Search for genotypes resistant to *Plasmopara viticola* by crossbreeding

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Summary: Crossbreeding between *Vitis vinifera* and hybrids resistant to some grapevine diseases began in 1985 in order to create biotypes which are tolerant or resistant to *Plasmopara viticola*, *Oidium tuckeri* and *Botrytis cinerea* and show quality features similar as the European parent varieties (Chardonnay, Sauvignon blanc, Prosecco, Moscato bianco and Cabernet Sauvignon) in order to reduce chemical plant protection practices.

Analysis of the F_1 population emphasized that 20 % of the plants have a favourable tolerance to downy mildew and can be employed in back-crossbreeding with European varieties. This proves that there is a different intensity of leaf reaction to the pathogenic agent.

The above-mentioned tolerance appeared to be steady throughout the years.

An interesting tolerance to oidium was also recorded in open field and greenhouse cultivations.

Key words: Plasmopara, oidium, variety of vine, genotype, resistance, tolerance, quality, crossing, analysis, Italy.

Introduction

Vine downy mildew, caused by the pathogenic agent *Plasmopara viticola* (B. et C.) BERL. et DE TONI, is the main parasitic adversity that causes serious damages to production in many Italian vineyards.

The viticultural areas of Northern Italy are considered those most subject to such risks because of summer climatic conditions which are typically rainy and humid. The frequent infections of downy mildew force viticulturists to perform a great number of treatments to prevent and restrict damages.

The growing attention towards environment problems and the consequent awareness that it is necessary to reduce chemical treatments used to control the various parasites that attack cultivations, induce research on new systems of plant protection and pest control.

For this purpose, new plant protection systems for the major cryptogamic diseases of vines are being perfected according to expected models of infection and utilizing new chemical products (TRAN MANH SUNG 1988).

A further contribution to the reduced use of plant protection products is provided by genetic improvement with studies aimed at creating genotypes capable of resisting or tolerating *P. viticola* and preserving organoleptic features that are equivalent and sometimes better than the best cultivated varieties.

Many researchers, in fact, emphasized the possibility of exploiting the genetic resources of vines to produce new varieties particularly resistant to downy mildew (MILLARDET 1891, 1894; BOUBALS 1956; DOAZAN and KIM 1978; KIM 1978; ALLEWELDT 1979; BECKER and ZIMMERMANN 1980; LI 1985).

The Istituto Sperimentale per la Viticoltura has also been promoting, for some years now, programmes of genetic improvement to obtain new genotypes with a certain degree of tolerance to the main vine fungus diseases (COSTACURTA *et al.* 1986; BORGO *et al.* 1987). The purpose is to select new individuals that require a reduced amount of chemical treatments, without, however, facing the serious risk of stimulating the diffusion of other pathogenic agents, such as *Phomopsis viticola* and *Guignardia bidwellii*, that cause excoriose and black rot.

Materials and methods

The activity of genetic improvement by crossbreeding for the above-mentioned purposes began in 1985 according to the illustrations in Fig. 1. The latter shows the European cultivars and the hybrids employed for the introduction of the character of 'resistance'.

The method of selection adopted for the F_1 generation mainly involved the degree of resistance to *P. viticola*. The plants selected for their resistance will be subject to production quality tests.

After a short period of greenhouse cultivation, F_1 populations were planted in an open field where downy mildew infections developed naturally. With regard to the type of vine protection, we must mention that these populations were only treated with fungicides during the 1st year of

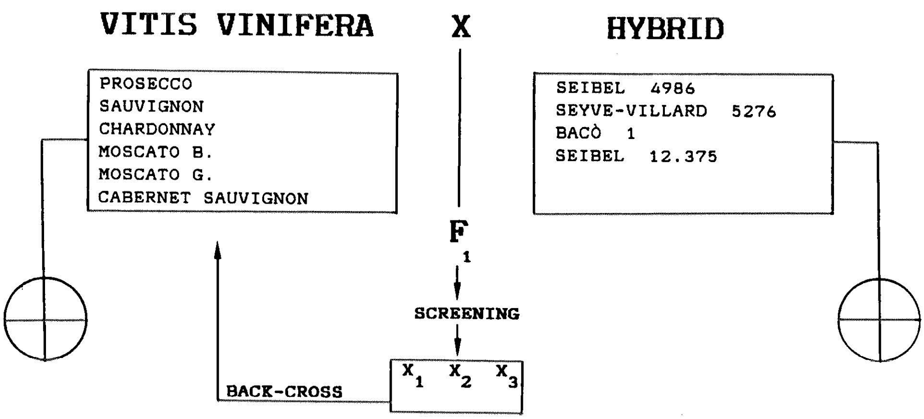


Fig. 1: Scheme of crossbreeding.

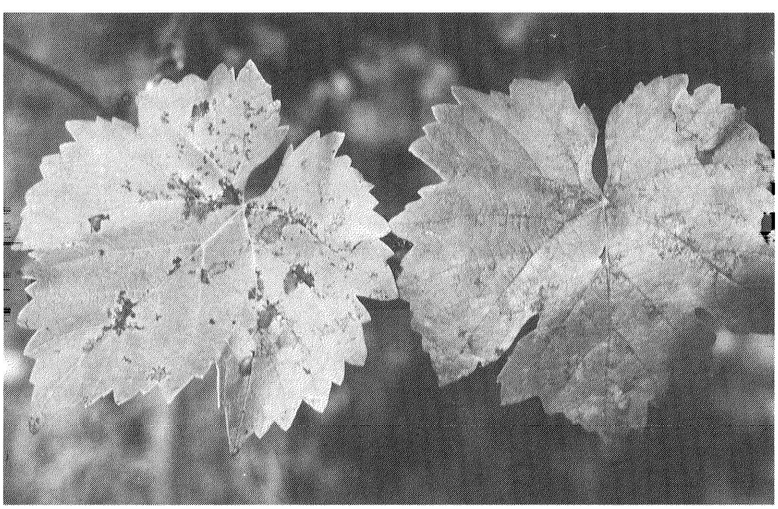


Fig. 2: Different symptomatology of downy mildew on F_1 hybrids (for further explanation see text).

Table 1: F_1 descendants of 1985 crossbreedings with different symptomatology of downy mildew recorded on leaves in the 3-year period 1987-1989

PARENTS	% DESCENDANTS	
	NECROTIZED DOWNY MILDEW	MANIFEST DOWNY MILDEW
PROSECCO X S 4986	82,6	17,4
CHARDONNAY X S 4986	78,6	21,4
SAUVIGNON X S 4986	86,0	14,0
MOSCATO B. X 4986	71,4	28,6
MOSCATO B. X SV 5276	75,8	24,2

cultivation, i. e. 1986, and that no chemical treatments were performed during the following years.

Tolerance was determined by evaluating the evidence of downy mildew on the leaves of crossbreedings, comparing them with those visible on self-fertilized control samples. Two types of symptomatologies were noticed:

- downy mildew with well defined necrotic spots of different sizes on which mosaics of sporangiophores formed only in a later stage (Type N; Fig. 2, left);
- manifest downy mildew with extensive spots and a large amount of sporangiophores (type P; Fig. 2, right).

Affected leaves and bunches were examined and classified according to a system composed of 7 classes, according to the organs involved and the extent of damage.

The results were processed according to the Townsend-Euberger formula to calculate the infection degree (I.D. %).

Results

a) Downy mildew tolerance

The F_1 descendants of crossbreedings produced in 1985 and 1986 (several hundred progenies) were repeatedly evaluated during the years of cultivation.

With regard to the results of a preliminary screening of 1985 crossbreedings, we refer to a previous report (Costacurta *et al.* 1986). In the following years, the genotypes selected for their degree of resistance were kept and observed. They proved to maintain their resistance throughout the years in which control was performed. About 80 % of the descendants constantly showed symptoms of downy mildew with necrotic type spots, whereas the residual 20 % showed mixed mildew spots, more evident under the worst climate conditions (Table 1).

The incidence of downy mildew's influence on the different groups of crossbreedings recorded in the course of the period is illustrated in graphs of Fig. 3.

The intensity of downy mildew attacks differed in the various years and was recorded in July and at the end of summer. The latter is the period that provides the most appropriate evidence of the genotypes' behaviour, especially when compared to the control testing of European varieties and their self-fertilizations grown without chemical protectant treatments, on which downy mildew affects almost 100 % of all plants with early defoliation.

The distinction between the different types of evidence of the disease's presence shows its major incidence in the group of descendants with evident signs of downy mildew on leaves in both the testing times.

Tests performed on bunches, present on 80 % of the descendants in 1989, showed that the disease occurred in 11-30 % of the individuals in all seedling populations. These amounts may be considered as acceptable according to the testing conditions; the more consistent attacks were noticed on genotypes with evident downy mildew of leaf (Fig. 4).

The results of surveys on more recent plants, planted in fields in spring 1988, are summarized in Table 2. The figures show the average number of attacks recorded at the end of 1988 and in the first 10 d of August 1989.

The genotypes with necrotic downy mildew are, on average, 28.7 % of the entire population of F_1 descendants, whereas those showing mixed necrotic and evident symptoms of the disease include about 13 % of the population.

The percentage of leaves affected is lower in the plants considered 'resistant'. Self-fertilized plants proved to be greatly affected with early defoliation.

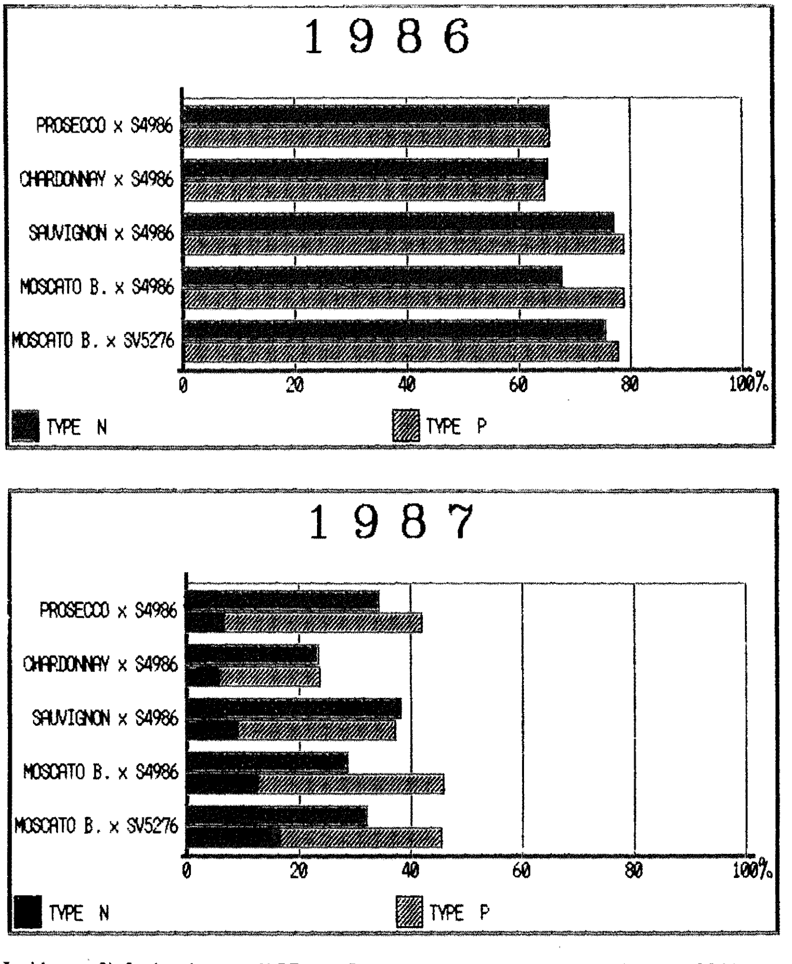


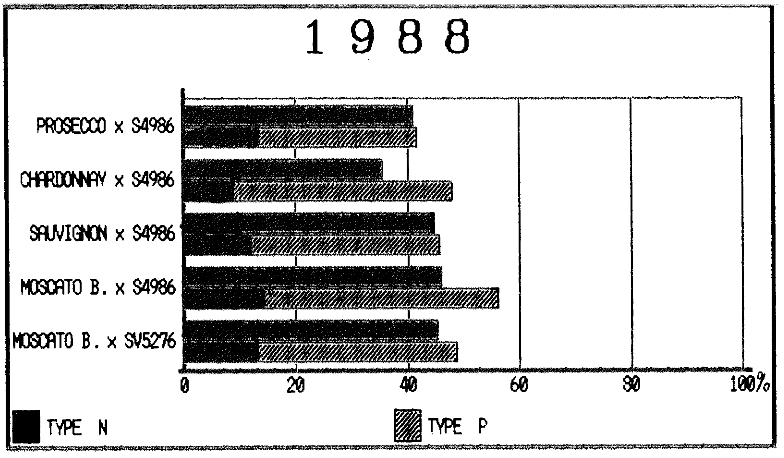
Fig. 3: Incidence of infection degrees (% I.D.) by *P. viticola* on leaves in crossbreedings F_1-1985 in several years and periods: July and August-September. (Continued overleaf.)

The figures reported show that among the European cultivars employed as parents seedlings of Sauvignon, Prosecco and Chardonnay seem to receive good resistance, in terms of frequency, to the disease, whereas amongst the donor parents the hybrid S. 4986 proves to be the best, especially when compared with S. 12.375.

b) Powdery mildew tolerance

The presence of *Oidium tuckeri* was examined on various F_1 descendants, by applying the same quantity survey systems as in downy mildew tests. The crossbreedings produced in 1985 were evaluated in field and greenhouse cultivations; those produced in 1987 were examined in the field.

Under normal cultivation conditions, powdery mildew was recorded only on a few plants (2.5 %) that seldom formed spots on some leaves and berries.



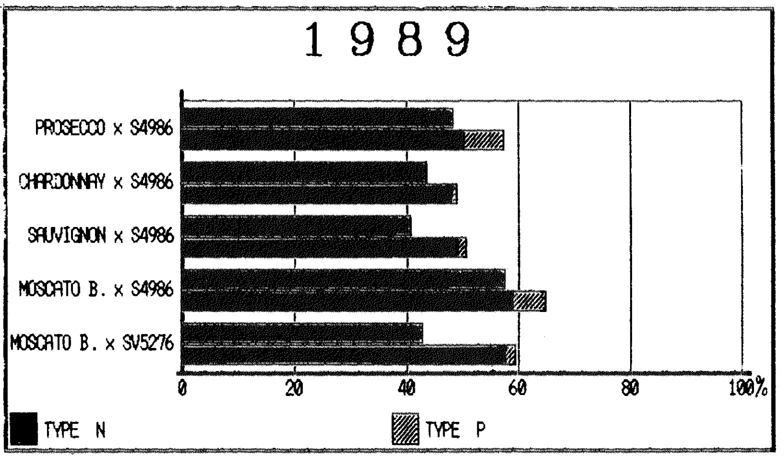


Fig. 3 (continued).

Table 2: F_1 descendants of 1987 crossbreedings divided according to different types of downy mildew on leaves

PARENTS	DOWNY MILDEW ON LEAVES					
	NECROTIZED (N)		MIXED (N-P)		MANIFEST (P)	
	GENOTYPE %	I.D. %	GENOTYPE %	I.D. %	GENOTYPE %	I.D. %
PROSECCO x S 4986	40,5	58,4	16,2	58,5	43,2	68,6
" x SV 5276	36,0	74,2	8,0	75,0	56,0	78,1
" x S 12375	18,7	45,0	18,8	47,3	62,5	63,3
SAUVIGNON x S 4986	27,6	50,3	13,8	70,0	58,6	72,9
" x SV 5276	38,9	61,9	10,7	67,3	49,7	71,7
PROSECCO x SE	35,7	55,3	21,4	59,2	42,8	86,0
CHARDONNAY x S 4986	42,8	66,7	-	-	57,2	75,0
" x SV 5276	18,2	32,0	-	-	81,8	80,0
" x S 12375	9,7	38,5	16,1	56,4	74,2	76,0
CABERNET S. x BA	18,8	48,0	31,2	36,0	50,0	77,2
AVERAGE	28,7	53,0	13,6	58,7	57,7	74,9

Table 3: Incidence of oidium attack on crossbreeding descendants of Prosecco x S. 4986 cultivated in greenhouse (Susegana, Treviso)

PARAMETERS	CROSSBREEDING DESCENDANTS 1988	CROSSBREEDING DESCENDANTS 1989	CONTROL 1988	CONTROL 1989
% infected plants	19,8	6,9	100	100
I.D. % on leaf	2,5	1,2	82,5	65,3
I.D. % on wood	2,2	0,8	64,7	18,7

The tests carried out on plants trained in greenhouses allowed us to better examine the behaviour of crossbreedings (Table 3). In 1988 approximately 20 % of the plants developed light infections on leaves and wood, whereas all the plants used as comparisons were strongly affected.

In 1989 there was a minor incidence of the disease, primarily due to an earlier survey.

Discussion and conclusions

The analysis of the descendants of some interspecific crossbreedings performed over several years, utilizing some of the most interesting European vine varieties cultivated in Venetia and several hybrid varieties resistant to *P. viticola*, demonstrated that this character is transmitted rather frequently to F_1 genotypes, with percentages ranging from approximately 20 to 40 %.

The results recorded so far proved that there are different behaviours for what concerns resistant parents: S. 4986 seems to be capable of transmitting resistance to *P. viticola* to a greater number of descendants, but S. 12.375 does not seem to be suitable for the same purpose. All the European varieties tested provided good results.

Over the years of observation, the selected genotypes maintained the acquired feature constantly, even when climate conditions and the epidemiology of *P. viticola* varied. The descendants affected by necrotic downy mildew recorded lower infections than those primarily bearing evident forms of the disease.

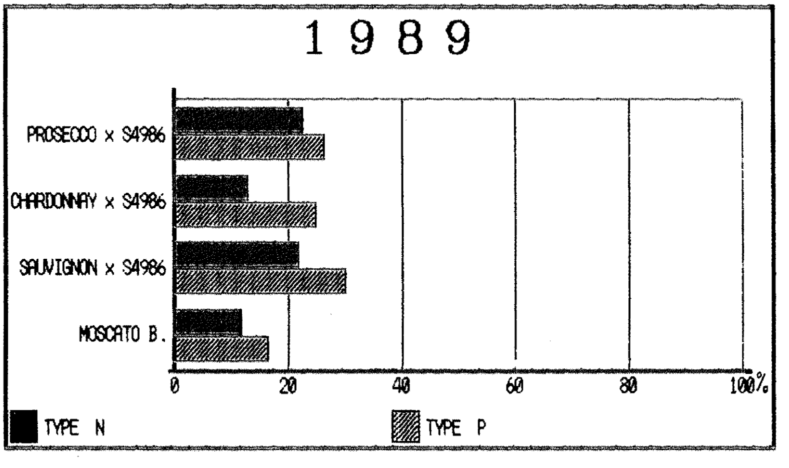


Fig. 4: Incidence of infection degrees (% I.D.) by *P. viticola* on bunches in crossbreedings F_1-1985.

Plants with intermediate features could be just as interesting considering the low incidence of downy mildew. The viticultural material selected was also of interest for what concerns its *O. tuckeri* tolerance, i. e. the number of plants affected and the extremely low incidence of disease attacks.

At present, there is no information concerning resistance to *Botrytis cinerea* PERS., as there was only a small amount of bunches on which tests could be performed in 1989.

We must emphasize that at this moment there were no other diseases due to cryptogams that might appear on unprotected plants.

Research will continue in the coming years according to the established crossbreeding programme: At the same time, new and future genotypes will be selected for resistance to grapevine diseases. The resistant genotypes will be subject to control to examine their productive and, primarily, organoleptic features.

References

ALLEWELDT, G.; 1979: Sélection de variétés résistantes en R. F. d'Allemagne. XVIe Congr. Vigne Vin, Stuttgart, 21-27 mai 1979.

AVRAMOV, L.; BABOVIC, M.; JOVANOVIC, M.; RUZEVIC, M.; 1980: Breeding plasmopara-resistant varieties in *Vitis*. Proc. 3rd Intern. Symp. Grape Breeding, Davis, 302-307.

BECKER, N.; ZIMMERMANN, H.; 1980: Wine quality of newly bred grape varieties resistant to downy mildew. Proc. 3rd Intern. Symp. Grape Breeding, Davis, 308-323.

BORGO, M.; CANCELLIER, S.; COSTACURTA, A.; 1987: Protection intégrée de la vigne avec l'amélioration génétique par croisement. Symp. Influence of Environmental Factors in the Control of Grape Pests, Diseases and Weeds. Thessaloniki, 6-8 October, 1987.

BOUBALS, D.; 1956: Amélioration de la résistance de la vigne au mildiou (*Plasmopara viticola* (B. et C.) BERL. et DE TONI). Recherche de géniteurs de résistance. Ann. Amélior. Plantes **4**, 481-525.

COSTACURTA, A.; CANCELLIER, S.; CORINO, L.; MORGO, M; 1986: Resistenza a *Plasmopara viticola* in incroci di *Vitis vinifera* con ibridi. Riv. Viticolt. Enol. **39**, 532-539.

DOAZAN, I. P.; KIM, S. K.; 1978: Recherche de génotypes résistants au mildiou dans des croisements interspécifiques. Génétique et Amélioration de la Vigne, 243-249. INRA Ed., Paris.

KIM, S. K.; 1978: Etude de croisements interspécifiques chez la vigne, transmission héréditaire de quelques caractères physiologiques et de la résistance au mildiou et au phylloxera. Thèse Doct. Ing., Univ. de Bordeaux II.

LI, H.; 1985: Etude de la relation entre le mildiou de la vigne (*Plasmopara viticola* (B. et C.) BERL. et DE TONI) et l'espèce *Vitis vinifera* L., variabilité de l'agent pathogène et de la sensibilité de l'hôte. Thèse Doct. Oen. Amp., Univ. de Bordeaux II.

MILLARDET; A.; 1891: Essai sur l'Hybridation de la Vigne. Masson Ed., Paris.

-- --; 1894: Sur les résultats généraux de l'hybridation de la vigne. Rev. Viticult. **1**, 57-61, 84-88, 108.

TRAN MANH SUNG, C.; 1988: Le comportement épidémique de *Plasmopara viticola* vu au travers de modèles EPI, POM et PCOP. C. R. 2e Conf. Intern. Maladies des Plantes, Tome III. ANPP, Paris.