A study on the oenological potentiality of the territory of a cooperative winery in Valpolicella (Italy)

Étude sur la potentialité œnologique du territoire de la société coopérative Valpolicella (Italie)

GIULIVO C. [1*], MORARI F. [1], PITACCO A. [1], TORNIELLI GB [2]

[1] Dipartimento Agronomia Ambientale e Produzioni Vegetali, Università di Padova, Italia
[2] Dipartimento di Scienze, Tecnologie e Mercati della Vite e del Vino, Università di Verona, Italia

***Corresponding author:** claudio.giulivo@unipd.it

Abstract

A 3-year zoning study promoted by the Cooperative Winery Valpolicella (Negrar, Verona, Italy) was carried out on a wine territory of about 500 ha. The aim was to individuate the oenological potential of the vineyards of associated growers in order to improve in general the quality of the wines and in particular to increase the production of premium wines (Amarone and Recioto). The zoning will be also used to apply differentiate payments of the grapes to the associated growers according to the production areas. On the basis of the results obtained from 12 reference vineyards it was possible to individuate zones at high and low oenological potential and to suggest a partition of the territory on the basis of the global performance of the vineyards taking into account 3 elements of economical relevance: yield, wine quality and technological quality of the grapes (drying aptitude).

Keywords: grapevine, zoning, Valpolicella, cv Corvina

Introduction

The economic performance of a vineyard depends on the optimal combination of crop yield and wine quality. The final result depends in part on the environment-variety interaction and in part on the vineyard model and management and oenological practices (Scienza, 1992). Within a wine territory exist a number of more or less slight variations of micro-climate and soils that may create recognizable differences in grape quality and yield not dependent on the viticultural variables.

Taking this into account a 3-year study was promoted by the Cooperative Winery of Valpolicella that has about 200 associates with a total of 500 hectares of vineyards, most of them located on the hillsides of the Valpolicella Classico region near Verona (Italy).

The climate is Mediterranean, annual rainfall averages from 850 mm on the plains (100 m above sea level), to approximately 1200 mm in the hillside zone (from 500 to 700 m a.s.l.), minimum average temperature for the grapevine vegetative period (April to September) is between 12 and 15°C, and the average maximum between 23 and 30°C. The climate and the soil allow beside Valpolicella Classico the production of great wines such as Amarone and Recioto, obtained from dried grapes.

The Winery is making every effort to increase the quality of its wines through the improvement of the viticulture. A particular effort is put into the study of the territory in order to identify the zones of different oenological potential. This zoning will be also used by the Winery to better differentiate the price of the grapes to be paid to the associated growers on the basis of the oenological potential of their vineyards. The aim of the Winery is to individuate also single vineyards to produce special selections and even individual "cru" wines.

Among the possible approaches to characterize a wine territory (Morlat, 2001; Bramley, Hamilton, 2006; Tisserye et al., 2006), the project was founded on a simple way of investigation selecting the study cases for maximum uniformity of model and management of vineyards located in zones individuated on the basis of a empirical knowledge of territory.

In this paper it will presented only a part of the large amount of the data collected from 2004 and 2006.

Materials and Methods

A network of plots of the local red variety "Corvina" was chosen in commercial vineyards trained as "Pergola in 12 different localities and their cropping and oenological performances were monitored from 2004 to 2006. All the vineyards have the same clone of Corvina (ISV-CV 48) and their planting year ranges from 1983 to 1999; unfortunately it was impossible to find vineyards with the same rootstock. Six are on Kober 5BB, five on SO4 and one on 41B (Tab.1).
Bud fertility, maturity pattern, yield per plant, cluster weight, and percent of clusters suitable for drying were determined in one selected row of each plots. Samples of grapes of 180 kg were collected in each plot for microvinification. Musts and wines were analysed and sensorial analysis was performed after some months.
Geology of the 12 vineyards is delineated by existing soil cartography (ARPAV, 2005) whereas hydrological, physical and chemical characteristics of the soils were determined by field sampling. Climatology of the area was defined by data of two meteorological stations and basic microclimate data were measured directly into the vineyards. The effect of site microclimate was considered synthesized by altitude (Fig. 1). Data were analysed by ANOVA and PCA multivariate analysis (Statsoft, vs 7.2).

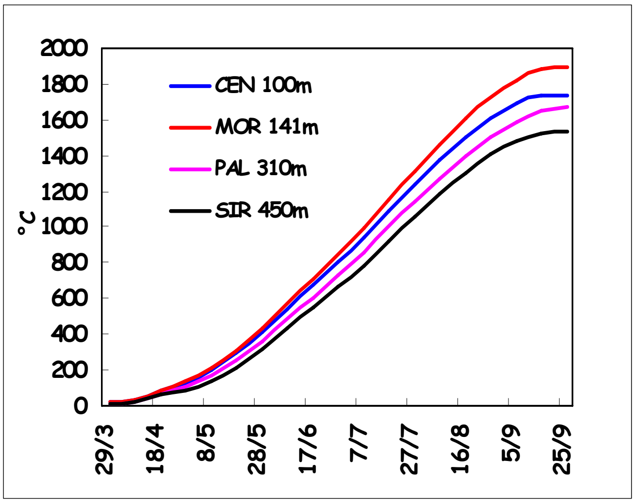

Figure 1 Cumulated active temperature in 2004 measured in sites at the lowest altitude (CEN, MOR) and in site at the highest altitude (PAL, SIR)

Results and Discussion

Site soils

The PCA analysis explained 83 % of the variability with 4 factors. Factor 1 explaining 43 % of variability represents Available Water (AW), Exchangeable Cations, Per cent Gravel and C/N, Factor 2 (20%) Theta at -15 bars and Clay content, Factor 3 Active Carbonate and Silt and Factor 4 Cation exchange capacity (CEC). The soil of site CEN, located at low altitude on the south-west part of the territory on an alluvial fan, presented characteristics very different from those of the other sites. The CEN soil is very sandy, gravelly with low CEC and AW. The soils of the other sites were clay or clay loam and relatively similar, but it is possible to distinguish the sites (VIL, CAR, ROS, SCI) from the others (CAS, CER, MAS, MOR, PAL, TOR, SIR) because of their higher AW, less clay, more sand and lower CE C.

Vineyard characteristics and performances

A PCA analysis was performed considering for each vineyard altitude (H), planting density (PD), rootstock (R), planting year (PY), crop components (yield/vine and cluster weight), grape sugars at harvest (S), and cluster drying aptitude (DA) (Tab. 2). The PCA analysis extracted 3 factors explaining 77% of the variability. Factor 1 represents DA and S; Factor 2 PD and yield/vine and Factor 3 PY and R. It was possible to divide the vineyards into 3 groups. Sites PAL, MAS and SIR are distinguished from other sites for high grape drying suitability, sugar accumulation and altitude (Tab. 2 and 1). In this group PD is different(PAL<SIR<MAS) as yield/vine (PAL>SIR>MAS) and also rootstocks are different: SO4 in PAL and SIR, 41B in MAS.

Site	Altitude m s l	Planting year	Rootstock	Planting Density vine/ha
CARPENE' (CAR)	178	1997	S04	2500
CASETTA (CAS)	353	1995	Kober 5BB	3012
CENGIA (CEN)	100	1995	SO4	2105
CERE' (CER)	260	1989	SO4	2500
MASUA (MAS)	305	1997	41B	3030
MORON (MOR)	141	1997	Kober 5BB	2500
PALAZZINO (PAL)	310	1989	SO4	1976
ROSELLE (ROS)	258	1997	Kober 5BB	3170
SAN CIRIACO (SCI)	370	1996	Kober 5BB	4167
SIRESOL (SIR)	450	1983	SO4	2857
TORBE (TOR)	320	1987	Kober 5BB	2500
VILLA (VIL)	240	1987	Kober 5BB	2500

Table 1 Characteristics of the vineyards selected in the indicated sites.

The PD and the rootstocks may depend on the planting year of the vineyards; in fact only recently PD was increased even in vineyards trained to Pergola and the choice of rootstocks more differentiated. Sites CAS, ROS and SCI were characterized by low yield/vine and low DA and S and high PD. Sites CAR, CEN, MOR, TOR and VIL presented low S and had also relatively high DP.
Factor 3 discriminates the vineyards for their age: CAR, CEN, MOR and MAS are the younger vineyards. As far as rootstocks are concerned only 41B in MAS is clearly individuated.

Wine chemical characteristics

PCA analysis performed on the chemical composition of the wines showed some differences dependent on the year. The variability of the 2004 vintage was explained for 90% by Volatile Acidity and Total Polyphenols (40 %), Total Acidity (25%), Glycerol (17%), and pH (9%). In 2005 93 % of variability was explained by Lactic Acid and Alcohol (54%), Total Polyphenols (21%), Glycerol (13%) and Volatile Acidity (5%). In 2006 variability was explained at 93% by Wine Colour (62%), Sugars (16%), Volatile Acidity (10%) and Alcohol (7%). It is interesting to note that in all the vintages the sites MAS, PAL and SIR expressed in the wine the highest alcohol content.

SITE	CLUSTER/VINE		YIELD/VINE (kg)		CLUSTER WEIGHT (kg)		MUST SUGARS * g/L	DRYING SUITABILITY** (%)
CAR	**34,9**	c	**9,4**	b	**0,266**	cd	**199**	**53**
CAS	**24,7**	e	**6,0**	de	**0,273**	bc	**208**	**49**
CEN	**30,3**	d	**7,1**	cd	**0,236**	de	**190**	**30**
CER	**26,0**	de	**8,1**	bc	**0,308**	a	**194**	**40**
MAS	**23,6**	e	**4,3**	f	**0,211**	efg	**216**	**49**
MOR	**38,6**	c	**8,3**	b	**0,219**	ef	**210**	**48**
PAL	**35,4**	c	**8,8**	b	**0,248**	cd	**222**	**54**
ROS	**17,4**	f	**5,0**	ef	**0,275**	bc	**200**	**37**
SCI	**23,2**	e	**6,5**	d	**0,300**	ab	**199**	**39**
SIR	**27,5**	de	**5,2**	ef	**0,194**	fg	**205**	**59**
TOR	**43,5**	b	**11,1**	a	**0,253**	cd	**209**	**46**
VIL	**47,7**	a	**9,1**	b	**0,186**	g	**191**	**42**

Table 2 Vineyard crop performances (average 2004-2006).

Sensory quality of the wines

The highest scores assigned by the panels were obtained by the wines of the sites PAL, CAR, MAS, and the lowest in the sites CEN, TOR and VIL (Tab. 3). The 2005 wine of CAS presents a low score compared to he other wines whereas in 2004 and 2006 the scores are not among the lowest; this may depend on the hail storm occurred at CAS in 2005.
A PCA analysis of the aromas pointed out the dominant descriptors of the wine of Corvina in the specific territory even if some variation occurred from year to year. In wines produced in 2004 85% of variability was explained by the attributes violet, raspberry, plum and jam; in 2005 the attributes cherry, pepper, violet, and spices explained 82% of variability; in 2006 blackberry, violet, spices, rose, pepper and cherry were the dominant attributes explaining 88% of variability. In general the wines of the sites PAL and CAR expressed every year the dominant descriptors at higher values whereas the wines VIL and ROS always obtained low scores; the results of the sensory evaluation of the 2006 wines are reported as example in figure 2.

Global performances of the vineyards

In order to classify the performance of the vineyards in all the sites (CAS excluded because of the hail damages of 2005) the wine chemical composition and sensory characteristics, the yield components and the aptitude of the grapes to drying were taken into consideration for the whole 3-years period.Scores were assigned according to the rank occupied by the sites in each variable (1 minimum; 11 maximum).

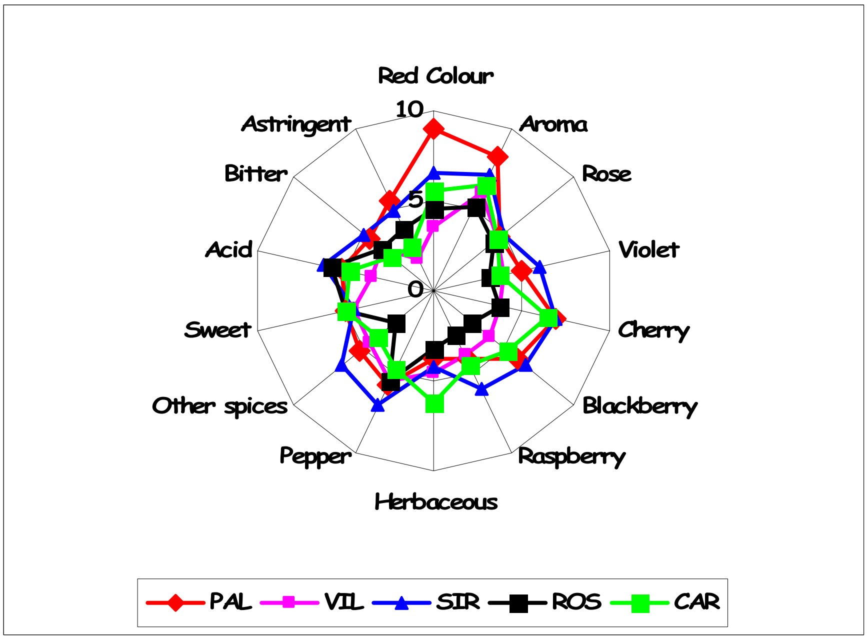

Figure 2 Descriptors of the 2006 wines of the sites PAL, VIL, ROS and SIR:

SITE	2004	2005	2006	GLOBAL
CAR	59,1	126,6	67	253
CAS	62	114,8	66,3	243
CER	50,4	110,5	46,3	207
MAS	65,4	122,9	73,8	262
MOR	63,5	122,6	68	254
PAL	73,1	127,1	79,3	279
ROS	54,7	97,8	56,3	209
SCI	59,4	118,1	78,3	256
SIR	66,4	117,1	82,8	266
TOR	60,1	116,2	63,8	240
VIL	52,1	112,1	58	222

Table 3 Sensory quality of the wine. Synthetic evaluation performed by panels in 2004-2006 and global scores. The high 2005 scores are consequences of a larger set of descriptors used in the panel.

The sites could be classified as follow: first class MAS and PAL, second class CAR and CER; third class SIR and TOR; fourth class MOR and SCI; fifth class CEN, ROS and VIL (Fig. 3). The quality score was predominant in determining the global scores but it is interesting to point out that the economical success of a vineyards is determined also by yield and grape drying aptitude and from this point of view the site PAL achieved the best evaluation; the site MAS that had the highest global score presented a very low yield and a moderate drying suitability. Even if the yield is modest, the site SIR shows the highest drying suitability and produces a wine of good quality. The site CAR also showed valuable performances.

Comparing the average of the principal components of the wines of first class (PAL, MAS) and of the fifth (ROS,VIL), it is evident that the first class wines had more alcohol, total acidity, tartaric acid, glycerol and total poliphenols and lower volatile acidity, lactic acid and pH (Tab. 4).

SITE	Alcohol % by vol	Total Acidity (g/L)	Volatile Acidity (g/L)	Lactic Acid (g/L)	Tartaric Acid (g/L)	pH	Glycerol	Total polyphenols (mg/L)
PAL-MAS (1)	14,1	7,1	0,47	0,59	2,54	3,10	8,56	1771
ROS-VIL (2)	12,1	6,0	0,48	1,06	2,20	3,31	7,99	1063
Ratio 1/2	1,16	1,19	0,98	0,55	1,15	0,93	1,07	1,67

Table 4 Chemical composition of the best (PAL and MAS) and worse wines (ROS and VIL).

Wine quality and soil characteristics

Some soil characteristics seem to influence the vineyard classification. Compared with the fifth class sites (ROS-VIL) the soil of the first class sites (PAL-MAS) has a clay loam texture and lower gravel, Ks, bulk density, organic matter, P, K, Mg, Ca, Fe and B whereas CEC and C/N are higher.

Global estimation of the variability of the selected population of sites

The PCA analysis performed using all the 40 variables related to soil, vineyard characteristics and performances, wine composition and sensory evaluation individuated 5 factors explaining 77% of the variability of the site population (Tab. 5). Factor 1, explaining 23,3 % of variability, is related to planting density of the vineyards and to some soil properties such as exchangeable cations and others correlated with available water. Factor 2 that explain 18% of variability, represents the drying aptitude of grapes and the sensory quality of wine. Factor 3 represents some components of wine and explains about 17% of variability. Factors 4 and 5 are related to active carbonate and rootstock, and yield components and age of the vineyards; their contribution to variability is about 10 and 9 % respectively.

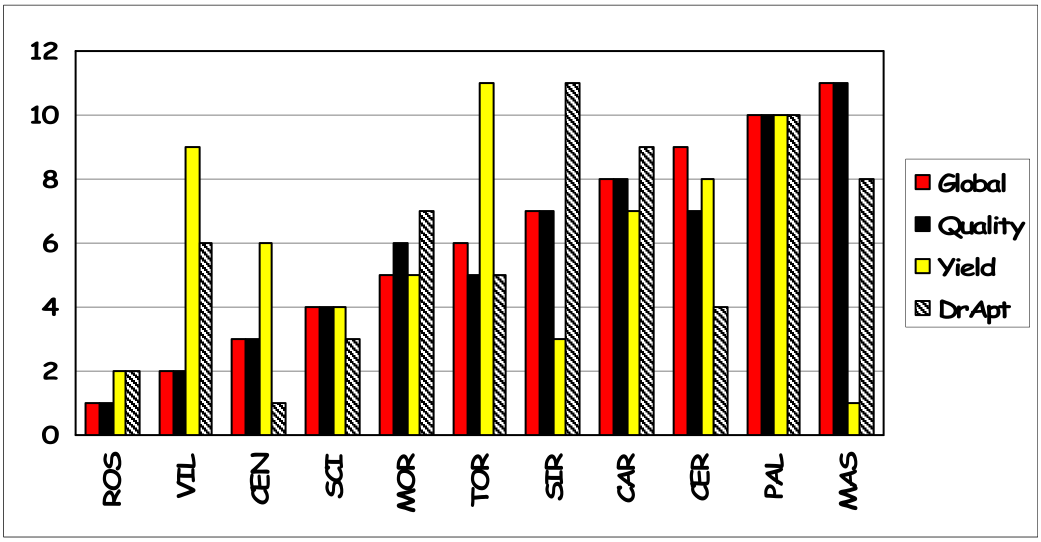

Figure 3 Performance evaluation of the sites. Scores attributed on the basis of the rank of the site in each variable (1 poor, 11 very good).

Few wine components were significantly correlated with site characteristics. The most sensible wine property was pH, that was correlated to altitude (-0,71), planting density (0,72), clay (-0,67), Ks

(0,68), per cent of gravel (0,83) and available water (-0,62). Alcohol content was correlated with organic matter (-0,75) and poliphenols with boron (-0,58). No significant correlations were ascertained between soil characteristics and sensory quality of wine.

Conclusion

The investigation allows classification of the sites in terms of viticultural and soil characteristics, and chemical and sensory quality of the wines. The general performances of the sites generated a useful criterion for their classification in five classes of value; from a practical point of view the PAL and MAS sites can be considered as cru, CAR and CER as good quality sites, TOR and SIR as sufficient quality sites, MOR and SCI as poor quality sites and ROS and VIL as very scarce quality sites.
This classification was carefully verified with the management team of the Winery and it largely confirmed the empirical knowledge of the area but in some cases the supposed oenological value was overestimated.
The derived site classification was already used by the Winery to select the grapes of the best sites for its premium wines and if it will be verify with further vintages, it will be used by the Winery to pay selectively the grapes the associated growers according to the oenological potential of the site of production.

Factor 1: Planting Density and Soil		
23,3%	A	B
Planting density	0,81	0,070
Bulk Density	0,80	0,069
K exch	0,80	0,068
AW	0,79	0,067
P ass	0,73	0,057
Iron	0,73	0,057
C/N	-0,73	0,057
Sand	-0,71	0,054
Mg exch	0,70	0,053
Ca exch	0,70	0,052
Ks	-0,70	0,052

Factor 2: Drying Aptit., Sensory Quality		
18,4%	A	B
Drying Aptitude	-0,88	0,104
Aroma Descriptors	-0,80	0,086
Sugars at Harvest	-0,79	0,086
Visual Aspect	-0,79	0,084
Taste	-0,79	0,084
Aroma	-0,72	0,070

Factor 3: Wine composition		
16,6%	A	B
Alcohol	0,79	0,093
Lactic Acid	-0,73	0,081
Total Acidity	0,69	0,071
Total Polyphenols	0,67	0,067
pH	-0,65	0,064

Factor 4: Active Carbonates, Rootstock		
9,9%	A	B
Active Carbonate	-0,76	0,147
Rootstock	-0,71	0,126

Factor 5: Yield Comp and Age		
8,7%	A	B
Clusters/vine	0,78	0,173
Cluster Weight	-0,60	0,102
Planting Year	-0,59	0,099

Table 5 PCA analysis considering all the variables of soil, vineyard characteristics and performances, wine composition and sensory evaluation. The 5 factors explain 77% of variability. (A: Factorial coordinates of variables; B: Variable contributions)

References

A.R.P.A.V, 2005. Carta dei suoli del Veneto. Ed. Regione Veneto

BRAMLEY R.G.V., HAMILTON R.P., 2006. Terroir and precision viticulture: are they compatible? *Terroirs Viticoles 2006, Bordeaux, 3-5 Juliet: 218-225.*

MORLAT R., 2001. Terroirs viticoles: ètude et valorisation. *Oenoplurimedia Sarl, Chaintrè, France.*

SCIENZA A., 1992. I rapporti tra vitigno e ambiente: le basi culturali e gli strumenti di valutazione. *In: Atti del convegno "La zonazione viticola tra innovazione agronomica, gestione e valorizzazione del territorio. L'esempio del Trentino", San Michele all'Adige,* 11-25.

TISSERYE B., TAYLOR J., OJIEDA H., 2006. New technologies to characterize spatial variability in viticulture. *Terroirs Viticoles 2006, Bordeaux, 3-5 Juliet: 204-217.*