Clonal variability of several grapevine cultivars (*V. vinifera* L.) grown in the Emilia-Romagna [1])

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Summary: Clonal selection has been performed over the past 2 decades by the University of Bologna to maintain the traditional grapevine cultivars grown in the Emilia-Romagna. Around 1980 budwood canes from several biotypes of the cvs Lambrusco di Sorbara, Lambrusco Salamino, Lambrusco Grasparossa, Lambrusco Maestri and Fortana were collected from old vineyards and used to establish a preliminary trial.

The vines were tested for their virus status and compared for yield, grape quality, leaf characters and phenological phases in order to evaluate the biotype variability and clonal repeatability within each cultivar.

L. Salamino, L. Grasparossa and L. Maestri showed very low degrees of genetic determination for yield and quality, while Fortana and L. Sorbara exhibited quite high degrees. The results in both cases were independent on the virus status of the vines. While for cvs L. Salamino, L. Maestri and L. Grasparossa selection can be made only on the basis of virus status, good selection potentials were found with cvs L. Sorbara and Fortana. Fortana also exhibited marked differences in leaf morphology and phenological phases. Further investigations are needed to better characterize the diversity among biotypes of this variety, since the delimitation between cultivars and clones remains questionable.

Key words: variety of vine, clone, Italy, variability, genetics, selection, biometry, virosis, yield, must quality, morphology, phenology.

Introduction

A necessary premise to clonal selection is variability among biotypes of a given variety. The main issue is genotypic variance, which can be transmitted by vegetative propagation and separated from environmental effects in planned trials. The proportion of the phenotypic variance which is due to permanent differences between individuals (genotypic variance) – which can be easily calculated – is called degree of genetic determination or clonal repeatability (Falconer 1981).

In Italy studies on the degree of genetic determination among biotypes have been performed recently for some cultivars of the Veneto Region and the results have indicated favourable conditions for selection (Calo *et al.* 1987). Similar research has been conducted in Emilia-Romagna since 1980 on several of the main grapevine cultivars of the area.

This paper focuses on the red cvs Lambrusco di Sorbara, Lambrusco Salamino, Lambrusco Grasparossa, Lambrusco Maestri and Fortana, whose biotype variability and degree of genetic determination were evaluated for productivity and must composition. An attempt to relate biotype heterogeneity to morphological characters and sanitary status of the vines is also reported.

Materials and methods

Budwood canes from 7 biotypes of L. di Sorbara, 6 of L. Salamino, 10 of L. Grasparossa, 5 of L. Maestri and 5 of Fortana were collected from old vineyards located in the cultural areas of the varieties and used to establish a preliminary trial (Intrieri 1976).

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The buds were grafted on a virus-free rootstock (SO 4) and in 1980 3 blocks of 4 vines per biotype were planted for each cultivar in a field in Modena area (30 km northwest of Bologna). In the subsequent years the biotypes were indexed by grafting to woody indicators, i. e. *Vitis rupestris* cv. St. George, LN 33, to detect grapevine fanleaf virus (GFV), grapevine fleck, grapevine stem pitting (LR), grapevine leafroll (GLR) and corky bark. In addition, enzyme-linked immunosorbent assay (ELISA) was also used to detect GFV infection (MARTELLI 1979).

Since 1983 the number and weight of bunches per vine have been recorded yearly at harvest. In 1986 and 1987 berry samples were taken and the juice analyzed for pH, titratable acidity and soluble solids concentration. In addition, the time of bud burst and flowering were recorded and the leaf traits were investigated for 5 biotypes per cultivar. 10 leaves from the medial part of the shoot were sampled after berry shatter as proposed by ALLEWELDT and DETTWEILER (1986) and data were collected as reported in Fig. 1.

Yield and must composition data were subjected to analysis of variance (ANOVA) and variance partitioning was calculated as reported in Table 1. Clonal repeatability as the ratio between genotypic and phenotypic variance (after OTTAVIANO 1968) was also determined.

To evaluate the variability in yield quantity and quality, multivariate analysis of variance (MANOVA) was performed after standardization on crop, bunch weight, must pH, soluble solids

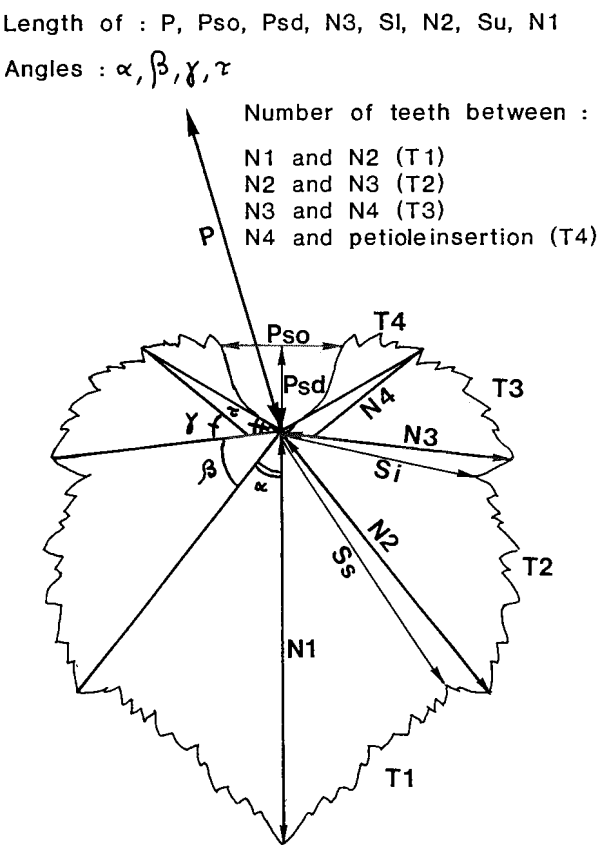

Fig. 1: Leaf characters measured for ampelographic descriptions.

Table 1: Analysis of variance and its partition

Source of variation	Degree of freedom	Variance	Partition of variance
Biotype	c - 1	V1	Ve + nVge + neV
Year	e - 1	V2	Ve + nVge + ncV
Biotype x Year	(c-1) (e-1)	V3	Ve + nVge
Error	c e (n-1)	V4	Ve

Environmental variance (Ve), Genotypic variance (Vg)
Genotype x Environment interaction variance (Vge)

and titratable acidity. MANOVA (Camussi *et al.* 1986) was also applied to describe leaf morphology, using the following standardized variables: length of petiole (P), of main vein (N1) and of lateral veins N2 and N3; distance from petiole insertion to lower (Sl) and to upper sinuses (Su); petiole sinus opening (Pso) and depth (Psd); number of teeth between vein N1 and N2 (T1), N2 and N3 (T2), N3 and N4 (T3), N4 and petiole insertion (T4); length, width and length/width ratio of teeth between N1 and N2; angles between N1 and N2 (α), N2 and N3 (β), N3 and N4 (γ), N3 and petiole insertion (τ); N2/N1 and N3/N1 length ratios; Sl/N3 and Su/N2 length ratios; petiole/main vein length ratio (Fig. 1).

Results

Virus status

The tests on woody indicators and ELISA showed a satisfactory health status in Fortana and L. Maestri, which had 1 infected biotype each. In contrast, virus status was critical in

Table 2: Grapevine fanleaf virus (GFV), grapevine fleck, stem pitting (LR) and grapevine leafroll (GLR) infections

Cultivar	Collected biotypes No.	Infected biotypes GFV No.	Fleck No.	LR No.	GLR No.	Disease-free biotypes No.
L. di Sorbara	7	0	2	2	1	2
L. Salamino	6	1	0	3	0	2
L. Grasparossa	10	2	2	10	8	0
L. Maestri	5	0	0	0	1	4
Fortana	5	0	1	1	0	4

Table 3: Significance of biotype effects (probability of F ratios) on yield and must composition at harvest

Cultivar	Yield	Bunch weight	Soluble solids	pH	TA
Lambrusco di Sorbara	.064	.041	.003	.470	.101
Lambrusco Salamino	.775	.005	.810	.484	.319
Lambrusco Grasparossa	.276	.262	.146	.498	.596
Lambrusco Maestri	.332	.265	.368	.017	.014
Fortana	.000	.000	.000	.000	.008

L. Grasparossa which had no virus-free biotypes. 2 virus-free biotypes were found for L. Salamino and 2 for L. Sorbara (Table 2). Corky bark was not present in any of the biotypes indexed.

Yield and must composition

L. Salamino, L. Grasparossa and L. Maestri showed a lack of variability among biotypes in yield, must soluble solids, pH and titratable acidity as can be readily inferred from the high probability of F values reported in Table 3. On the other hand, Fortana evidenced a wide variability in yield and must composition, while biotypes of L. Sorbara were different in bunch weight and must soluble solids concentration.

The biotype x year interaction was negligible for all 5 cultivars, indicating that the collected biotypes were similarly affected by the environmental conditions (Table 4). The high clonal repeatability in Fortana and L. Sorbara indicates good selection potential (Table 5). MANOVA confirmed that variability was lacking among biotypes of L. Salamino, L. Grasparossa and L. Maestri, but clearly indicated its presence in Fortana as well as in L. Sorbara (Figs. 2-5).

Table 4: Significance of biotype x year interaction (probability of F ratios) and must composition at harvest

Cultivar	Yield	Bunch weight	Soluble solids	pH	TA
Lambrusco di Sorbara	.115	.400	.938	.470	.408
Lambrusco Salamino	.970	.304	.919	.046	.396
Lambrusco Grasparossa	.034	.752	.016	.367	.084
Lambrusco Maestri	.370	.366	.399	.037	.026
Fortana	.583	.064	.499	.823	.006

Table 5: Clonal repeatability i. e. genotypic variance as percentage of the total phenotypic variance ($h^2 = V_g/V_p$) for yield and must composition at harvest

Cultivar	Yield	Bunch weight	Soluble solids	pH	TA
Lambrusco di Sorbara	(16)	58	93	(53)	(46)
Lambrusco Salamino	(36)	70	(3)	-	(10)
Lambrusco Grasparossa	-	(51)	-	-	-
Lambrusco Maestri	(8)	(22)	(7)	22	17
Fortana	92	98	96	93	29

Phenological phases and leaf morphology

Differences in phenological phases were found only within Fortana, in which 2 biotypes bud-burst and flowered 1 week earlier.

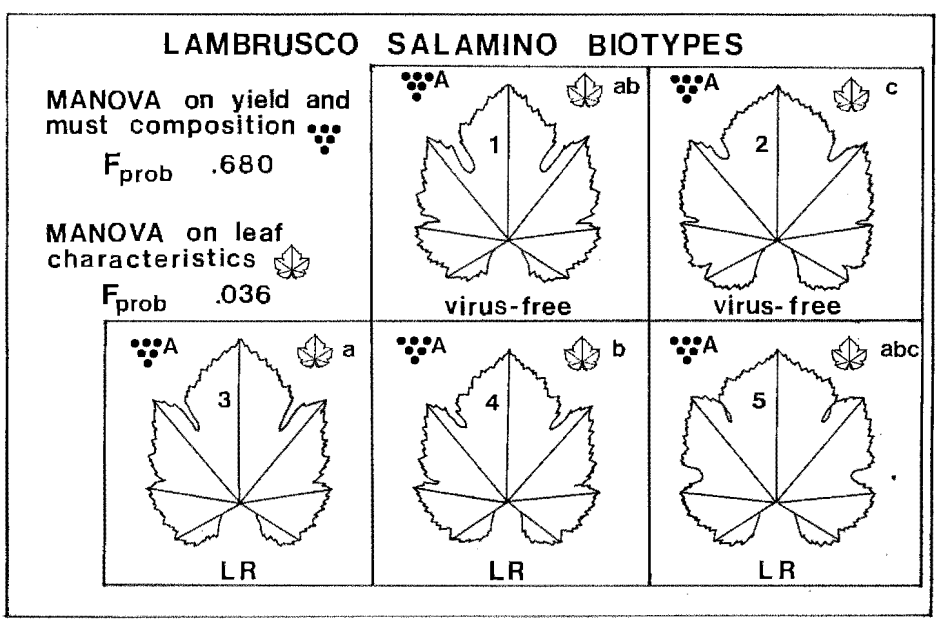

Fig. 2: Drawings of the mean leaf traits of 5 biotypes of cv. Lambrusco Salamino and results of MANOVA on yield and must composition and leaf characteristics. For each biotype the virus status is also reported.

Although some differences among biotypes within a cultivar were always evidenced, a very low variability in leaf characteristics was found in L. Maestri; MANOVA revealed variations within L. Sorbara, L. Grasparossa, L. Salamino and Fortana (Figs. 2-5). Differences among L. Grasparossa and L. Salamino biotypes were not as prominent as within Fortana and L. Sorbara, which were divided into 3 and 4 groups, respectively.

Discussion and conclusions

High degree of genetic determination for yield and must composition was found in Fortana and L. Sorbara. In contrast, negligible variability and hence low degree of genetic determination for the same characters was found within cvs L. Salamino, L. Maestri and L. Grasparossa, although differences among biotypes were evident for virus status. In addition, while leaf trait investigations indicated significant differences among L. Salamino and L. Grasparossa biotypes, they were unable to characterize or to identify them. We may speculate that the restricted growing areas of these cultivars and a prior mass-selection for yield carried out by local nurseries might have strongly reduced an eventual heterogeneity. As already suggested (Calo *et al.* 1987), a rough selection may have eliminated low cropping biotypes regardless of their virus status, so that infected vines with satisfactory yield and must quality might also have been propagated.

As regards the cvs L. Sorbara and Fortana, the trials indicated differences among biotypes in crop and juice composition, however independently on their virus status, which could not completely account for the recorded variability. Leaf trait differences among biotypes of L. Sorbara and Fortana were also found. With L. Sorbara these variations did not correlate with the previous findings on yield quality and quantity and virus status; with Fortana variations in the ampelographic characters were larger and associated with differences in yield and must quality.

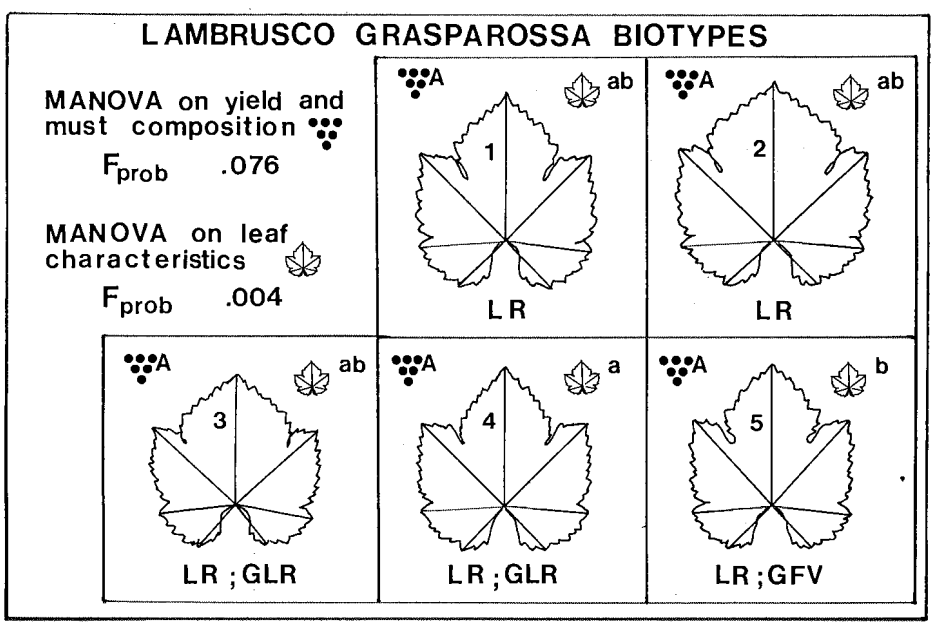

Fig. 3: Drawings of the mean leaf traits of 5 biotypes of cv. Lambrusco Grasparossa and results of MANOVA on yield and must composition and leaf characteristics. For each biotype the virus status is also reported.

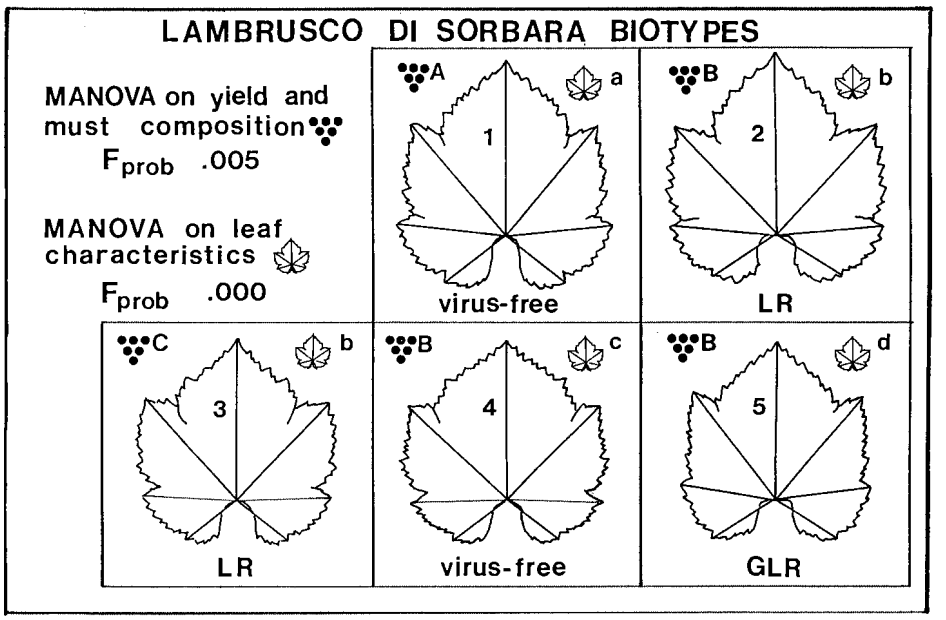

Fig. 4: Drawings of the mean leaf traits of 5 biotypes of cv. Lambrusco di Sorbara and results of MANOVA on yield and must composition and leaf characteristics. For each biotype the virus status is also reported.

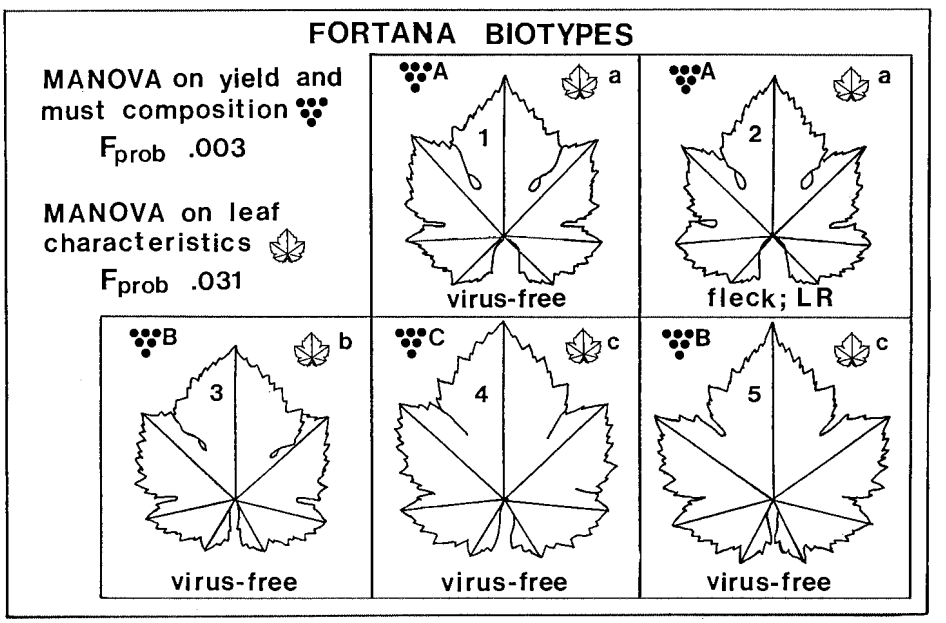

Fig. 5: Drawings of the mean leaf traits of 5 biotypes of cv. Fortana and results of MANOVA on yield and must composition and leaf characteristics. For each biotype the virus status is also reported.

The biotypes of L. Salamino, L. Maestri, L. Grasparossa showed low potentials for clonal selection, which can only be made by choosing the initially disease-free biotypes or the disease-free biotypes after heat-treatment. In contrast, the cultivars L. Sorbara and Fortana showed a high degree of genetic determination and their clonal selection can be performed for yield and quality as well as for virus status. It should also be noted, however, that Fortana exhibited marked differences in leaf morphology and phenological phases, leading to a well-differentiated polyclonal variety, as already reported for other cultivars like Pinot noir (BOURSIQUOT *et al.* 1989) and Arneis (MANNINI *et al.* 1986).

In situations such as this, when crop, grape quality and ampelographic differences are in evidence, further investigations are needed to better characterize the diversity among biotypes since the delimitation between cultivar and clone remains questionable.

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