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ESTIMATE OF VITICULTURAL SUITABILITY IN THE OLTREPÒ PAVESE

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INTRODUCTION

The viticultural production of today demands innovative productive models that are governed by the reduction in the amount of wine consumed and, at the same time, the increase in demand for better quality. Production must adapt to these changes in demand. Improving cultivation and enological techniques through a reduction of yield per ha and limiting viticulture to the most suitable environments could be one way to adapt. But this is not enough. Therefore, making the most of the relationship between grape variety and environment becomes essential. This involves choosing pedo-climatic and cultivation conditions that allow the grape variety to fully express its genetic potential, given the multiple interactions inherent to the viticultural ecosystem.

In fact, the phenotypic expression of yield and quality is a result of the interaction between the grape variety and the environment and represents ultimately the extent to which the genetic inheritance shows itself.

There are economic and social reasons why grape growing should be carried out in areas most suitable for it and this is why the relationship between grape variety and environment should be explored more deeply. Also, there is an underlying conviction that for each environment there are just a few grape varieties capable of adapting and of expressing their genetic characteristics to the full.

For centuries, opinion has wavered as to whether the grape variety or the environment had the most important impact on the quality of the wine.

The introduction of grape cultivation in the New World, the era of great exploration in the 19th century and, above all, the introduction of the Phylloxera in Europe, resulted in widespread transfer of grape varieties around the world, and in particular of those that formed the basis for the famous French wines.

The most famous grape-growing regions, for legitimate self-defense, attempted to demonstrate the special characteristic of the environmental conditions of the area of production and its role in wine quality, defined in the concept of *terroir*. While the grape variety can be reproduced in other countries, this is not true for the concept of *terroir*. In fact, the great grape varieties, such as Chardonnay, Cabernet Sauvignon, Pinot Noir and Sauvignon, can only fully express their genetic attributes in precise climatic and pedological (as well as the human aspect of the viticultural and enological tradition) conditions. Any other association between terroir-grape variety-tradition is only a reproduction, even though it is often a faithful copy of the original.

Many research studies have attempted to define the relationships between environmental characteristics (macro-, meso- and micro-climate) and the quality parameters of the must and the wine (BRANAS et al., 1946; WINKLER, 1962; COSTANTINESCU, 1967; HUGLIN, 1978; HILDAGO, 1980). These studies form the basis for the development of climatic indexes used to characterize grape-growing regions. Different approaches are observed in the experiments conducted in America and in Australia.

In these situations, the complete absence of environmental reference points with the European grape-growing regions has meant that those responsible for study design have had to adopt very simple and pragmatic evaluation criteria to identify territorial vocation. Rather than defining a relationship between environment and grape variety in terms of quality, the studies showed the factors that limit yield.

In California, the proposal was made to subdivide areas with different vocation characteristics according to the summation of temperature in degrees Celsius per day (AMERINE and WINKLER, 1944) and soil temperature (DUTT et al., 1981). In contrast, in Australia (SWART and DRY, 1980), the definition of suitability of some environments was made on the basis of risk of some fungal diseases, of spring frost and the temperatures during maturation. Instead in France, the relationship between edaphic conditions and grape variety seems to have the biggest impact on the quality of the harvest.

BONFILS (1977) and SEGUIN (1981, 1986) concentrated their attention on water availability for the grape vines. SEGUIN formulated a theory that geology and soil texture are not the only factors that determine quality, and that the depth of the soil and its drainage were the reasons for the different quality of the wines in the Bordeaux area. The same Author recognized that it was impossible to attribute a decisive role in wine quality to any single soil component. On the other hand, AMERINE and WINKLER (1944) consider the soil to have no significant effect on wine quality except when conditions are not ideal (shallow depth and poor drainage, high concentration of clay or of salts, etc.). More recently in South Africa, SAAYMAN (1977) proposed that the hydromorphic conditions of the soil, modified by the climate, and the landscape determine wine quality and gave no importance to the chemical properties of the soil. Practically, the only action of the soil is to modify the microclimate inside the vineyard. In Italy, an increase in methodology and research into the problem of zoning only began in the 1970s.

Zoning according to the chemical-physical makeup of the soil was performed in the grape-growing areas of Franciacorta and Valtenesi (Lake Garda) (FREGONI and DOROTEA, 1986) and in Canneto

Pavese (FREGONI and BAVARESCO, 1985) in order to identify edaphic conditions that could compromise the grapevine and to propose the use of rootstocks with a certain degree of resistance to these conditions. This also proposed identifying areas with the best quality according to some pedological and climatic indexes. In the 1980s, studies into how grape varieties adapt to their environment finally became more integrated and multidisciplinary. The definition of environmental suitability was, therefore, obtained by integrating information about climatic, topographic, pedological and cultivation conditions with the grape variety. This has shown a synergic relationship between climate, soil and grape variety regarding quality.

ASTRUC et al., (1980), in the grape-growing areas of the South of France (Aude) proposed a method to evaluate grape variety suitability through the characterization of different ecosystems found in the vineyard. These were identified by the combination of spontaneous vegetal species present.

MORLAT et al. (1981, 1983) and MORLAT and ASSELIN (1987) proposed a clearly more sophisticated method to describe the capacity of a grape variety to adapt to the different sites that make up a meso-environment. The study was conducted in the Loire Valley in a single macro-climate and considered the grape-growing area as the sum of basic environments each of which could be defined as a geological sequence and a pedological sequence. Taken together, these sequences provide the edaphic habitat in which the intensity of the pedogenesis allows us to characterize the rock-soil combinations in a series of pedological sequences. Finally, meso-climatic information is also introduced thus defining the eco-geo-pedological sequences.

Once the favorable characteristics of the sequences have been classified and a reference sequence has been identified, it is essential to measure the behavior of the grapevine in the different sequences in a series of experimental plots. The wines obtained are tasted and evaluated, and then analyzed by multivariate statistical analysis (multiple factor analyses). The groups of wines positively correlated with the sensorial indexes came from different plots, and the biggest variation was seen in the type of eco-geo-pedological sequence, where plant response was stable.

The first integrated studies in Italy were carried out in Tuscany and aimed to identify suitable soils for the production of quality wines to make Vernaccia di San Gimignano (MIRABELLA et al., 1989; LULLI et al., 1987). Sufficiently homogeneous soil units were identified in the study area. These soil units were defined as “series” each with its own microclimate and morphology. The relationship between the “series” and wine quality was established through tasting and the subsequent statistical analysis of the data obtained.

Finally, an innovative approach to the study of environmental suitability was proposed for the grape-growing activities in the Oltrepò Pavese . This is based on some methodological assumptions derived from quantitative genetic research. These were used to study more deeply the relationships that establish themselves between genotype and environment with the cultivation of new vegetal varieties (corn, soya, wheat). The study uses the degree of response of the grape variety to describe the environment rather than the usual methods of climatic evaluation; this is evaluated on the quantitative-qualitative parameters of the wine (SCIENZA et al., 1984; SCIENZA, 1986). The suitability of an area to produce quality wines cannot be defined by the physical characterization of the environment, that can never be complete, but by the enological results that the wine is able to express.

The study was conducted in 3 phases:

- classification of the factors of the grape-growing model in order of their role in wine quality;
- evaluation of the role of the interaction "grape variety x site" and "grape variety x year" on the qualitative expression of the wine;
- improvement of the adaptability interaction between grape variety and environment through the management of the area using maps showing suitability, genetic innovation and modification of the cultivation techniques.

This strategy explicitly recognizes the different levels of importance of the various factors involved in grape production and their impact on the yield and quality parameters (FIGURE 12).

If we examine the variables that govern yield, we can classify the different factors according to importance: year, grape variety, rootstock, site, number of buds and planting density. Discriminatory analyses confirm the information obtained in relation to the scope of/objectives of the interaction / confirm the expected consequences of the interaction.

The results of studies conducted in Alto Adige (SCIENZA and STEFANINI, 1988) confirm grape variety and year to be the most important factors in determine quality. The grape variety, therefore, represents the essential element for adaptation. On the other hand, the grape variety cannot exert a genotypic control over all the parameters governing quality.

The problems that arise from these considerations vary greatly between the European grape-growing regions linked to French culture and those in Anglo-Saxon countries and the New World, even though the strategies adopted to resolve them seem to be more and more similar.

In Europe, there is a need to restore quality production in the appellations. Therefore, integrated study, exploring the interrelationship between soil, climate and grape variety, can provide a rational scientific approach to confirm the delimitations of the areas developed over the years on the basis of tradition and experience.

The concept of suitability for grape production based on production costs is no longer pertinent. It is the degree of adaptation of the grape variety to the environment that allows the best economic results to be obtained. From this, therefore, the concept has been developed that there are no 'good' and 'bad' grape varieties but rather those that, according to their environment, express their natural qualities in different ways.

THE "UPPER VALLE VERSA" EXAMPLE

The phases of research carried out in the 3-year period 1983-1985 in the Valle Versa are described in order to illustrate the methodology that can be used to evaluate the suitability of a grape-growing area. This study was carried out in Canevino, Golferenzo, Montecalvo Versiggia, Santa Maria della Versa, Volpara. Detailed results are available to the local community. Examples are shown here.

MATERIALS AND METHODS

A preliminary examination of lithological, pedological and topographic documentation allowed us to identify 8 sites (reference vineyards) located on the two sides of the valley. These are representative of the grape-growing potential of the two meso-environments. The vineyards are located at 200-550 m a.s.l. and are characterized by silt, marl and clay, with alternating/dominant marly, calcareous, clayey order and with dominant sandy soil order.

Pinot Noir, Chardonnay and Riesling Italico grape varieties were cultivated in each vineyard. Various measurements were taken in the reference vineyards at fruit set and veraison: penetrometry, water infiltration and temperature, porosity and humidity along the soil profile (FIGURE 1 and photographs).

The parameters related to the composition of the must were measured at harvest. Results were analyzed: variation analysis, multiple regression analysis, discriminant analysis and cluster analysis.

PRINCIPAL FACTORS OF THE “UPPER VALLE VERSA” PRODUCTIVE MODEL

ANOVA variance analysis showed a significant “genotype x site” interaction on the yield per vine-stock (FIGURE 3). In fact, while on the lower hill slopes there is remarkable homogeneity of yield between the grape varieties, on the middle slopes, there is a notable difference in grape variety behavior.

In these conditions, Pinot Noir has a low yield while Riesling Italico has higher yields. The greatest homogeneity of yield among the grape varieties is observed in vineyards on the higher slopes.

Chardonnay is shown to be the most stable grape variety in terms of yield *per* vine in the different sites while Pinot Noir is the most unstable (great variability in yield in the different sites); Riesling Italico lies somewhere between.

A comparison of the percentage of sugar in the musts showed a significant “grape variety x year” interaction (FIGURES 2 and 3). This means that the grape varieties behaved very differently over the years of study.

The attribution of the variability evidenced by ANOVA also showed a determining role of the genotype in controlling sugar content. It is, therefore, necessary to choose grape varieties that are efficient in the accumulation of sugar and that are little influenced by seasonal change. For example, while, over recent years, Riesling Italico has shown remarkable differences, Chardonnay has seemed more stable. Also the “grape variety x site” interaction appeared to be significant for the percentage of sugar, both for the role of altitude on the different grape varieties (a greater influence on Riesling Italico than on Pinot Noir and Chardonnay), and for the different negative correlation between sugar level (%) and yield *per* vine in the three grape varieties (more than proportional in Riesling Italico with respect to Chardonnay).

The lower altitudes, in general, gave better results for the sugar in the must. Sufficiently adequate results were obtained at the higher altitudes; low percentages at the intermediate altitudes.

Results of multiple regression analysis show that sugar level is poorly correlated with the pedological characteristics of the site. On the other hand, the role of the meso-climate is shown to have an important influence on the sugar level in the must, in particular, the temperature of the surface layer of soil (0-30 cm). This is related to an ‘effect of position’ that can be seen in particular at locations at lower altitudes that are more exposed to solar radiation, where there are consequently the highest soil temperatures.

As far as titratable acidity is concerned, no significant “grape variety x site” interactions are seen, above all because the slope and the altitude each have a similar and non-differential role for all three grape varieties studied. Furthermore, it must be remembered that the use of the musts of these grape varieties as a base for sparkling wines *méthode traditionnelle* requires an early harvest to guarantee a good level of acidity.

Acidity seems to be controlled above all by the “year x site” interaction, and the same is true of pH (FIGURES 2-4). This means that the acidity, although strongly influenced by the climatic conditions for the year, also changes according to the location of the vineyard. In particular, the physical characteristics of the soil and its water reserves in particular play an important role, while altitude and aspect are much less important.

In fact, multiple regression analysis showed that the physical soil parameters (penetration resistance, infiltrometry, temperature, etc.) rather than chemical parameters have a direct or inverse influence on the qualitative variables and, among these, in particular, acidity and pH of the must. The acidity is positively correlated to the compactness of the first soil layers (% of clay) and negatively correlated to the temperature of the area around the roots and to porosity along the soil profile. This explains why musts with a high acidity are obtained from those sites where the high levels of clay keep the soil wetter and fresher during maturation, thus slowing down the degradation processes of the organic acids. It is no coincidence that the sites with good acid levels are those where the penetration resistance is higher.

The significant “site x year” interaction also demonstrates that, over the years, less porous soils have a more constant titratable acidity (FIGURE 6).

The soil characteristics also controlled the pH of the must. In fact, besides showing a negative correlation with the compactness of the first layers of soil and with the porosity, pH maintains a similar correlation with potassium content and with the percentage of organic matter in the layer of soil that contains most of the root system. Moreover, the role of organic matter on the pH seems to be linked to keeping the highly humid conditions of the soil constant. Therefore, soils with good amounts of organic matter in the rhizosphere layers are more suitable to obtain musts with a low pH.

The combination of the soil characteristics correlated positively with the acidity of the musts showed their effects above all in the sites at higher altitude and in the more mountainous areas, characterized by lower average soil and air temperatures. In the study area, therefore, altitude was the factor that made a bigger difference in behavior among the grape varieties under study than slope and exposure (FIGURE 4).

PHENOTYPE STABILITY OF THE PRODUCTIVE FACTORS AND SUITABILITY OF THE OF THE REFERENCE VINEYARDS TO THE CULTIVATION OF THE PINOT NOIR, CHARDONNAY AND RIESLING ITALICO

The ability of each grape variety to adapt to its environment has been estimated by an evaluation of the suitability of the sites to obtain high-quality grapes and musts, and also through the statistical study of the phenotypic stability of the phenological, productive and qualitative properties. The genotype of Riesling Italico was shown to be very sensitive to the environment of the upper Valle Versa and, therefore, expresses the best quality only in well-defined sites. In contrast, Pinot Noir and Chardonnay show a better genotypic control of the qualitative characteristics and so they can be cultivated in a wide variety of different pedo-climatic environments.

MULTIVARIATE ANALYSIS TO DESCRIBE AND CLASSIFY THE GENETIC AND CULTIVATION BEHAVIORS OF THE GRAPE VARIETIES

Processing of multivariate analysis allowed us to create hypothetical homogeneous groups of the pedological and productive findings, establishing the relationships between the groups and the variables with the greatest efficacy in determining the groupings themselves.

Discriminant analysis allowed us to classify the “reference vineyards” using some variables with a high capacity to separate the different groups, in particular, the pedo-analytical and quantitative-qualitative measurements of yield. In fact, this analysis allowed us to put together sites with the same pedo-climatic conditions and suitability in groups. The pedo-climatic conditions even of small environments were identified and compared with their suitability. In particular, measuring the extent of infiltration facilitated the subdivision of the environments under study. Furthermore, this differentiation was carried out on the basis of the pedological types of the soils. Figure 7 shows the evaluation of suitability for cultivation and stability of the vineyards.

The most important finding was that, for each environment or groups of environments, there were only one or in any case only a few grape varieties capable of adapting and, therefore, expressing the maximum of their genetic characteristics, obviously when the grapes were put to appropriate enological use according to expert production techniques.

Chardonnay adapted itself best to the environment and was the least sensitive to those environmental conditions that are statistically diversified. Riesling Italico was shown to be only suitable for a more restricted range of environmental conditions and was more sensitive to the environments found in the Valle Versa, in particular, to soil drainage conditions. It was also seen that the most homogeneous conditions of infiltration capacity and velocity corresponded to similar response of the grape varieties to the environmental conditions (FIGURE 8). Interesting results were also obtained from the analysis of resistance to penetration in the reference vineyards in terms of the grape variety's ability to respond to the environment (FIGURE 9). In fact, the best-differentiated sites identified those areas most suitable for the production of wines that form the basis of sparkling wines *méthode traditionnelle* with the three grape varieties under study (Pinot Noir, Chardonnay and Riesling Italico).

Cluster analysis was used to translate the results obtained from the reference vineyards to a vaster range of homogeneous environmental units and to subsequently create a hierarchical scale. In particular, the analysis showed a good correspondence between the pedological characteristics and the quantitative-qualitative responses of the grape varieties obtained in sites at lower altitudes on type "a" brown calcareous soils (FIGURE 10). In these sites, the three grape varieties showed a modest suitability to the production of wines that form the basis of sparkling wines méthode traditionnelle. In contrast, the greatest suitability of sites at the higher altitudes with type "c" brown calcareous soils was confirmed. The conditions of these sites showed notable differences among themselves and even more when compared with the other sites. These findings were confirmed in the analyses carried out for each grape variety in the 8 reference vineyards (FIGURE 11). It was, therefore, possible, for each grape variety studied, to indicate the sites with similar pedological characteristics and qualitative suitability.

SUITABILITY MAPS

Sufficient information data were collected to create a suitability map for each grape variety studied, indicating the most suitable sites on which the "grape variety x site" interaction could be optimized and enhanced, and, on the other hand, where the "grape variety x year" interaction could be minimized. The suitability maps are derived from available topographical maps and are not necessarily definitive, being based on a current interpretation of the characteristics of the land derived from the existing ampelographic platform.

The permanent limitations established by the diversified nature of the land were considered: climatic (areas subject to frost, risk for hail, etc.). The areas most suitable for the different grape varieties were shown on topographical maps of the area under study using the so-called "analogy" method with different colors and lines, also taking into consideration the best enological use of the grapes produced (wines that form the basis of sparkling wines *méthode traditionnelle*, red wines, still white wines, slightly sparkling white wines).

CONCLUSIONS

The most suitable sites from the point of view of quality identified by this research are, nevertheless, only used to their best advantage if, on the one hand, grape varieties with an adequate degree of response and stability in the specific climatic conditions of the site are cultivated, and on the other, a high planting density approach (that promotes modest yield) is adopted. In fact, a low yield *per* vine means that the grape variety is less influenced by the climatic conditions for the year and, therefore, reduces the negative "grape variety x year" interaction and instead reinforces the advantages of the "grape variety x site" interaction. Perfection of the "grape variety x environment" interaction is, therefore, the guiding force to improve the quality of grapes destined for use in sparkling wines *méthode traditionnelle* in the Valle Versa.

In general, for the most suitable sites, such an improvement can be made by choosing grape varieties with a genotype that can be best expressed in those specific climatic and soil conditions (e.g. Pinot Noir and above all Riesling Italico). For those less suitable environments, grape varieties should be selected that can reduce the extent of the interaction with the site, given their stability and suitability for a wider range of conditions (e.g. Chardonnay).

«Piano per il riassetto territoriale dell'Oltrepo' Pavese», Regione Lombardia, Ufficio Speciale per l'Oltrepo' Pavese; Scala 1 : 25.000 (Carte dell'uso del suolo al 1954-55 ed al 1976-77; Carta delle penenze; Carta della permeabilità; Carta pedologica; Carta dell'utilizzazione del suolo).

«Proposta di riassetto globale del territorio», Regione Lombardia, Progetto Speciale Oltrepo'; Carta dell'utilizzo del suolo, Scala 1 : 10.000.

Carta litologica-strutturale dell'Appennino Pavese; Ufficio geologico dell'Amm. Prov. di Pavia, Scala 1 : 100.000.

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Figure 1 - Experimental protocol of the zoning.

<table>
<tr><th>Study of the pedological environment</th><th>Evaluation of the interaction "grape variety x environment"</th></tr>
<tr><td>Identification of "reference vineyards" (sites) using existing thematic maps (U.S.D.)
Chemical and physical-mechanical analyses of soil samples collected at two different depths: 0-30 cm and 30-60 cm</td><td>Collection of the productive data in the different sites
Yield Kg/vine
Number of grapes
Average weight of the bunches
Number of fertile shoots
Fertility (number of clusters/fertile bud)</td></tr>
<tr><td rowspan="2">Infiltrometry tests at fruit set and veraison using a falling head infiltrometer
Penetrometry tests at fruit set and veraison using a manual penetrometer
Measurements of temperature at fruit set and veraison at 20-40-60 cm
Humidity at fruit set and veraison from 0 to 60 cm drying out the samples in a stove</td><td>Chemical analysis of the must produced
Sugar % - titratable acidity g/l - pH
Malic acid g/l - tartaric acid g/l</td></tr>
<tr><td>Optimization of the "genotype x environment" interaction
SUITABILITY MAPS</td></tr>
</table>

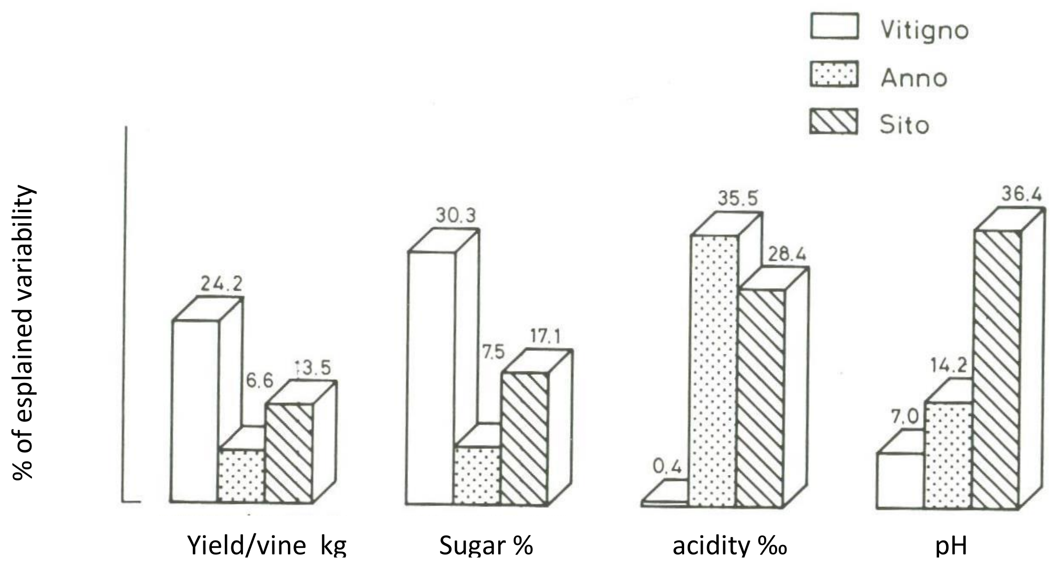


Figure 2 - Hierarchical classification of the factors of the Valle Versa grape growing model in relation to the yield and quality parameters, using ANOVA. In particular, the analysis shows the different role of grape variety, year and site in the control of the main **components of the must.**

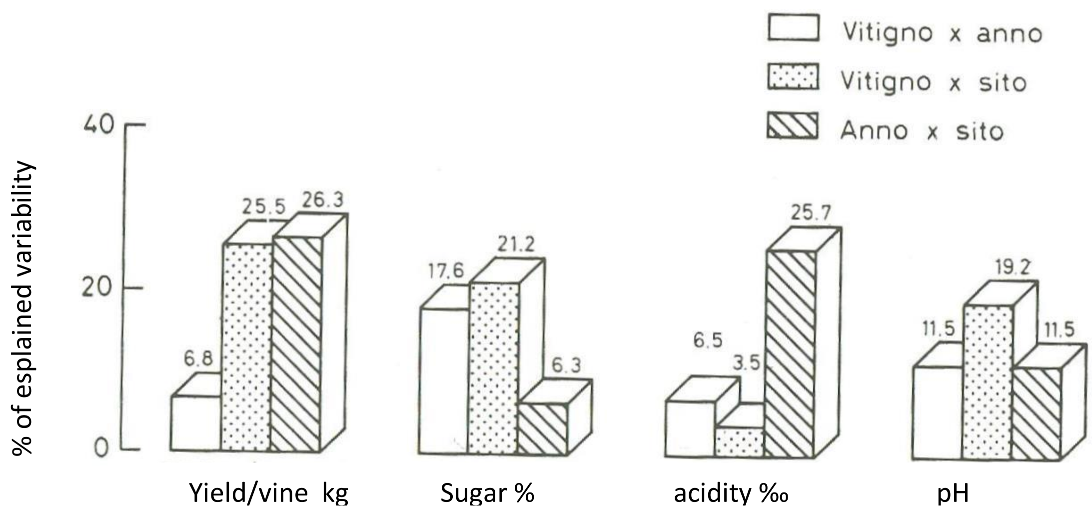


Figure 3 - Impact of the interactions on yield and chemical composition of the must.

Particularly important seems the "grape variety x site" interaction in relation to the identification of suitability on the basis of yield/vine, sugar amount and pH

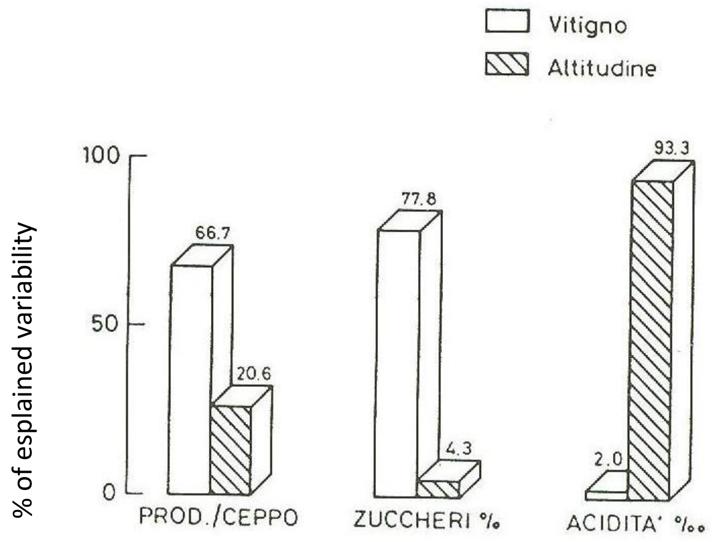


Figure 4 - Role of grape variety and altitude on the control of the yield/vine-stock, the sugar amount and the titratable acidity.

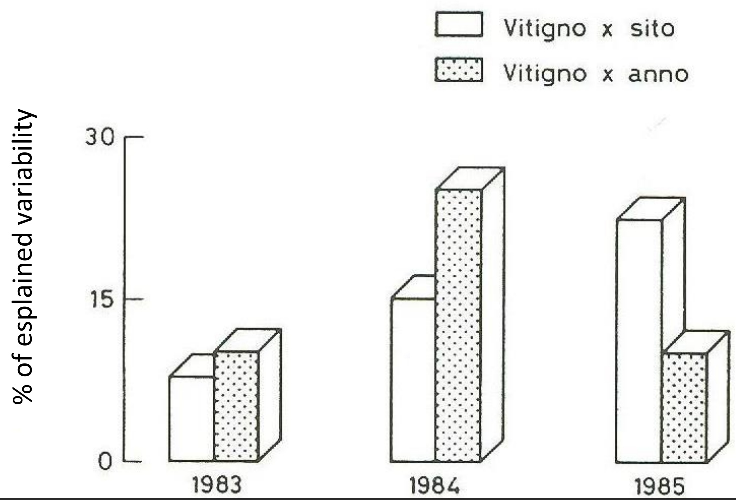


Figure 5 - Value of the "grape variety x site" and "grape variety x year" interactions in the different years. The "grape variety x year" interaction shows to have an important role in relation to quality in the unfavorable years (e.g. 1984). On the contrary, the role of the interaction "grape variety x site" becomes essential in the intermediate years (1985), when the role of the most suitable environments emerge, while in the particularly unfavorable (1984) and favorable (1983) years this role is

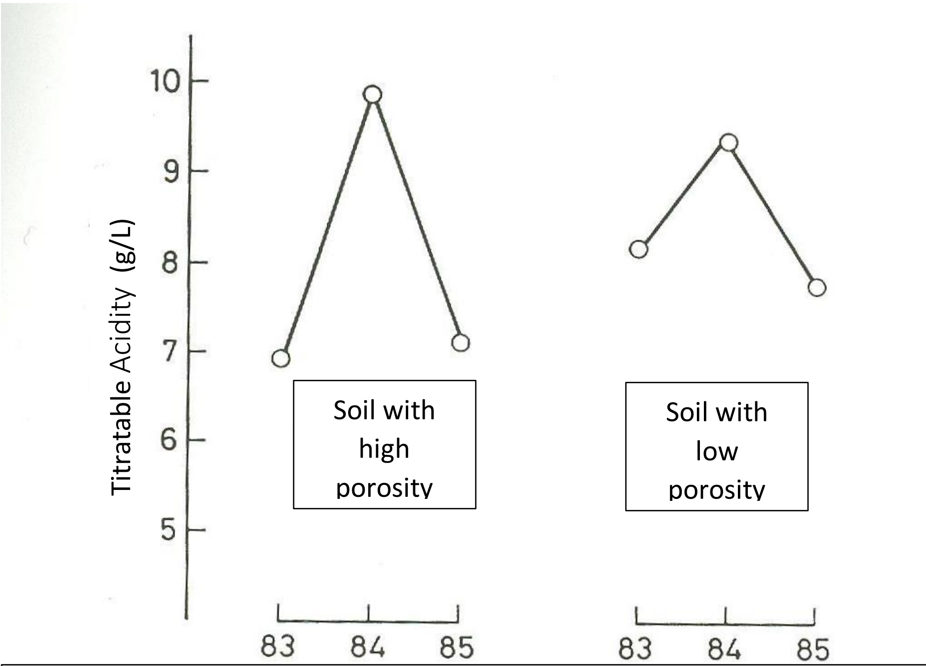


Figure 6 - Role of soil porosity on the titratable acidity of the musts (g/l) in the "site x year" interaction. In the less porous soils of the Valle. Versa the titratable acidity becomes more stable over the years

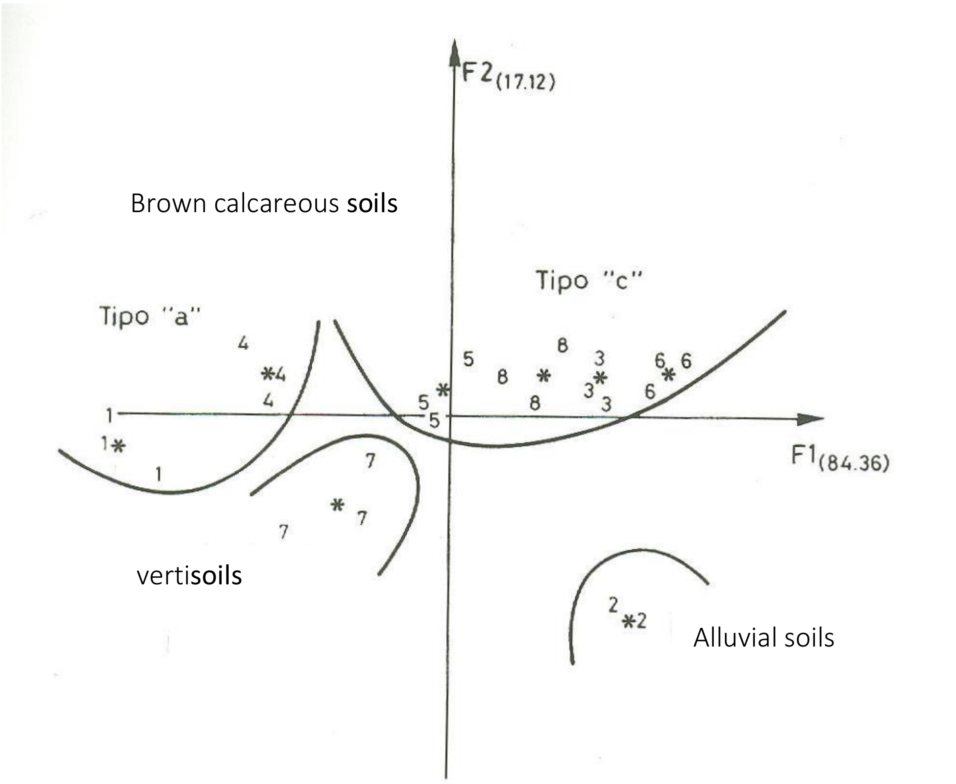


Figure 7 - Distribution on two vectors of the soils in the vineyards under study of the Valle Versa, on the basis of water infiltration velocity. Groupment according to the pedological characteristics.

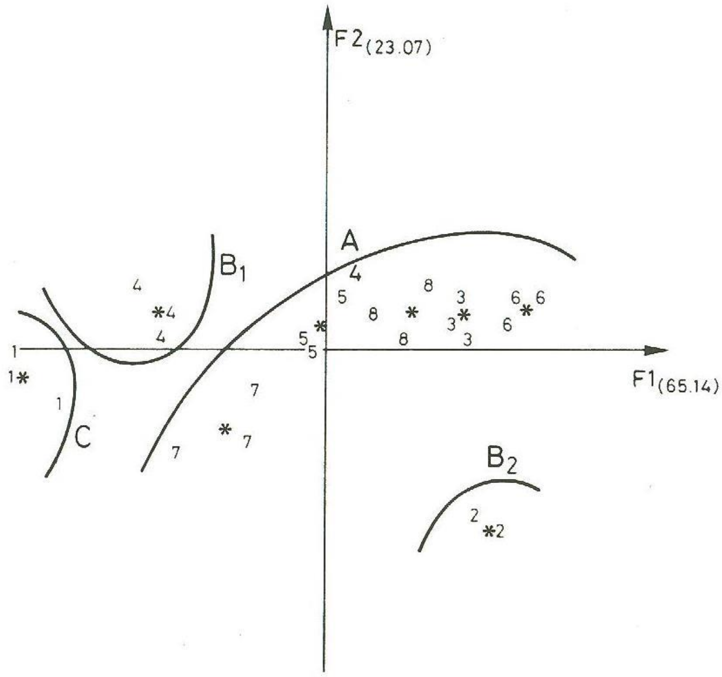


Figure 8 - Classification of the quality production according to the discriminated vineyards on the basis of the infiltration velocity. The vineyards can be classified on the basis of the quality results determined by the clay amounts as: A= high suitability, B1 and B2= medium suitability, C= poor suitability.

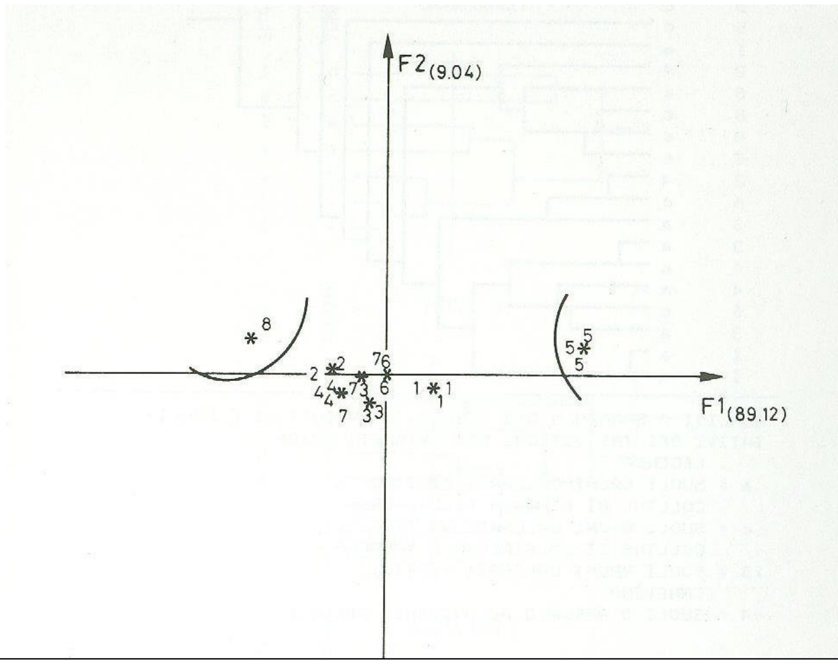
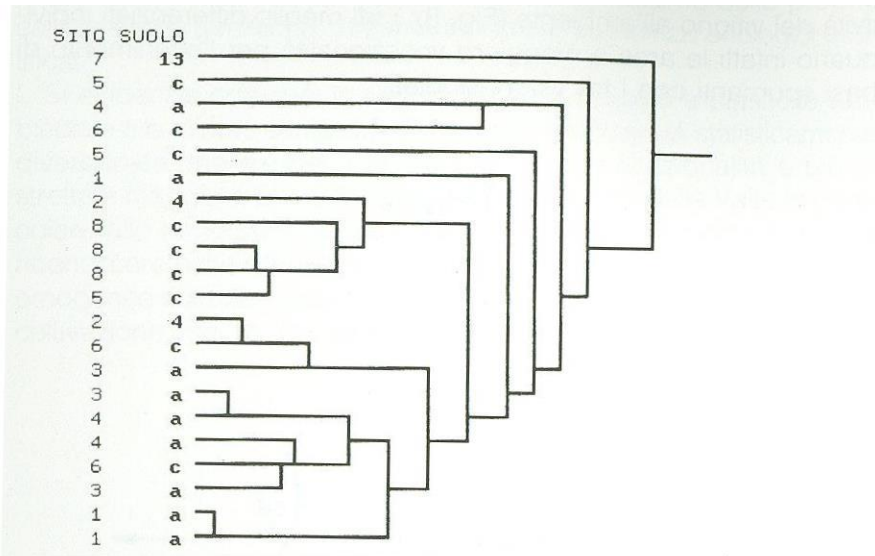


Figure 9 - Classification of the study environments according to the measurements of penetration resistance. They allow us to separate only partially the reference vineyards



Cluster analysis of the productive and qualitative results of the three grape varieties in the reference vineyards.

type "**a**" brown calcareous soil, hills of Santa Maria della Versa;

type "**c**" brown calcareous soils, hills of Golferenzo and Volpara

13 brown calcareous vertisoils, Canevino

Figure 10 - The generalization of the data collected from the reference vineyards to wider homogeneous landscape units and the subsequent hierarchical classification is carried out through the cluster analysis for all the vineyards under study.

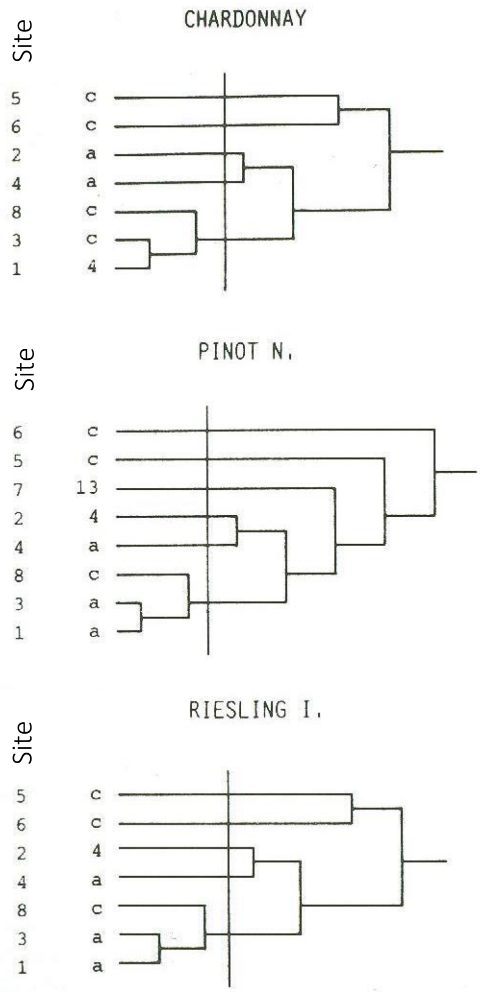


Figure 11 - Generalization of the information obtained from the reference vineyards through the cluster analysis. For each grape variety under study (Chardonnay, Pinot Noir and Riesling italico), the sites with similar pedological characteristics and suitability for the production of quality wines are indicated

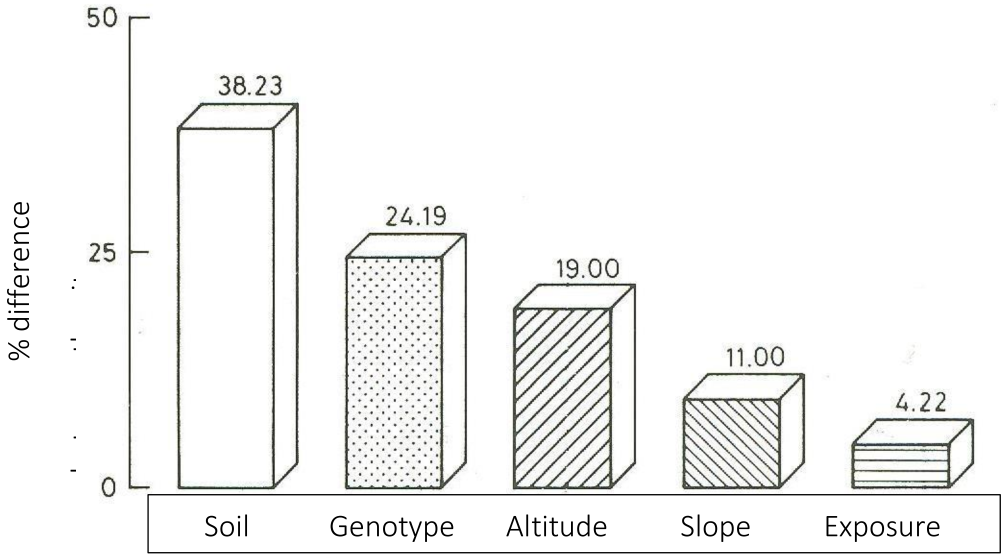
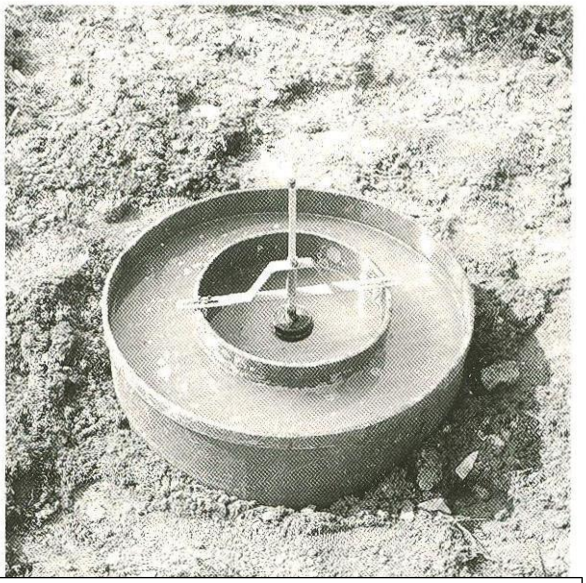


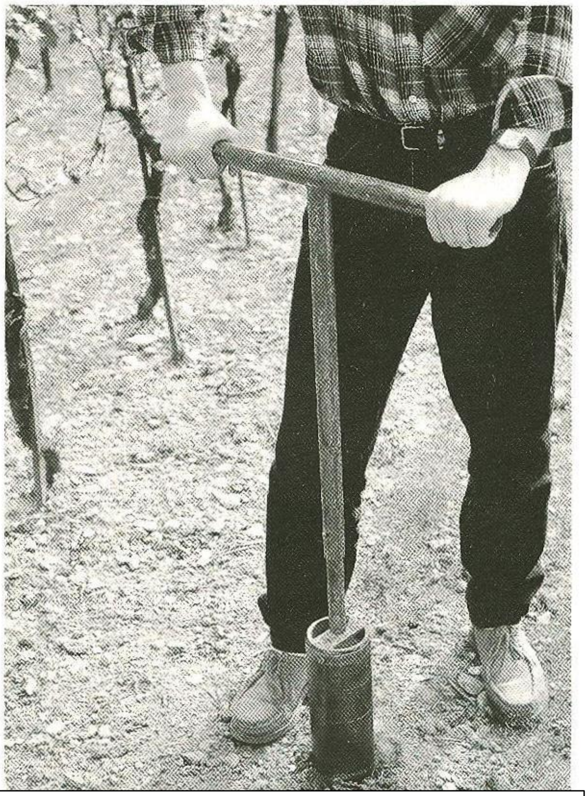
Figure 12 - Hierachical classification of the relative importance of the different factors of the productive model in determining the difference between the site-grape variety pairs under study, according to the results of cluster analysis.



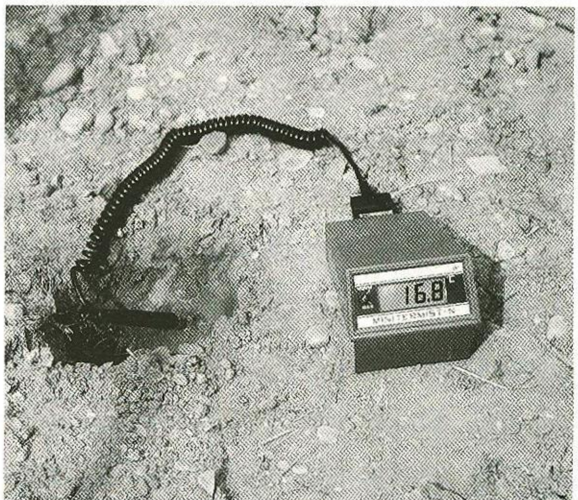
Double ring falling head infiltrometer used to measure the rate of water infiltration into soil in the unit of time (soil permeability).

This device allows to simulate the soil drainage

Eijkelkamp '74 manual penetrometer. It allows to measure the soil resistance to penetration and crushing, caused by the cohesive forces that tend to keep the soil particles bound together

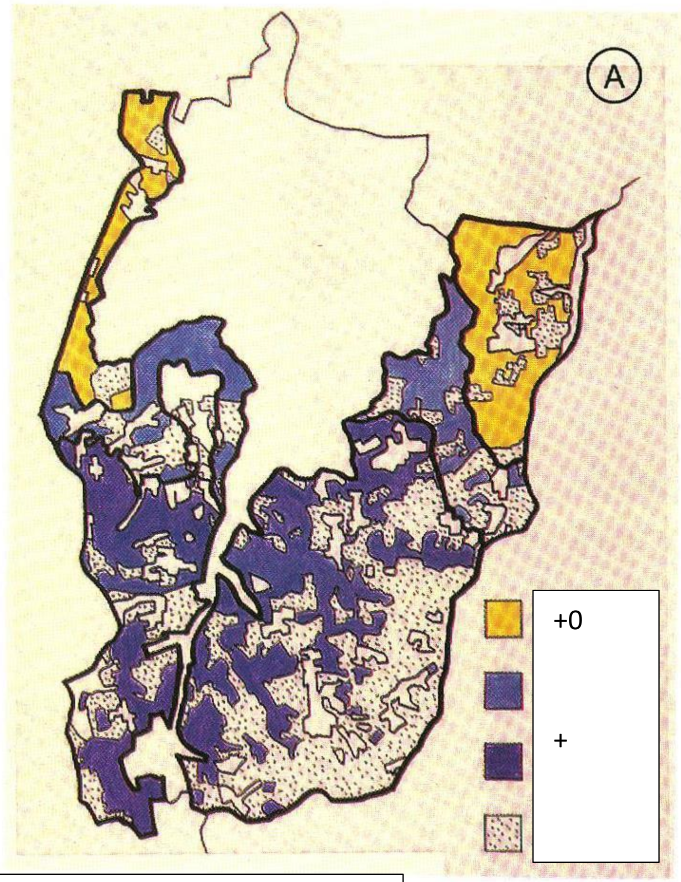


Auger realized by the Istituto di Coltivazioni Arboree (University of Milan) for the pedological analysis. It is possible to measure the percentages of porosity and humidity of the collected soil samples of known volume.



In the soil layer that is mostly penetrated by the roots, temperature is measured using a probe geothermometer.

The thermal aspect of pedoclimate is essential to understand how the plant behaves, because it has an effect on the activity of the microflora, the water and mineral nutrition of



Suitability maps drawn with the method of the analogies for Pinot n. (A) and Chardonnay (B).

+0, low suitability;

+, medium suitability;

++ high suitability;