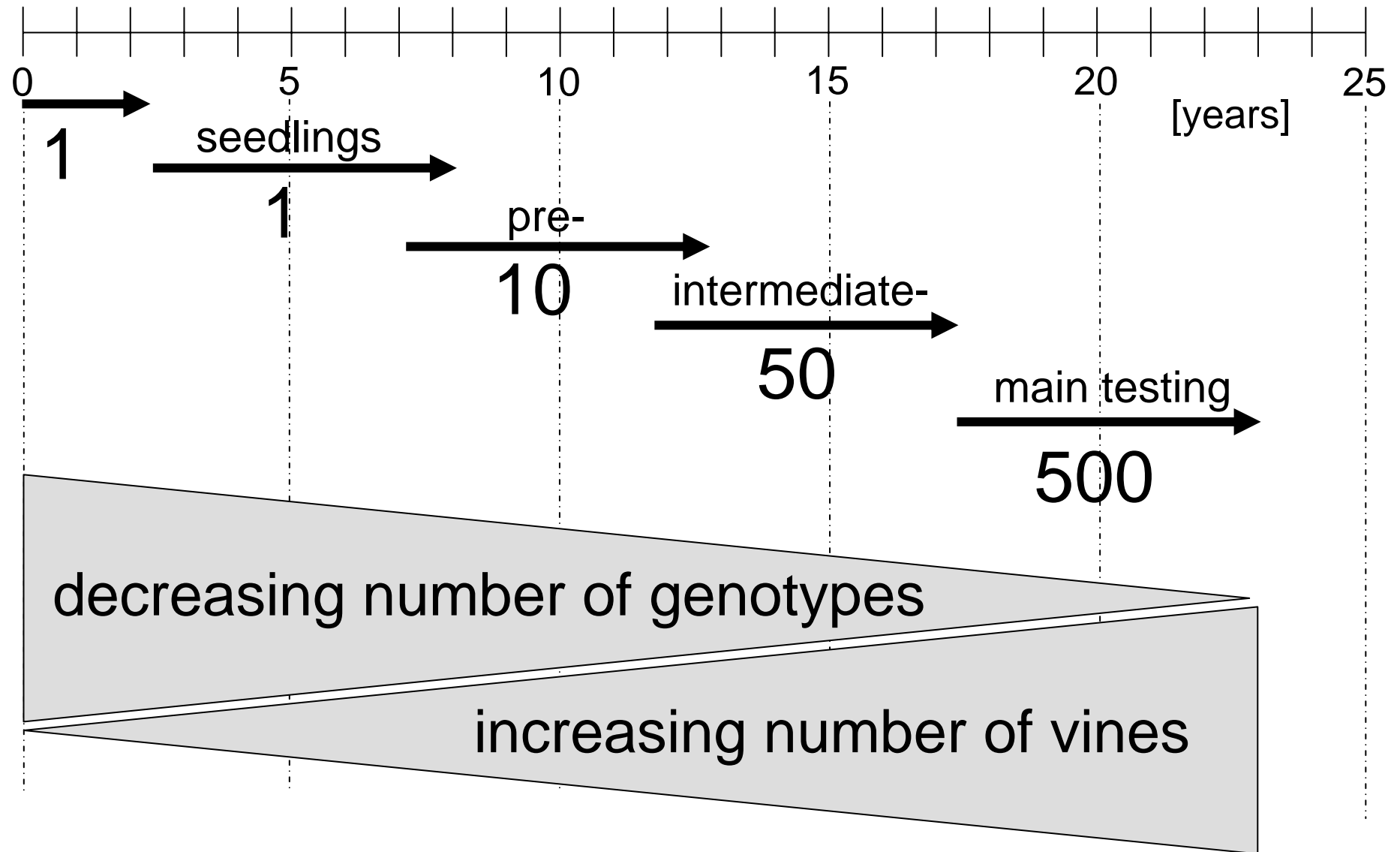
- 1967: cross Diana (B) x Chambourcin (N)
- 1969: planting in seedling field
- 1972: selection of individual plant
- 1973: transfer in second test phase
- 1981: transfer in third test phase
- 1985: establishment of first commercial vineyard
- 1989: application for variety protection and variety list
- 1994: confirmation of German variety protection
- 1995: accepted for variety list
- 1996: - accepted for production of quality wine
- confirmation of European variety protection

Classification:

- 1996: Rheinland-Pfalz
- 1997: Baden-Württemberg
- 1998: Hessen
- 1999: parts of Franconia
- 2000: other areas of Bavaria and Sachsen-Anhalt
- 2001: Sachsen

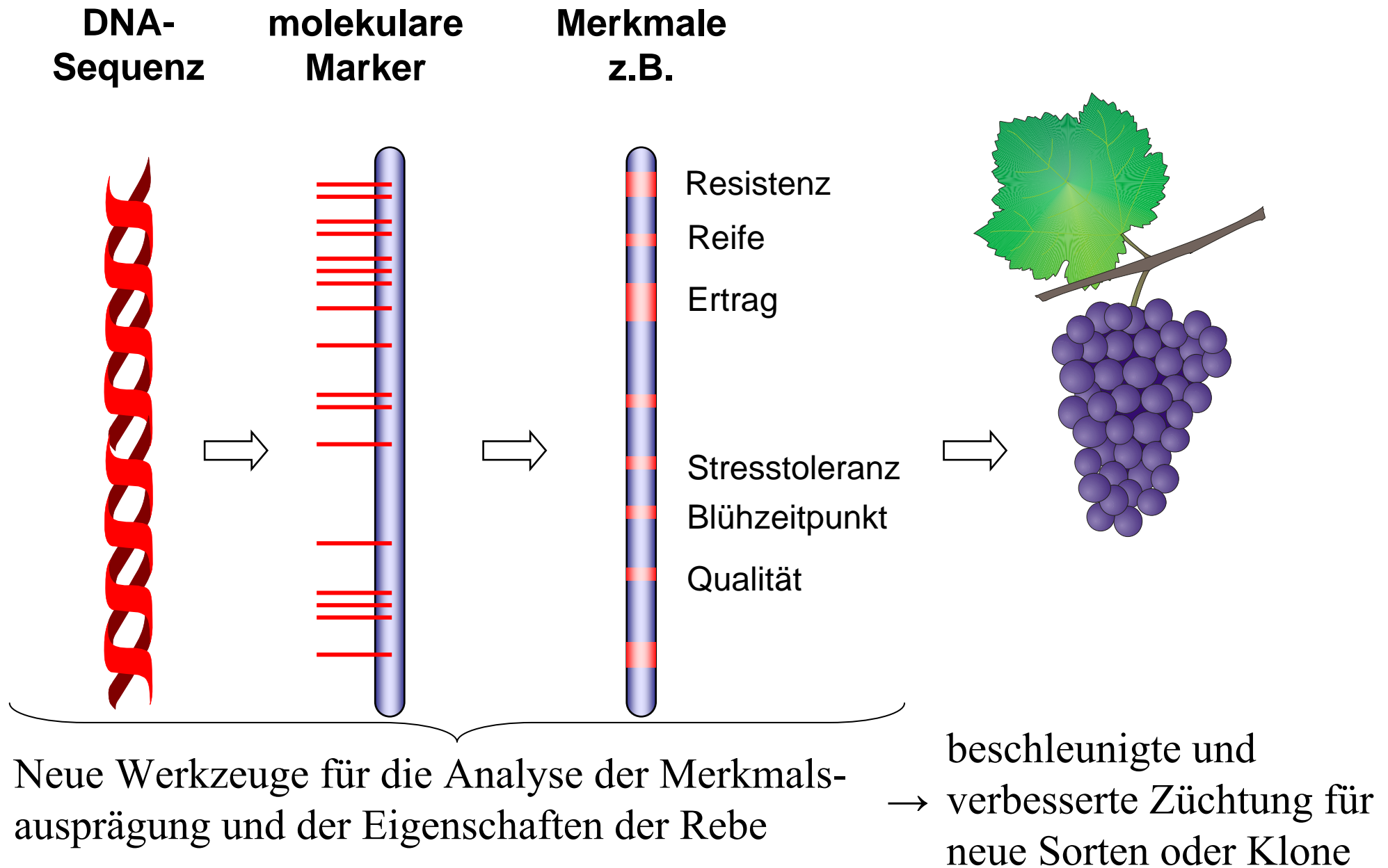


time schedule for a traditional grapevine breeding programme



Innovation in grape breeding
through
new molecular tools:

Genomanalyse - Neue Impulse für die Züchtung



Innovation in grape breeding through new molecular tools:

MAS - Marker Assisted Selection as a tool for:
– **pyramiding resistance genes**

parents:

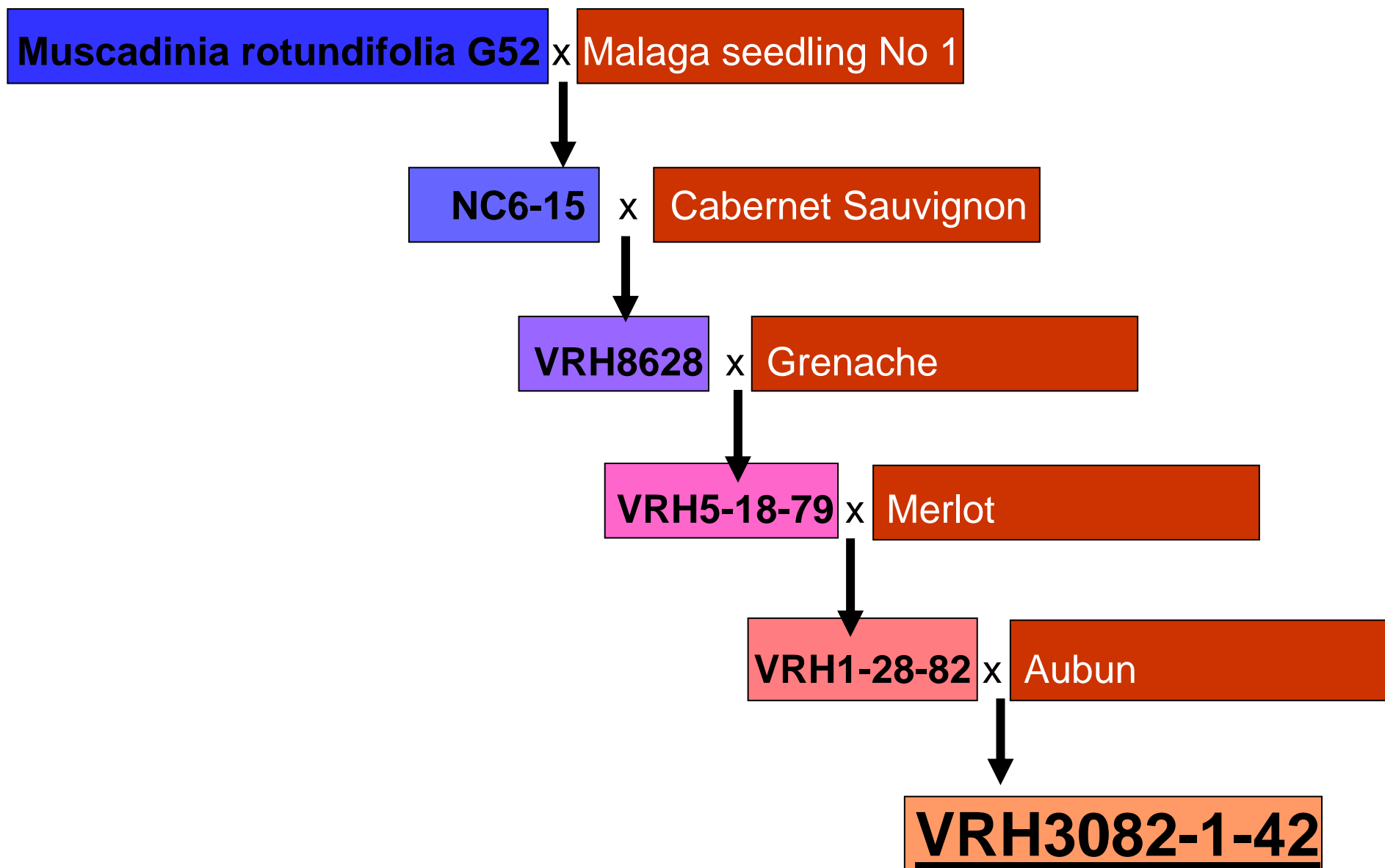


X



119 individuals in offspring

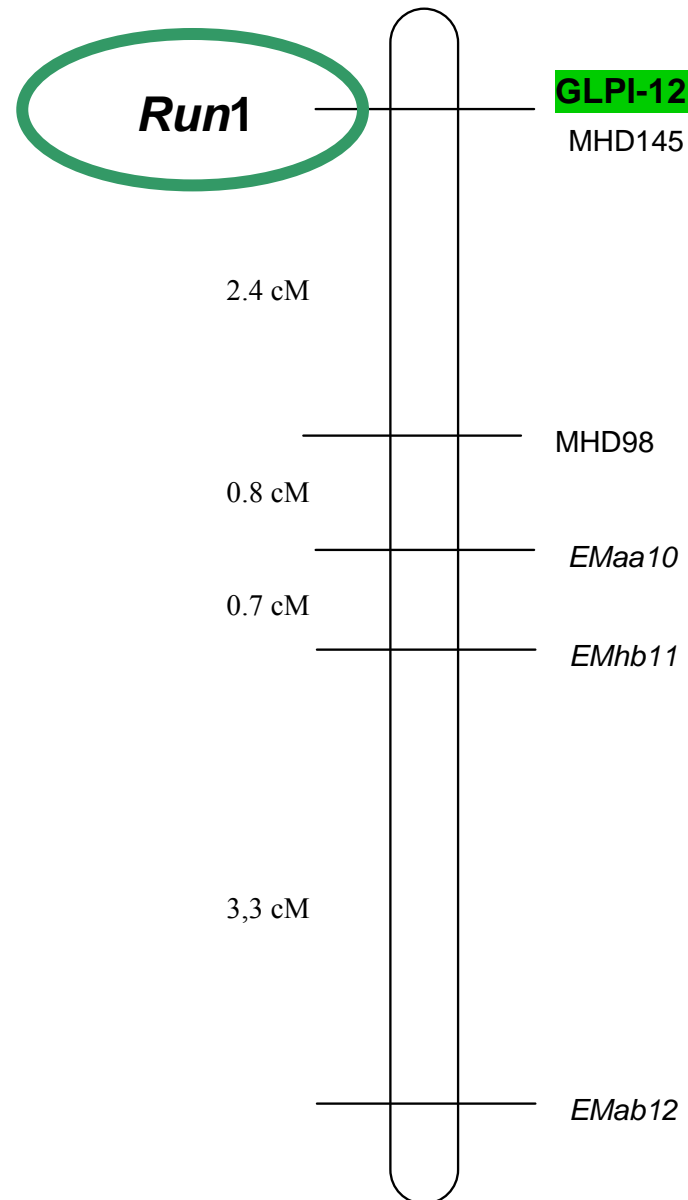
Pedigree of VRH3082-1-42 (female)



VRH3082-1-42(BC4) x Cabernet Sauvignon

RL 12

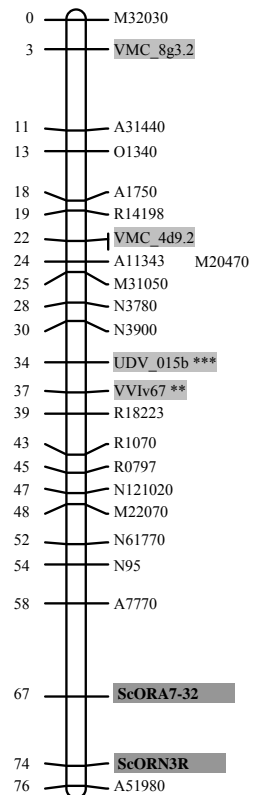
resistance powdery
and downy mildew



Donald et al, (2002): Identification of resistance gene analogs linked to a powdery mildew resistance locus in grapevine. Theor Appl Genet 104:610-618

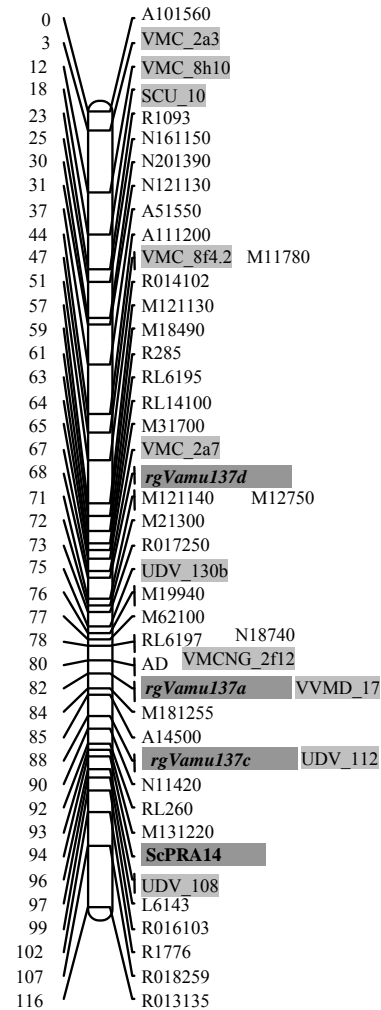
Localisation of mildew resistance in „Regent“

RL-15



Ren2

RL-18



Rpv3

Ren2 = resistance erisyphe necator

Rpv3 = resistance plasmopara viticola

phenotypical evaluation of powdery mildew resistance:



**natural infection in
greenhouse on leaves**



phenotypical evaluation of powdery mildew resistance:

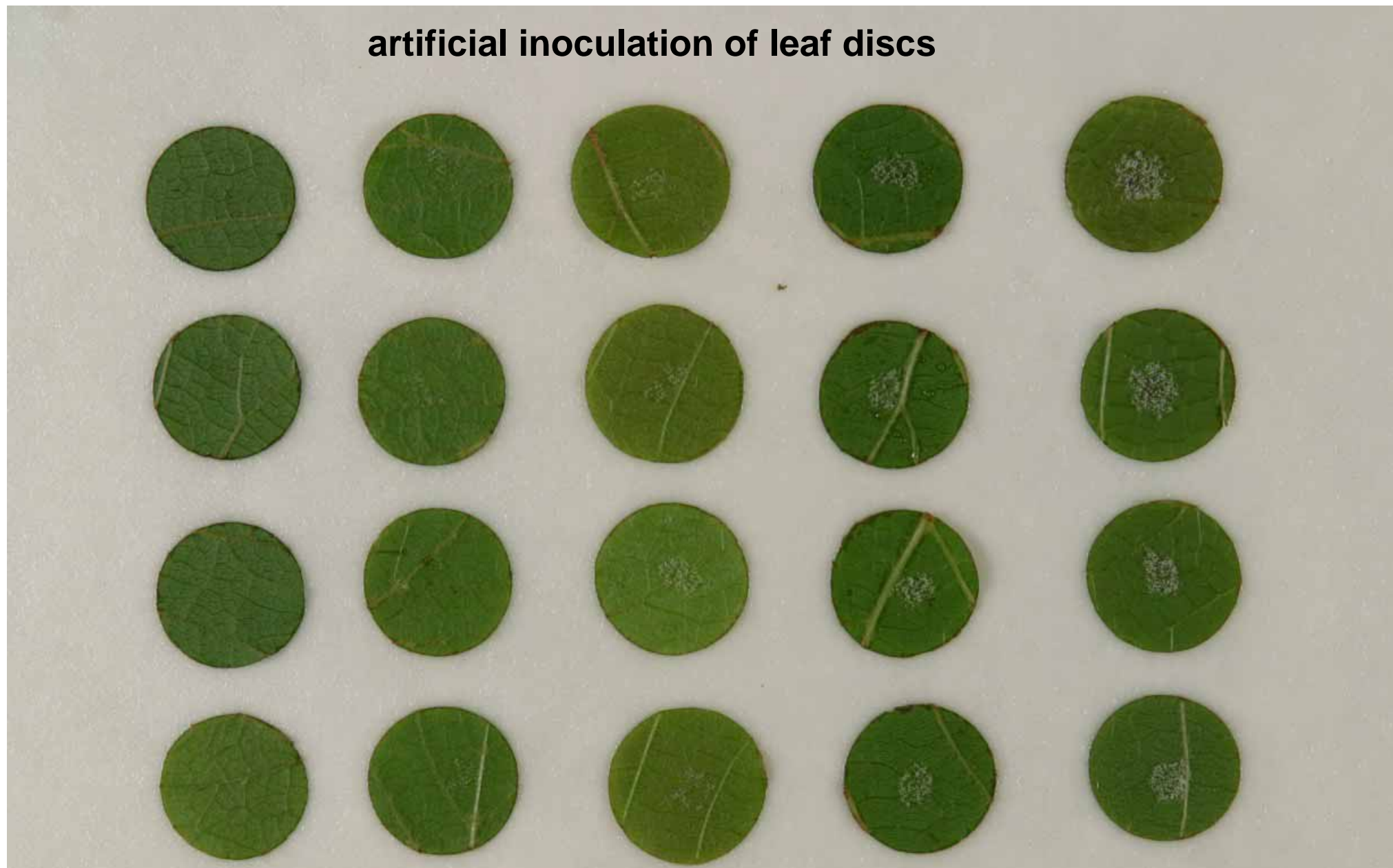


**natural infection in
greenhouse on berries**



phenotypical evaluation of downy mildew resistance.

artificial inoculation of leaf discs



1

3

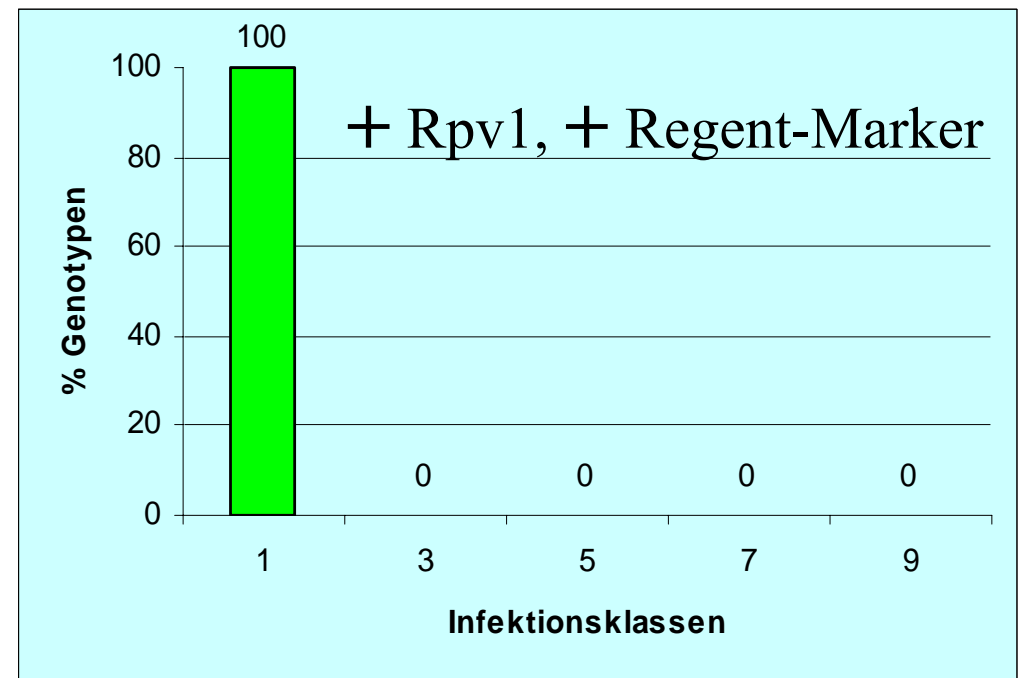
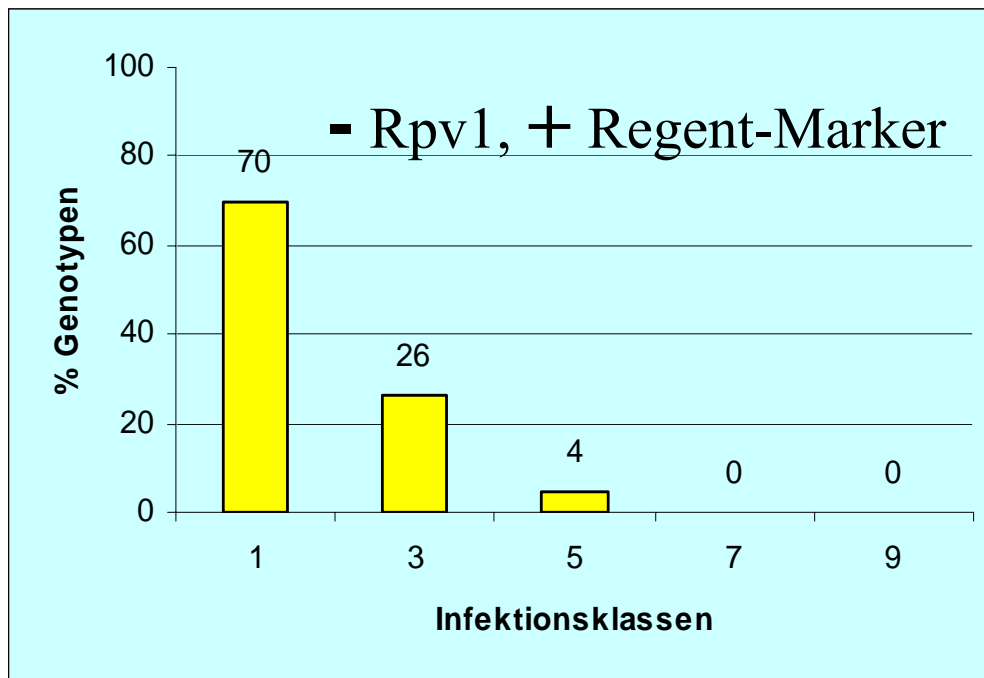
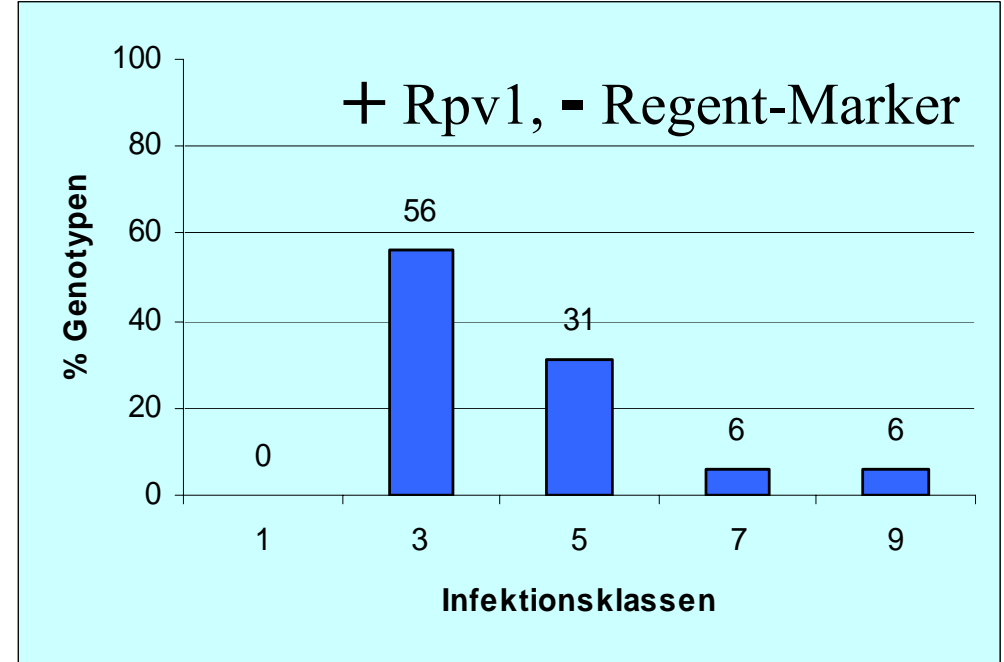
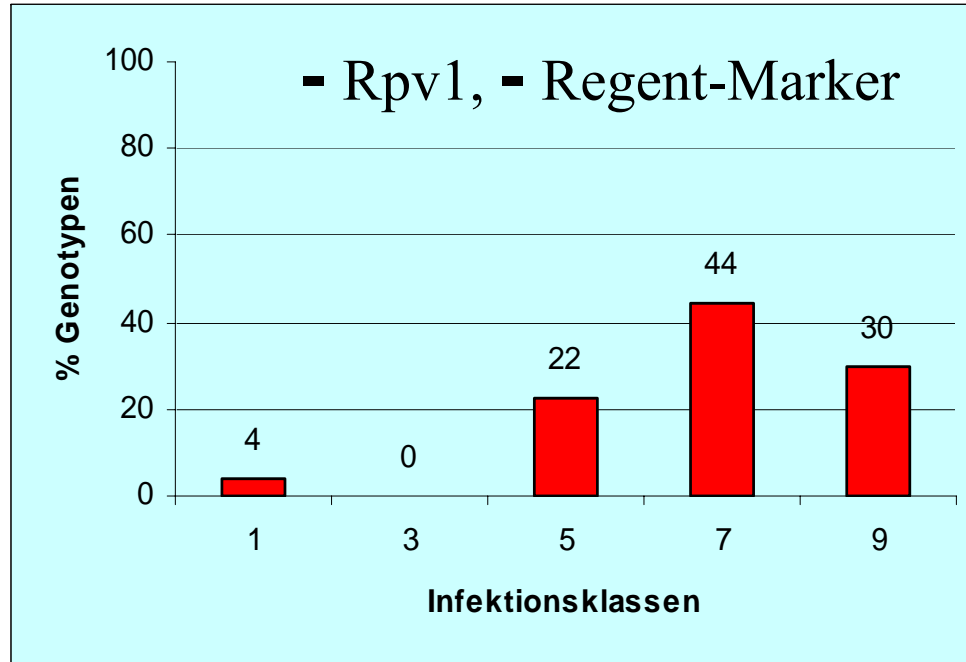
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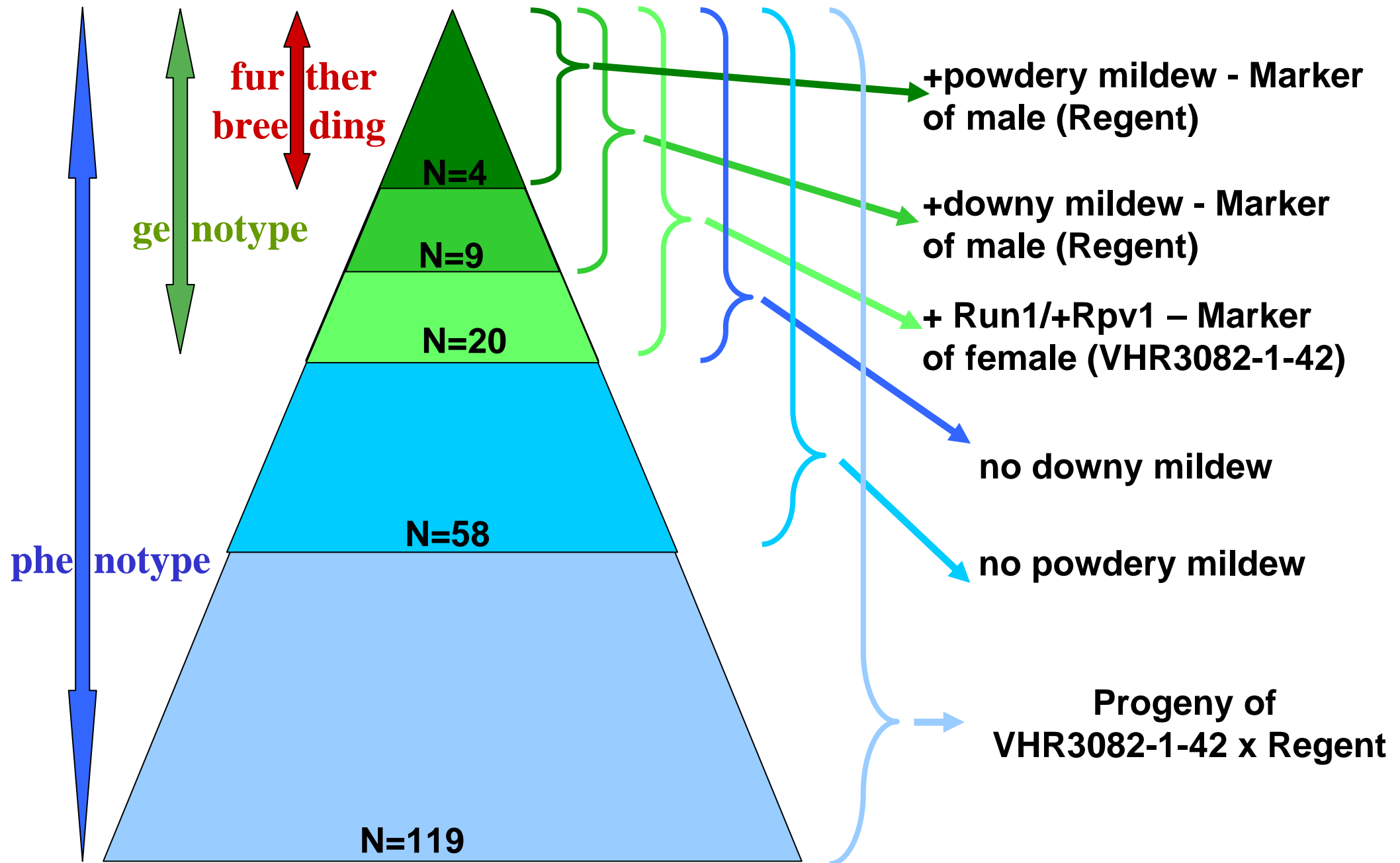
9

degree of infection

**frequency distribution for different marker combinations
correlated with downy mildew resistance**



merging different mildew resistance sources by the combination of phenotypical evaluation and genetic fingerprinting



Innovation in grape breeding through new tools:

MAS - Marker Assisted Selection as a tool for:

- pyramidizing resistance genes
- **establishing breeding lines with homzygous resistance loci**

**marker analysis of S1-selfing progenies derived
from the cross VHR 3082-1-42 x Regent**

	Run1+Rpv1 correlated markers	
seedlings (N)	state of correlated marker	seedlings (N)
369	no markers	56
	marker heterozygous	260
	marker homozygous	53

Marker analysis to select S1-genotypes with homozygous resistance at loci Run1+Rpv1

Run1+Rpv1 correlated markers		Downy mildew resistance Correlated markers of ,Regent‘	
	seedlings (N)	state of correlated markers	seedlings (N)
homozygous	53	no markers	6
		heterozygous	35
		homozygous	12

Marker analysis to select S1-genotypes with homozygous resistance at loci Run1+Rpv1

Run1+Rpv1 correlated markers		downy mildew resistance correlated markers of ,Regent‘		powderymildew resistance correlated markers of ,Regent	
	seedlings (N)	state of correlated markers	seedlings (N)	state of correlated markers	seedlings (N)
homozygous	53	no markers	6	no markers	3
				heterozygous	2
				homozygous	1
		heterozygous	35	no markers	9
				heterozygous	14
				homozygous	13
		homozygous	12	no markers	1
				heterozygous	8
				homozygous	3

Innovation in grape breeding through new tools:

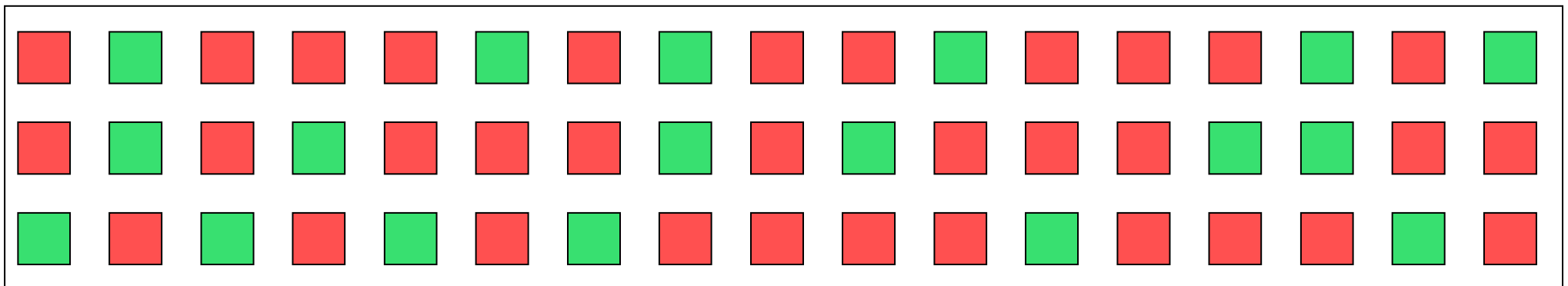
MAS - Marker Assisted Selection as a tool for:

- pyramidizing resistance genes
- establishing of breeding lines with homzygous resistance loci
- **selection of parents suitable for pyrimidizing resistance genes**

selection of downy mildew resistance

traditional procedure

susceptible x **resistant**

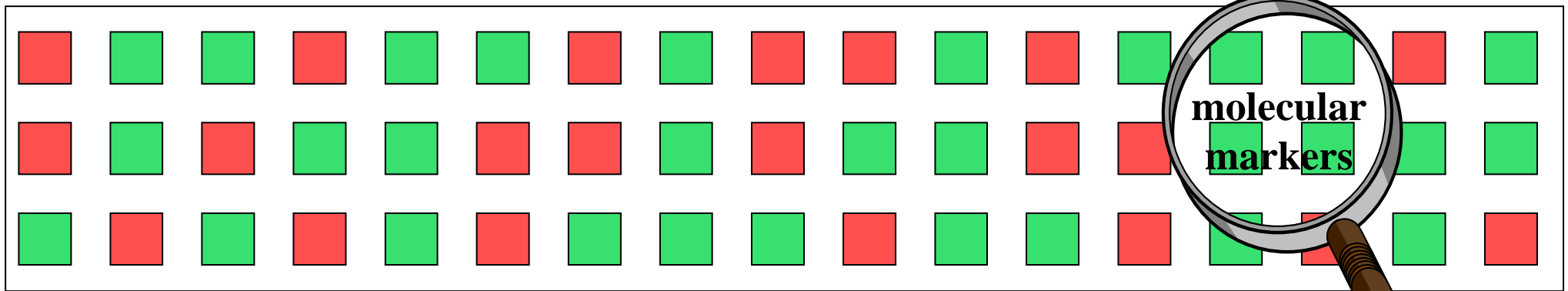


selection of downy mildew resistance

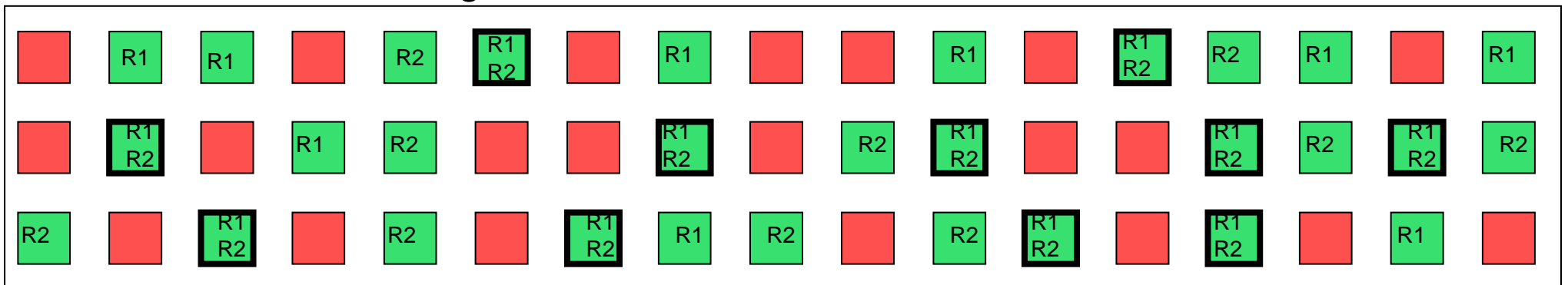
combination of traditional procedure and marker assisted selection

resistant (R1) x resistant (R2)

phenotypical selection



genetic selection ↓ molecular markers



evaluation of genetic resources for resistance genes



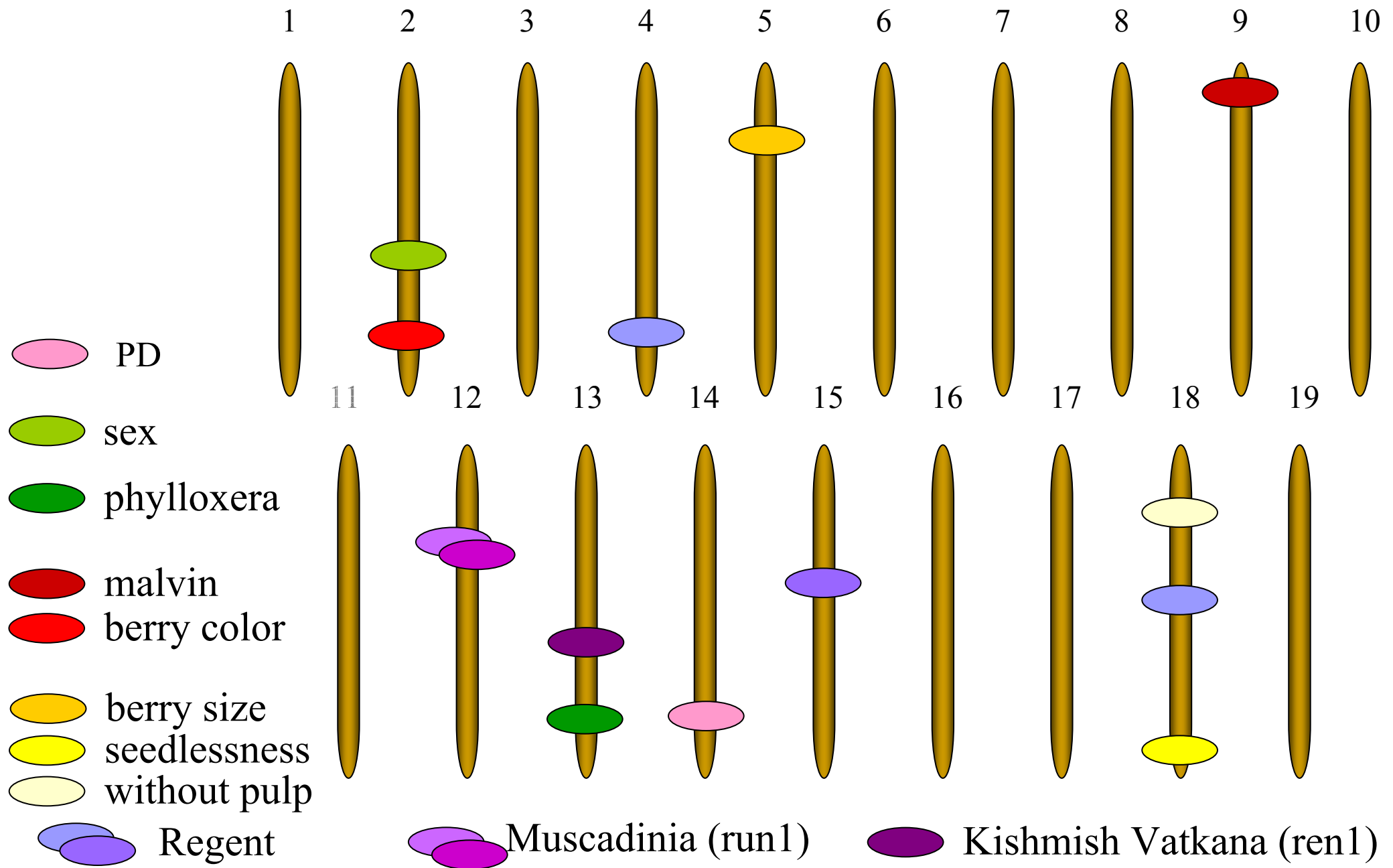
Future developments

- extended suitable marker sets
- development of further marker types for routinely usage (SNP)
- improving marker techniques (high throughput)
- improving phenotypical evaluation (high throughput through sensor based evaluation)

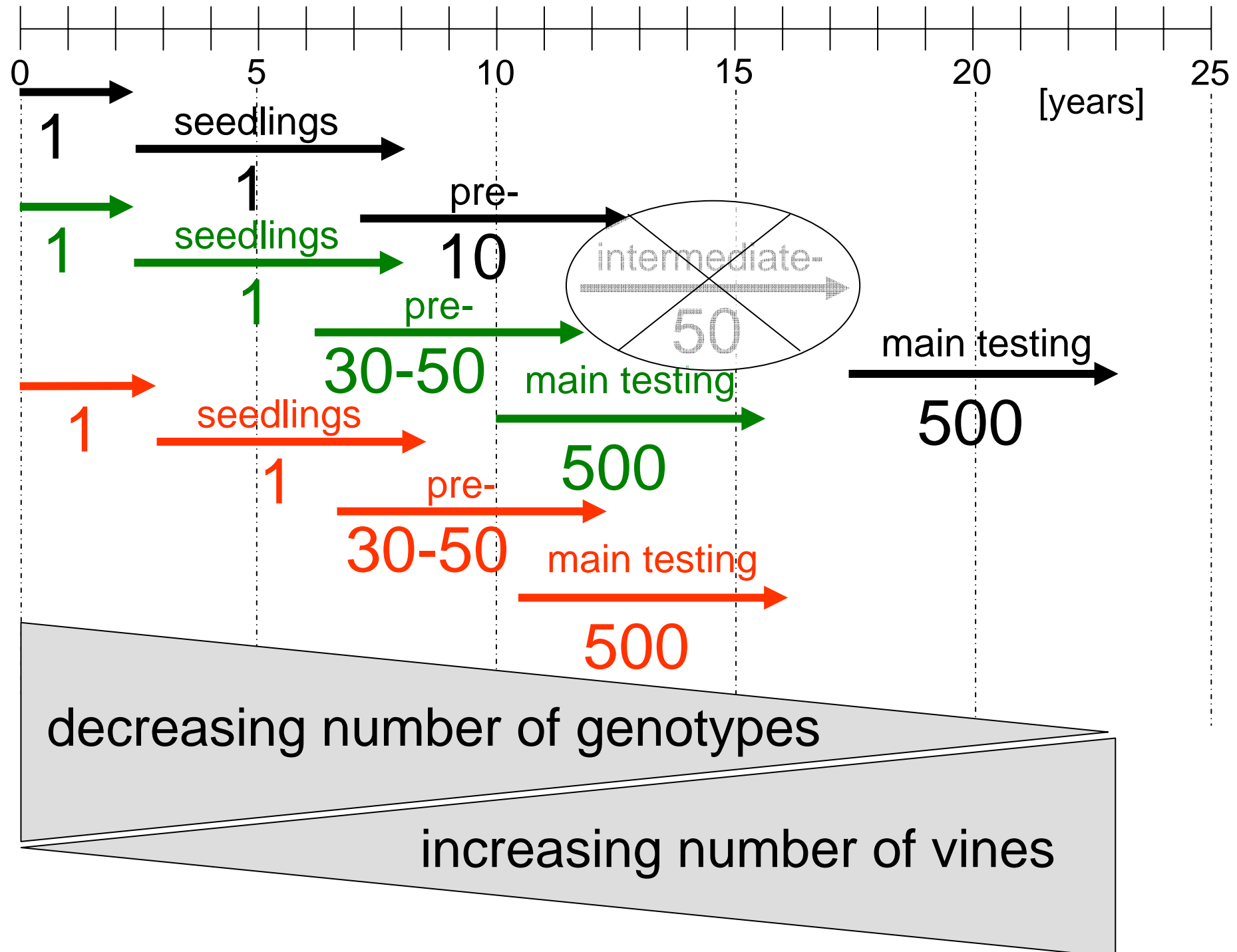
lead to:

- markers for new/additional resistance sources (pyramiding)
- improved genetic description of the gene pool used in breeding programmes (association genetics)
- extension of MAS for other important traits (quality parameters, climatic stress, etc.)
- marker assisted pseudo-backcross breeding

Loci for resistance and **other traits interesting for breeding**



Optimistic time schedule for grapevine breeding: **classically**, **MAS**, **GMO**



Conclusions:

The introduction of molecular tools in grapevine breeding will lead to:

- efficient selection of suitable parents for breeding programmes
- establishing breeding lines with homozygous loci for important traits like resistance
- increased degree of resistance against mildews and other fungal diseases (pyramidation)
- reduced timeframe for developing new improved grapevine cultivars

Molecular tools open the door to switch step by step from empirical breeding to knowledge based breeding!

Thank you for your attention.....

