New fungus resistant grapevine varieties

approaching the market.

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During the 19th century powdery mildew (about 1845), phylloxera (about 1863), and downey mildew (about 1878) were introduced as satellites on vines imported from North America and spread to castigate European viticulture. They caused terrible damage and since than these pests have to be combat in order to maintain viticulture. Phylloxera could be controlled most sufficiently by grafting scions on resistant rootstocks which were developed from interspecific crosses between American *Vitis* species such as *V. berlandierii* x *V. riparia* (the principle was suggested by Laliman 1869 and proven 1872 by Bazille). Both fungi could be controlled by massive plant protection treatments (fugicidal activity was detected 1846 for sulphur (powdery Mildew) and 1883 for copper (downey mildew)). Despite the successful strategies of combating these pests it was suggested (Millardet, 1880), that it must be possible to combine the high quality of European vines (*V. vinifera*) and the high resistance of American wild vines (e.g. *V. berlandieri, V. riparia*). First selected interspecific hybrids proved to be highly resistant but of poor wine quality. Recurrent backcrosses and selection for high wine quality and high resistance improved the breeding material considerably. Consequently, in 1976 the OIV (Organisation Internationale de la Vigne et du Vin) recommended to the member states to put emphasis in grapevine resistance breeding particularly focussing on the identification of high quality pest resistant varieties in order to reduce plant protection. Furthermore, OIV recommended to test the quality of the resulting varieties independent from their descent.

As with other crops grapevine breeders used the primary gene pool of the crop, i.e. *Vitis vinifera* and related *Vitis*-species which can be crossed easily, to combine quality and resistance. During decades hundred thousands of plants were screened by different breeders constantly improving wine quality and resistance. While it takes roughly one decade to introduce a mildew or a rust resistance into wheat (*Triticum aestivum*) from related species such as *Agropyron elongatum, Secale cereale, Triticum persicum* or *Triticum timopheevii* to develop a new and improved wheat variety, in grapevine it took at least 120 years until Millardet's idea of combining quality and resistance was

put into reality. Furthermore, tracing back the various breeding steps to improve quality and resistance, lots of drawbacks occurred and it was even longer to come via interspecific crosses and numerous backcrosses to today's elite varieties. The reason for this huge difference in time frame is fourfold: (a) for *Vitis* it takes several years to reach the generative phase and to evaluate the progeny compared to wheat, (b) it suffers extremely from inbreeding depression (i.e. selfing results in lower fitness of the progeny), which means that certain breeding strategies can not be used, (c) vines are vegetatively propagated and all desired traits must be combined within one crossing step and (d) wine quality is an extraordinary complex trait which needs to be combined with other agronomical traits including resistance.

One of today's leading varieties in Germanycoming out of resistance breeding was crossed in 1967. The breeding strain, which was later called REGENT, received variety protection in 1994 on a national and on EU level. In 1996 REGENT was classified for quality wine production in Germany giving the start for commercialisation. From roughly 200 experimental plantings in all German wine growing areas covering about 11 hectare in 1996, it's growing area developed to about 1350 hectare in 2003 (see figure). Wine-growers were attracted by the excellent wine quality and viticultural properties under German wine-growing conditions (see Table 1). Plant protection could be reduced by 70 % to 80 % or even more. In the meantime other varieties have been developed and are ready to be used by wine-growers (see Table 2).

Table 1: Results of evaluation tests in different German wine-growing areas. Tests during 1988-1996, n = number of evaluation tests.

Reference variety	Yield (kg/100m2)		Sugar content (°Oe)		Acid (g/l)	
	(n)		(n)		(n)	
test variety	∅	%	∅	%	∅	%
Pinot noir	101	100	80	100	11,1	100
	(145)		(149)		(122)	
Regent	104	**103**	82	**103**	8,3	**75**

Table 2: Overview about new fungus resistant grapevine varieties. Test plants were cultivated in field trials without fungicidal treatment and evaluated for their resistance: 1 = resistant; 9 = susceptible (Source: German Variety List 2000)

Fungus resistant variety	**Breeding Institution**	**Resistance**		
		Plasmopara	***Uncinula***	***Botrytis***
Bronner	Freiburg	2	4	3
Merzling	Freiburg	4	4	4
Orion	Geilweilerhof	2	5	5
Phoenix	Geilweilerhof	2	4	6
Regent (N)	Geilweilerhof	2	3	4
Sirius	Geilweilerhof	2	5	5
Staufer	Geilweilerhof	2	5	5
Hibernal	Geisenheim	7	5	2
Prinzipal	Geisenheim	6	8	3
Rondo (N)	Geisenheim	3	5	4

As a reference variety Pinot Noir would be entirely susceptible to Plasmopara/Uncinula/Botrytis, respectively.