Grapevine performances in five areas of 'Chianti Classico'
Comportement de la vigne en cinq zones des « Chianti Classico »

Giancarlo SCALABRELLI[1*], Claudio D'ONOFRIO[1], Eleonora DUCCI[1], Mario BERTUCCIOLI[2]

[1] *Dipartimento di Coltivazione e Difesa delle Specie Legnose "G. Scaramuzzi", Sezione di sColtivazioni Arboree, Università di Pisa, Via del Borghetto, 80 56124 Pisa*
[1] *Dipartimento di Biotecnologie agrarie, Università di Firenze, Via Donizetti 6, 50144 Firenze*
[*]*Corresp. author: Scalabrelli, Telephone (39)0502216139, Fax (39)0502216147, Email: gscalabrelli@agr.unipi.it*

ABSTRACT
The research was carried out in the 'Chianti Classico' area and it was part of the 'Chianti Classico 2000' research project. The performances 'Sangiovese' grapevine (clone 'SSF-A548') grafted on '1103P' and '420A' rootstocks, were evaluated during a six years period, on five experimental vineyards located in the Province of Florence and Siena. The vineyards were established at a density of 3500 plants per hectare, trained to horizontal spur cordon (m 0.7 from the ground) with 30000 buds per hectare. The main meteorological data were monitored by automatic stations and soil analysis was performed at the beginning of the trials. Vines were planted in a randomized block design with four or five replication according to the vineyard size and uniformity. During six consecutive years on 30 plants from each thesis were carried out the following observations: phenology earliness (budbreak, veraison), bud fertility, bunch weight, and yield and pruning weight per plant, must characteristics of the berries at harvest. Physical and chemical analysis of wines obtained from microvinification (made in 500 L containers), were also performed. The climatic differences resulted among the zones of the 'Chianti Classico' examined, had a significant effect on vine phenology also in relationship with altitude, which together to soil characteristics contributed to affect the agronomic behaviour of the three varieties, the must composition and the wine characteristics. Discriminant analysis allowed distinguishing some sites, whose differences can be ascribed to the territorial influence on the vegetative and productive activity of the grapevine, berry ripening and wine composition. Hierarchical influences due to clone 'SSF-A548' according to the site and year are presented.

Keyword: Vitis vinifera, Sangiovese, yield, wine.
Mots-clés : Vitis vinifera, Sangiovese, production, vin.

1 INTRODUCTION

The behaviour of the grapevine varieties is depending on the environmental conditions of the territory which in a wide Denomination of Origin may have a significantly variability. So as is difficult to have uniformity on vegetative and productive behaviour which can affect wine features. Assuming the existence of the variability of the performances of varieties in the space and during the time it is possible to examine the factors responsible of such variation in order to direct the production process and to carry out productive forecasts for the best destination of grapes. In practice the studies of characterization of the main factors able to influence the productive and qualitative obtained in certain territories, can offer a valid support to the technical choices in viticulture management, while more deep and interdisciplinary studies are necessary in order find out a specific terroir, which is of the result of complex interactions between natural, biological and human factors (1, 2), In Tuscany area today remains not completely explored the peculiarities of some territories, like as an example the, and in particular in the Chianti Classico DOCG area in which studies on wide scale have regarded above all the province of Siena (3, 4). In this paper are summarized several results obtained on 'Sangiovese' during the 'Chianti Classic 2000 " research project, in addition to those previously reported (5, 6).

2 MATERIALS AND METHODS

The research was carried out in the 'Chianti Classico' area and it was part of the 'Chianti Classico 2000' research project. The performances of 'Sangiovese' grapevine (nine clones) grafted on '1103P' and '420A' rootstocks, were evaluated during a six years period, on five experimental vineyards located in the Province of Florence and Siena. The vineyards were established at a density of 3500 plants per hectare, trained to horizontal spur cordon (m 0.7 from the ground) with 30000 buds per hectare. The main meteorological data were monitored by automatic stations and soil analysis was performed at the beginning of the trials. Vines were planted in a randomized block design with four or five replication according to the vineyard size and uniformity. During six consecutive years on 30 plants from each thesis were carried out the following observations: phenology earliness (budbreak, veraison), bud fertility, bunch weight, and yield and pruning weight per plant, must characteristics of the berries at harvest. Physical and chemical analysis of wines obtained from vinification (500 L containers), were also performed (7). Data from 'Sangiovese',

clone 'SSF-A548' subjected by MANOVA (SPSS pkg) are reported.

Table 1. Main geologic and lithologic features referred to the vineyards areas.

N	Sito	Tipologia	Group
3	MAD	Calcareous marne	**B**
2	FON	Clay schist and calcareous marne	**C**
1	ALB	Calcareous marne	**B**
4	REN	Series of sands	**A**
5	SFE	Calcareous marne	**B**

3 RESULTS AND DISCUSSION

The soil features of the territory in which the vineyards are located, reveals some fundamental differences (tab.1) The more common matrix is constituted from the marne calcareous that are dominant in three zones, while the series of sands differentiates 'REN' clearly and the slates appear, mixed to the marne calcareous, in 'FON'. Chemical composition of soils (tab.3) revealed enough homogeneity of alkaline pH (8,3-8,4) going down to 7,9to MAD. Sandy matrix is clearly dominant in the land of REN, while the clay in the four 4 grounds ranged between the 29,2 and 33.4%. The organic substance more is elevated in the ground of MAD, while the lowest value was found on SFE which contains more limestone, nearly absent in the vineyard of MAD. Moreover the C.E.C slightly turns out lower to REN and SFE; the K was more elevated in FON and while it is lower on REN which contains more P_2O_5 than in the other vineyards. The relationship C/N was found higher on MAD and lower in SFE.

Table 2. Physical and chemical features of the soils where vineyards were established.

Parametro	ALB	MAD	FON	REN	SFE
pH	8,4	7,9	8,4	8,3	8,3
Organic matter (%)	1,36	3,64	2,06	1,65	1,18
Total Nitrogen (%)	0,09	0,14	0,14	0,08	0,15
Ratio C/N	8,7	15	8,6	11,96	4,6
P_2O_5 assimilable (ppm)	5,5	4,5	10,3	16,9	5,7
K_2O assimilable (ppm)	322	193	306	160,1	207
C.E.C. (m.e./100 g)	25,3	31,2	33,7	21	23,2
Limestone tot. (%)	8,3	7,6	20,1	19,3	47,5
Limestone active(%)	4,75	<0,3	10,6	3,1	16,1
Sand (%)	49,6	41,2	38,3	71,4	41
Silt	23	25,4	28,2	12,8	29,8
Clay	27,4	33,4	33,5	15,7	29,2

Regarding the characteristics of the climate (1995-2000) we can observe on ALB, placed at higher elevation more cold and rainy while FON and MAD had the greater thermal excursion (fig. 1).

The statistic MANOVA has evidenced that the total variability recorded in the vineyards (tab. 3) were more largely accounted by the site (53.34%) than from the year (39.28%), and particularly this occurred on productive parameter (MCW, Y, MSW,Y/PW) while the phenologic parameters were more affected from the year. Only bud fertility showed the greatest interaction site x year (tab.3). For BW, SAR, MHD and Tam the greater influence was due the site while for must pH, Ma TA and TSS the year explained a greater variability than the site. Earlier bud break and veraison were directly correlated related to an advanced ripening especially in vineyards set to lower altitude like MAD and REN.

The MANOVA performed on wines showed that the site had accounted for the greater variability on pH, TA, Flavonoids and Tone while for Anthocyanins (free and total), the dry extract and the alcohol the influence explained by the year was prominent (tab. 4). Interactions although being meaningful accounted for a smaller percentage of variability.

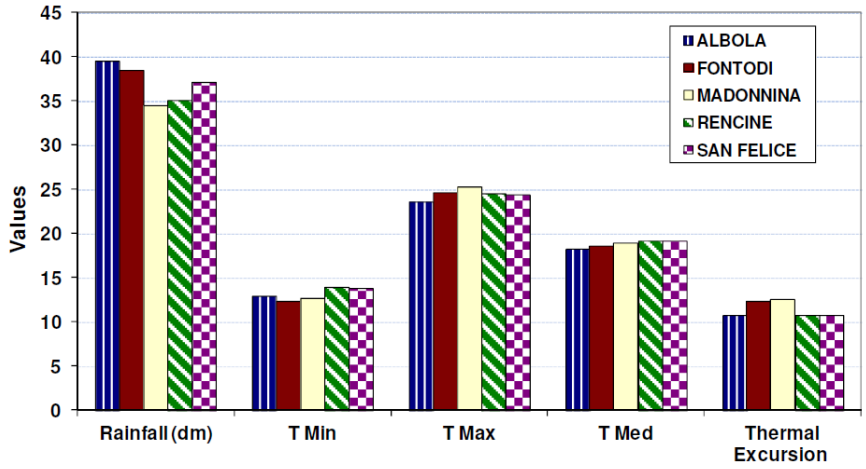

Figure 1. Average climatic features from April to September in 5 sites located in Chianti Classico (avg of the period 1995-2000).

Table 3. Multivariata analyses of the vegetative and yield behaviour, significance and source of the explained variance (5 sites, 6 years).

Variables	Zone	Sig.	Year	Sign	Zone x year	Sign.
Budbreak earlyness	13,84	0,000	79,39	0,000	6,42	0,000
Fertility Index	12,29	0,207	25,74	0,017	54,16	0,000
Flowering Index	37,93	0,000	54,48	0,000	6,48	0,000
Veraison Index	12,87	0,001	72,95	0,000	12,11	0,000
Mean Cluster Wgt	72,17	0,000	14,34	0,047	7,93	0,186
Yield	55,00	0,000	25,42	0,003	14,15	0,009
Mean Shoot Wgt	72,17	0,000	14,34	0,047	7,93	0,186
Pruning Wgt	72,50	0,000	19,12	0,003	4,23	0,472
Yiel/Pruning Wgt	42,56	0,000	41,16	0,000	10,10	0,108
Mean Harvest Date	78,87	0,000	18,63	0,000	2,41	0,000
Malic acid must	37,02	0,000	57,05	0,000	5,41	0,000
Mean Berry Wgt	52,19	0,000	34,73	0,000	11,64	0,000
pH must	13,14	0,001	81,31	0,000	3,42	0,117
Ripening Index	43,28	0,000	44,77	0,000	5,66	0,590
Sugar Accum. Rate	73,63	0,000	18,13	0,000	5,30	0,071
Titratable Acidity must	47,02	0,000	43,17	0,000	7,19	0,006
Tartaric acid must	54,32	0,000	19,48	0,009	21,08	0,000
Total Soluble Solids m.	24,69	0,203	41,14	0,043	18,63	0,320
Average	*43,16*		*42,47*		*9,79*	

Table 4. Multivariata analyses of the wine features, significance and source of the explained variance (5 sites sites, 6 years).

Variables	Zone	Sig.	Year	Sign	Zone x year	Sign
Alchool	23,32	0,000	59,55	0,000	13,85	0,000
Ash	34,07	0,037	38,44	0,017	15,84	0,218
Colour intensity	47,48	0,000	35,79	0,000	15,57	0,000
Dry extract	19,14	0,037	65,02	0,000	9,29	0,188
Flavonoids non Anthoc.	56,92	0,000	36,53	0,000	5,83	0,000
Flavonoids	57,91	0,000	34,97	0,000	6,38	0,000
Free Anthocyanins	28,77	0,000	61,13	0,000	9,11	0,000
Fenols index (UV)	45,05	0,000	41,33	0,000	11,86	0,000
pH	67,35	0,000	25,99	0,000	4,60	0,022
Phenols (mg/L)	48,36	0,000	44,21	0,000	6,66	0,000
Tone	53,93	0,000	27,79	0,000	15,98	0,000
Total acidity	67,13	0,000	9,93	0,321	14,85	0,064
Total Anthocyanins	23,55	0,000	70,63	0,000	5,28	0,000
Average	*44,08*		*42,41*		*10,39*	

Results obtained from physical and chemical analysis performed on wines obtained from nine clones of Sangiovese in the five area (five years) showed that the contribution to the total variability was accounted mainly by year (48.07%) and by zone of cultivation (41,37 %), while clone and interaction had lower effect. The average data of wines for each site highlighted the following features. Alcohol content was higher on MAD and lower on REN and FON, phenols flavonoids content were higher on MAD compared to REN and FON. Total anthocyanins were higher on MAD, ALB and SFE, while were lower at REN and FON. Titratable acidity was lower at ALB and MAD while was higher at SFE and REN, the wine pH were higher at ALB as compared to the other locations. The dry extract were higher at SFE and lower at REN. Greater differences on structure and phenols compounds were found in wines produced on ALB and MAD.

Discriminant analysis performed on all data recorded allowed distinguishing some sites (fig. 2), whose differences can be ascribed to the territorial influence on the vegetative and productive activity of the grapevine, berry ripening and wine composition. The consistent year effect would require a detailed approach to explain its specific effect from the total variability especially in view of the annual climatic variations.

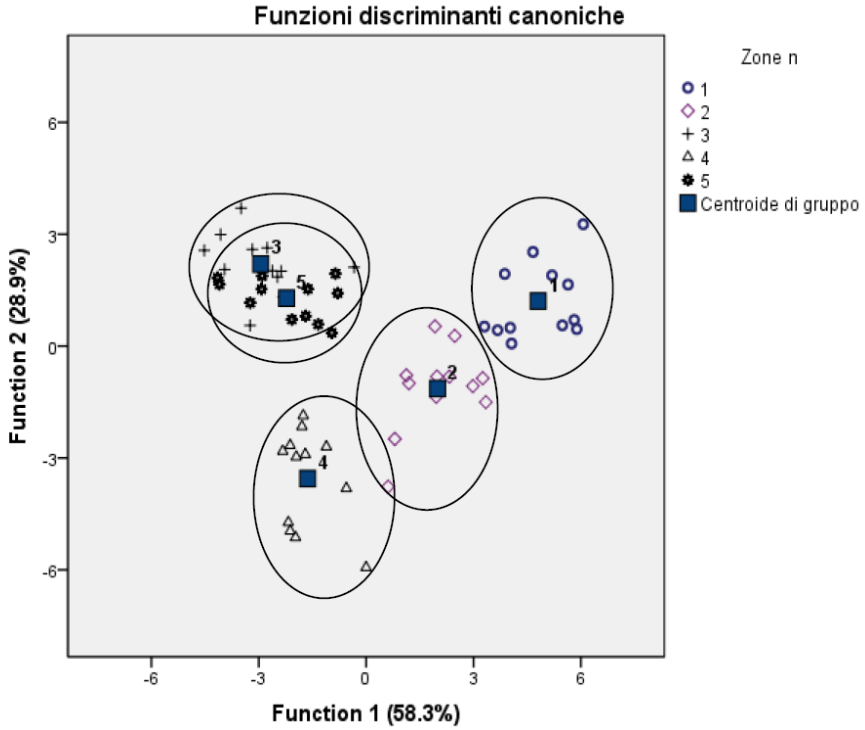

Figure 2. Centroids of Discriminant analysis of all data recorded. For zone number see table 1. The first two canonical functions explained 87.2% of the total variability; 95% of data were correctly classified while, cross validation classify correctly 88.3% of data.

4 CONCLUSIONS

The environmental conditions the soil characteristics and the exposition of vineyards accounted for significant difference on vegetative and yield performances of 'Sangiovese' among the five zones of the 'Chianti Classico' examined, which can affect the wine characteristics. It is suggested to dedicate more attention to the vineyard management in order to obtain adequate vine performances during climatic change.

REFERENCES

1. C. ASSELIN, R. MORLAT, G. BARBEU, 2003. Les terroirs viticoles: du concept au produit. Terroir Zonazione Viticoltura. Phytoline, 159-186.

2. M. FREGONI, D. SHUSTER, A. PAOLETTI, 2003. Terroir Zonazione Viticoltura. Phytoline, Verona, 648 p.

3. E.A.C. COSTANTINI, R. BARBETTI, 2008. Environmental and Visual Impact Analysis of Viticulture and Olive Tree Cultivation in the Province of Siena (Italy). Europ. J. Agronomy 28, 412-426.

4. E.A.C. COSTANTINI, R. BARBETTI, G. L'ABATE, P. BUCELLI, S. PELLEGRINI, P. STORCHI, 2008. La cartografia dei terroirs della provincia di Siena attraverso un approccio GIS climatico, geomorfologico, pedologico ed agronomico. Atti del convegno "Paesaggi, terroirs e i paesaggi del vino" (Perugia 6-9 November 2006). A cura di L. Gregori, Univ. Perugia (Italy), 123-139.

5. G. SCALABRELLI, C. D'ONOFRIO, A. MACCHIA, D. ROSELLINI, M. BERTUCCIOLI, M. BOSELLI, 2006. Comportamento agronomico del vitigno "Sangiovese" in undici zone del Chianti Classico. II° Sym. Int. Il "Sangiovese". Firenze 17-19 novembre 2004. Vol. unico, 529-540.

6. G. SCALABRELLI, C. D'ONOFRIO, F. LORETI, R. BANDINELLI, D. ROSELLINI, 2008. Comportamento vegeto produttivo e qualitativo del vitigno Malvasia nera in 5 zone del Chianti Classico. Riv. di Vitic. e di Enologia 2-3-4, 81-98.

7. M. BERTUCCIOLI, S. FERRARI, L. LENCIONI, A. SILIANI, S. ZINI, 2001. Effetto della densità e del sesto d'impianto sulla composizione delle uve e vini di Sangiovese in due zone del Chianti Classico 2000 Atti Symp "Il Sangiovese". Firenze, 457-460.