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PINOT NOIR: PRODUCTIVE CHARACTERISTICS AND NUTRITIONAL ASPECTS IN THE OLTREPÒ PAVESE

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INTRODUCTION

Some historical facts about Pinot Noir

Pinot noir is more precisely a group of Pinots: Pinot grigio, Pinot bianco, Pinot verde, etc., that are now believed to derive from Pinot Noir. They are probably grape varieties of ancient origin. Some of their characteristics (almost round leaves, predisposed to mutation) make them seem closer to the 'little domesticated' grape varieties of ancient times than others. We find descriptions of the characteristics of wine grape varieties in the ampelographic records of the Romans, by above all Cato the Censor, who was writing around 185 B.C. and Columella Lucio Giunio Moderato, author of the most famous ampelographic account edited under the Roman Empire, *De Re Rustica*, written around 41 A.D. Looking through these ampelographic records, we are surprised by the precision with which some very typical characteristics are described. These characteristics are those for which Pinot Noir is still known today and were attributed to this group of grape varieties that was referred to by Cato almost two centuries before the birth of Christ. Columella classified them as Helvolae (DALMASSO, 1931; CALLECCHI, 1948). Columella emphasizes the color of the grape berries as "*helvus*" ("*neque nigrae neque purpurae, ab helvo colore vocitatae*"), a light yellow-Isabella color that matches the description of Cato more than two centuries earlier of "*Helveolum vinum*" ("*helveolus*" being pale red or yellowish). Again it is Columella who confirms the extremely dishomogeneous color that often distinguishes the color of the grape berries ("*color acinorum in neutra conspicitus aequalis*") and the characteristic production of light or white musts ("*candidi musti*"), as well as the exceptional fertility seen even in poor soils.

Today, the area where Pinot Noir is cultivated most is Burgundy, where the grape variety began to be known in the 4th A.D. (GALTIER 1951). Denominations similar to Pinot (Pynos and Pinoz) were only recorded in a document dating from 1394 (VIALA, 1901). Because of this it is likely that the original genotypes of today's Pinots (also because of environmental adaptation) were cultivated in north-western Italy and in the south of France, populated first by the Ligures (the term Labrusca, as the Romans called the little domesticated grapevine, originated from the Paleo-ligurian language) (SERENI, 1964). The area was then populated by the Romans: the north-western Apennines from 222 B.C. and the Gallia Narbonensis from 118 B.C.. It was probably the Romans who introduced the predecessors of the Pinot genotypes of Burgundy into northern France. In this context, in the period 500-600 B.C., also the Greek colonies of Marseille had a certain influence, as some authors claim (SERENI, 1964; FAILLA, 1988). However, GALTIER reports that this is difficult to quantify given the well-known socio-economic and agricultural differences between Greek colonization and that of the Etruscans and the Romans (1951). The Greek influence is to be felt above all in the training systems used for the plants. In hill areas in north-western Italy and in southern France these were already

characterized by a relatively contained development of the grapevines supported by stakes, in contrast to the rest of Italy where plant vigor was not contained and grapevines were trained on live trees (SERENI, 1964).

In north-western Italy, above all in the hills of the northern Apennines (provinces of Alessandria, Pavia and Piacenza), over the centuries frequent descriptions are to be found of grape varieties whose nomenclature and characteristics remind us of the Pinots. These grape varieties all have an often quite small pine-shaped cluster with compact grape berries of variable color. PIER DE CRESCENZI spoke of the Pignuolo grape variety in the first half of the 13th century, as did GALLO in the first years of the 16th century. In the early 1600s, the Pineolo wines are reported in the area around Piacenza, and BACCI describes the Pignole del Piacentino as "*…pine-shaped bunches… compact grape berries close together in the cluster, of a red-black color*", also cultivated in the area south of Pavia. Later, in 1793, BRAMIERI spoke about the grapes Pignolo gentile and Pignolo grappolato, cultivated on the hills of Piacenza. The Pignolo grappolato is similar to the Pignuola grigia of San Colombano. At the beginning of the 19th century, GALLESIO spoke about Pignolo cultivated in the area south of Pavia. At the end of that century GIUGLIETTI talked about how the same variety had been cultivated since ancient times in the Oltrepò Pavese (SODERINI, 1600; BRAMIERI, 1793; DE MARIA, 1875; GIUGLIETTI, 1884; DALMASSO, 1937). Therefore, the current Pinots derive from genotypes that already existed at the beginning of the Roman age, or even before. They were perhaps the result of natural hybridization between Greek and local grape varieties, and they were to be found in north-western Italy and introduced in Burgundy by the Romans in the first centuries after the birth of Christ. The current Pinots may have been the result of a natural and anthropic selection that took place in northern Italy. It is a group of grape varieties that has continued to diversify amongst themselves over time also because of the ever more well-established local grape growing tradition of the consequent high diversification of tastes and of grape cultivation throughout the area. These varieties had in fact almost disappeared with the post-Phylloxera reconstruction of the vineyards.

In northern France, and more precisely in Burgundy, there is no ancient grape growing tradition and this only began many centuries after it had already been established in Italy. The transfer of a grapevine cultivation *ex novo* resulted in a much more homogeneous landscape, articulated on a more restricted ampelographic platform. Given this, only a few grape varieties adapted themselves to these climatic conditions. However, it was in Burgundy that there was the largest area of cultivation of Pinots. The production in this area achieved, through time and selection, the highest quality standards. In fact, from the 14th century A.D. onwards, many authors, both French and from abroad, praised these wines. It was from this area that the Pinots spread to other parts of France and then worldwide.

PINOT IN THE OLTREPÒ PAVESE

French Pinot Noir has been 'exported' in various French and European grape growing regions. Its presence in the Oltrepò Pavese probably dates from some centuries ago, given that this area has always been characterized by frequent exchanges with the surrounding areas of Piacenza and Alessandria, where this variety was already known. It is thought that Pinot from Burgundy was introduced in the hills around Piacenza in the mid-17th century (VECCHIA, 1967) and the Ampelography of Alessandria (1875) reports that this grape variety had been known there for several

years (DE MARIA *et al*., 1875). It was probably cultivated in the area from around the mid-19th century (VALENTI, 1988) and is reported to be quite widespread in some Communes of the Oltrepò at the end of that century (GIUGLIETTI, 1884).

It is, however, at the beginning of the 20th century that this grape variety starts to be planted according to a precise grape growing program with the aim of using it to make sparkling wines *méthode traditionnelle*. The material used came directly from France.

EVOLUTION OF THE CULTIVATION OF PINOT NOIR IN RECENT YEARS

We could say that the land area of the Oltrepò Pavese destined for cultivation of Pinot Noir has since then continued to grow, above all in the last 20 years. The cultivation of the Pinots in general (Pinot Noir represents the biggest part) was approximately 700 ha in 1975 (FREGONI, 1979) and today involves approximately 2,400 ha (LECCHI, 1988).

The Oltrepò Pavese is the biggest producer of Pinot Noir grapes for sparkling wines *méthode traditionnelle* in Italy. The reason for such a great expansion lies, above all, in the higher earnings available to producers given on the one hand the large request for Pinot Noir grapes for the production of sparkling wines *méthode traditionnelle*, and on the other, the possibility of achieving high yields and also good quality.

The great diffusion of this grape variety has, however, involved every corner of the Oltrepò Pavese and often planning new vineyards has not taken into consideration the principal climatic-pedological characteristics in which the different clones of Pinot Noir are able to best express their qualitative-quantitative profile according to pre-determined enological objectives. Furthermore, there still has not been sufficient study of the vocational character of different grape-growing areas in the Oltrepò Pavese (Valle Scuropasso, the lower Valle Versa). This includes both the production of Pinot Noir grapes to make sparkling wines *méthode traditionnelle* and the use of this variety to make quality wines vinified in red. In consideration of this latter use, and given the typical characteristics of the Oltrepò Pavese, it is interesting to consider the possibility of using Pinot grapes to make a great mature red wine, the high quality of which is internationally recognized. In order to do this, however, accurate studies must be developed given the prerogatives that the vineyards destined for such a production must satisfy (high planting density, few shoots *per* vine-stock, low or very low production, clones with small bunches and small grape berries, etc.) that do not correspond to the typical habitat of Pinot grapevines in the Oltrepò Pavese.

THE AIMS OF THE EXPERIMENT

This study aims to widen our understanding about the behavior of the Pinot Noir grape variety in terms of the principal qualitative characteristics acquired by the grapes in different environmental conditions of the Valle Scuropasso (Oltrepò Pavese), with specific reference to the production of sparkling wines *méthode traditionnelle*. The study was conducted over four years and entailed an analysis of, above all, the acidic and sugar components of the grape berries. This study was part of ongoing research being carried out in the Valle Scuropasso with the collaboration of the Institute of

Viticulture of the Università Cattolica del Sacro Cuore of Piacenza, the Technical-Viticultural and Enological Consultancy Center of the Valle Scuropasso, and the Italkali Company of Palermo.

MATERIALS AND METHODS

A series of grape growing plots representative of local vineyards were examined. Six Pinot Noir grape varieties that were cultivated in a sufficiently similar way were followed for four years from 1986 to 1989. Grape samples were taken and different properties were determined: above all, the amount of sugar (degrees Brix), titratable acidity (g/L, tartaric acid eq.) and malic acid (g/l). In 1988 and 1989, samples from 15 plants, representative of 23 vineyards of different areas of the valley, were analyzed for the following:

- number of buds *per* vine-stock;
- number of grape clusters *per* vine;
- average weight of the grape (g);
- yield *per* vine (kg).

The following analyses were carried out on must samples of 3-4 representative bunches of a single vine-stock:

- amount of sugar (refractometric degrees Brix);
- pH;
- titratable acidity (g/L, tartaric acid eq.);
- tartaric acid (g/L);
- malic acid (g/L).

These analyses were part of an experimental investigation that took into consideration a total of 44 Pinot Noir vineyards in 1988. Besides examining the principal cultivation characteristics of the plots, we also analyzed the leaves according to the method proposed by FREGONI (1973) in two phenological phases: fruit set and the veraison. The leaf analysis involved mineral elements evaluated on dry matter: nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, carbon, iron, sodium and boron. Analysis of the soil examined its granulometric components: sand, silt and clay. It also examined pH, cationic exchange capacity (CEC), organic matter and active limestone. We also examined the mineral elements: total nitrogen, assimilable phosphorus (Olsen) and exchangeable sulfur, potassium, calcium and magnesium. In 1989, tests were carried out on the 23 vineyards considered the most significant given the pre-determined objectives.

Results of the analyses provide a first step towards identifying the factors that influence productive performance of Pinot Noir in the different typical areas of the Valle Scuropasso, also in relation to the pedo-climatic and nutritional characteristics found.

RESULTS AND DISCUSSION

The soils of the Pinot Noir vineyards in this study are frequently characterized, from a granulometric point of view, by a particularly high clay index. In fact, over half of the soils examined could be

classified as clayey and a smaller part as clayey-sandy according to the international SISS methodology (FIGURE 1).

The pH of the soil in almost all cases was over 7.5 and an appreciable fraction of the soils tested (approx. 20%) was over 8 also because of the presence of a large amount of active limestone (from "good" to "rich" in >40% of cases) (FIGURE 2). The CEC was "high" or "very high" in over 90% of the cases examined, in agreement with the high amount of clay. Only in a few cases could the amount of organic matter be considered sufficient or even good; in most cases it was scarce (<2%). The amount of macronutritional mineral elements in the soil (FIGURE 3), evaluated in the 15-60 cm deep layer, showed interesting results. While the amount of nitrogen was more frequently sufficient or more than sufficient, the amount of assimilable phosphorus was scarce or very scarce in over 60% of cases. Exchangeable potassium was measured also in relation to the CEC of the soil and was frequently found in high or very high amounts. "Very high" amounts of magnesium and calcium were found in almost all cases.

This nutritional profile concerning the macronutritional mineral elements did not correspond with the nutritional situation of the leaves. In fact, evaluating the presence of macronutritional elements in the leaves in 1988 and 1989, compared with the reference levels defined by the overall interpretation of the results of the leaf analysis emerging from the nutritional maps developed by FREGONI and his team from 1970 to today (TABLE 3 and FIGURE 4), the leaves were found to have a nutritional deficit of potassium and magnesium. Above all, these results do not agree with our expectations given the potential of the soils examined. In fact, in 1988 we observed a deficit of potassium on the leaves that was widespread in some areas.

Probably the particular makeup of the soil found (frequently very clayey with little organic matter), in relation to the typical seasonal rainfall in the Valle Scuropasso that alternates between periods of good if not too high amounts of water with periods of drought, and to frequent working with a rotary hoe to eliminate weeds, determines hypogeal environmental conditions that do not favor the assumption of potassium and magnesium even if these are present in sufficient or more than sufficient doses in the soil.

Celine: Attenzione sia terroir che metodi di allevamento

In almost all cases, the grapevines studied had been grown according to a modified Guyot training system with planting patterns of approximately 2.00-2.20 m on the row and 2.30-2.50 m between rows, with a planting density of nearly 2,000 plants/ha. The vegetative-productive habitat of these Pinot Noir grapevines, followed in the 2-year period 1988-1989, was characterized by approximately 37 buds *per* vine-stock and an average yield of a little under 6 kg. In most cases, grape production in these vineyards varied around 10,000-11,000 kg/ha. However, it should be noted that yields of almost 10 kg *per* vine were also recorded. The average weight of the grape cluster varied from 79 to 176 g with average values more frequently around 110 g. With this, we can comment on the great difference in size of the Pinot Noir grapes observed in the Valle Scuropasso. (In none of the vineyards studied had genetic material derived from clonal selection been planted).

There were, however, even within the same vineyard, plants characterized by medium or low vigor and medium or small grape size, together with plants with medium or high vigor and big grapes clusters.

The analyses carried out on the musts of the grapes examined (TABLE 5) in the years 1988 and 1989 showed medium amounts of sugar (nearly 18 °Brix) and an average titratable acidity of approximately 10g/L. pH was 3.16 (range 3.04-3.34). The acidic component and pH of Pinot Noir grapes are very important for the production of sparkling wines *méthode traditionnelle*, and in this context, the grapes produced in Valle Scuropasso, in the same cases, showed pH values that were too high and that were difficult to manage in the enological transformation of the musts.

We carried out analyses of variance of acidic and sugar component of musts from 6 localities studied in the 4-year period 1986-1989, according to an experimental design that considered year and location together with the significance of the different sources of variation (year, location, interaction), and the resulting percentage of variability was calculated (TABLE 6).

In almost all cases, the three sources of variation were shown to have a significant effect on the values obtained from the variables considered ($P<0.01$).

The amount of sugar showed the greatest variability with regards to year, while the acidic component was more heavily influenced by location. This last phenomenon seems to be due, above all, from the impact that the different locations has on the malic component of the acidic fraction. This seems to show that, as far as the titratable acidity of the musts is concerned, so important in defining the quality of the grapes destined for production of sparkling wines *méthode traditionnelle*, the location of the vineyards has the biggest influence.

CONCLUSIONS

The Pinot Noir of the Valle Scuropasso is cultivated in particularly clayey soils frequently with high levels of active limestone. pH values are quite high (7.5-8.0) and the amount of organic matter is often below 2% and, therefore, not sufficient. The combination of these characteristics with the most common soil management methods (mechanical working) probably result in the fact that plant nutrition does not correspond to the potential in the soil as regards K, but above all Mg. In fact, these elements, although present in good or more than good doses in the soil, are often not found in sufficient quantities in the leaves. However, with regards to grapes produced for sparkling wines *méthode traditionnelle*, the importance of their acidity, the overall dynamics of the potassium and magnesium nutrition requires further controls of any possible presence of cations in the musts.

From a study of the diversification of Pinot Noir from different localities in the Valle Scuropasso produced over a certain number of years (1986, 1987, 1988, 1989), above all concerning some chemical components of the grape berry (sugars, titratable acidity, malic and tartaric acids), it was seen that the location of origin of the grapes has the biggest influence on the acidic composition of the grape berries rather than seasonal conditions for the year. This highlights the importance of a careful evaluation of the suitability of the numerous and diversified grape growing contexts in the Valle Scuropasso.

The productions observed in the 2-year period 1988-1989 showed average values near to or slightly over the D.O.C. reference limits, even though, in some cases, yield seemed to be considerably higher.

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Table 1 - Estimated diffusion of Pinot noir in the world (cultivation surface, ha).

Countries	ha	references
France	22,000 ha	(Boursiquot, 1988)
Italy	4,000 ha	(*)
West Germany	3,900 ha	(Hillebrand et al., 1984)
Switzerland	3,000 ha	(Galet, 1985)
U.S.A.	3,000	3,000 ha
Total	39,900 ha	
Also cultivated in Argentina, Chile, Uruguay, Austria, Bulgaria, Czechoslovakia, Hungary, Rumania, Yugoslavia and U.S.S.R.		
(*) Although the ISTAT Census of 1982 estimated a cultivation surface of approximately 1,700 Ha, on the basis of the works of several authors (BENETTI, 1983; DICORATO, 1983; IANNINI et coll., 1985; LECHI, 1988; VALENTI, 1988), we can consider that today the total surface is approximately 4,000 Ha.		

Table 2 - Estimated diffusion of Pinot noir in Italy (ha).

regions	ha
Lombardia (Oltrepò Pavese)	1,700 ha
Veneto (Eastern Provinces)	1,100 ha
Friuli Venezia Giulia	200 ha
Trentino Alto Adige	230 ha
Data taken from the publications referring to the abovementioned Regions (DI CORATO, 1983; IANNINI et coll., 1985; BENETTI, 1983; LECHI, 1988). Pinot Noir is also cultivated in in other Regions, above all Piedmont and Emilia Romagna.	

Table 3 - Levels of mineral elements in the leaves (% on the dry matter) as resulting from sample collections in various Italian grape growing areas during the creation of the Nutritional Maps by Fregoni and his colleagues from 1973 to 1986 (VERCESI et al, 1987). Average values at fruit set and veraison.

elements	poor	scarce	medium	rich	very rich
N	<1.65	1.65-2.40	1.90-2.40	2.40-2.60	>2.60
P	<0.11	0.11-0.14	0.14-0.20	0.20-0.24	>0.24
K	<0.57	0.57-0.80	0.80-1.24	1.24-1.46	>1.46
Ca	<1.41	1.41-1.78	1.78-2.54	2.54-2.91	>2.91
Mg	<0.15	0.15-0.23	0.23-0.39	0.39-0.47	>0.47

Table 4 - Average values and variations (C.V. = coefficient of variation) of some characteristics of the vegetative and productive habitus of grapevines examined during the 2-year period 1988-1989 in 23 vineyards studied in the Valle Scuropasso (A. W. = average weight).

variables	Range of variation	Average value	C. V.
Number of buds	28-50	36.66	34.38
Number of grapes	40-78	54.75	39.67
Grapes (A. W. g)	79-176	111.19	31.80
Yield/vine	3.3-9.8	5.99	46.71

Table 5 - Average values and variation (C.V. = coefficient of variation) of the analytical analysis on the musts obtained from the study vineyards (1988 and 1989) in the Valle Scuropasso(A. W. = average weight; Tit.=titrable).

variables	Range of variation	Average value	C. V.
Sugar (°Brix)	16-21	18.04	13.86
pH	3.04-3.34	3.16	4.29
Tit. acidity (g/L)	8.04-11.09	9.77	17.08
Tartaric acid (g/L)	5.89-7.90	6.93	19.04
Malic acid (g/L)	3.38-6.79	5.1	33.28

Table 6 - Percentage distribution of the different sources of variation on the total variability (ANOVA) - Analyses carried out on the musts obtained from 6 locations during a 4-year period (1986-1989)

Sources of variation	d. f.	Sugar (°Brix)	Tit. acidity (g/L)	Tartaric acid (g/L)	Malic acid (g/L)
Year	3	19.6 **	3.4 **	30.0 **	5.1 **
Location	5	4.8 *	15.8 **	7.1 **	11.6 **
Year x location	15	16.6 **	38.5 **	30.7 **	40.6 **
Residue	156	59.0	42.3	32.2	42.7

d.f. = degrees of freedom
n.s. = not significant
(*) = significant for P< 0.05
(**) = significant for P<0.01

Figure 1 - Texture characteristic of the soils (•) under study (C = Clay, Si = Silt, Sa = Sand).

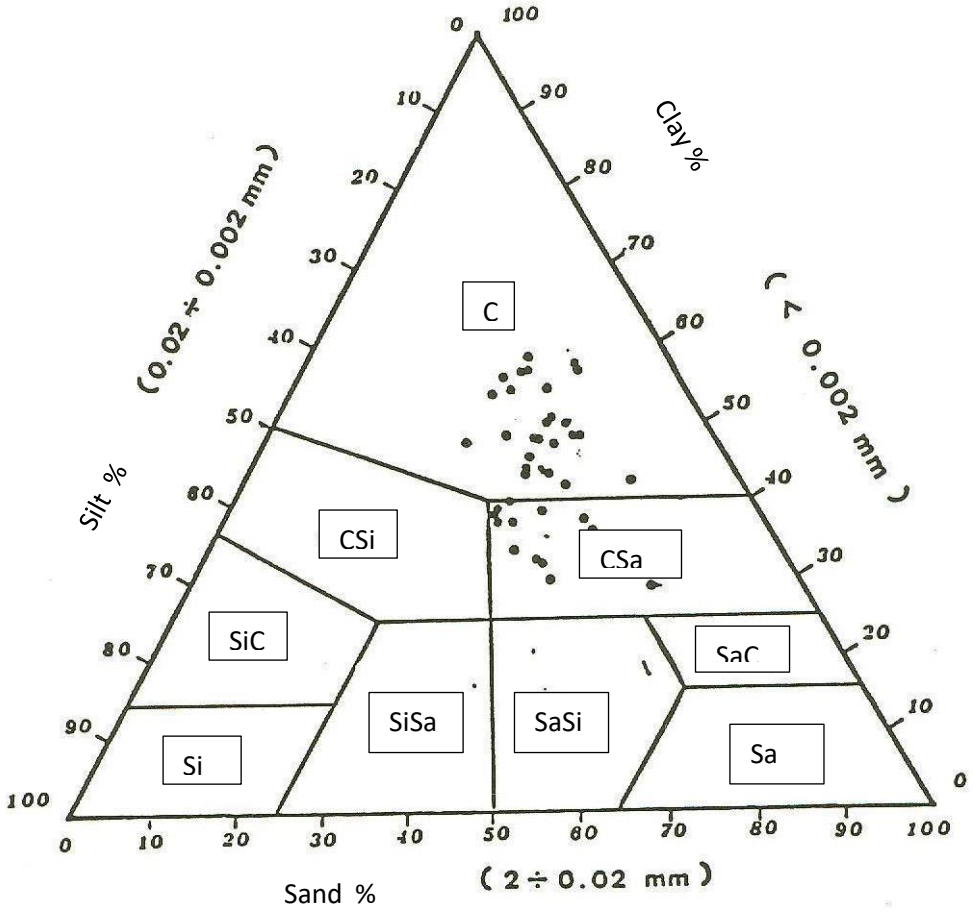


Figure 2 - Frequency histograms of the percentage values of pH, CEC (cationic exchange capacity), active limestone and organic matter in the soils under study (L = low, M = medium, H = high, V = very, P = poor, S = sufficient, R = rich)

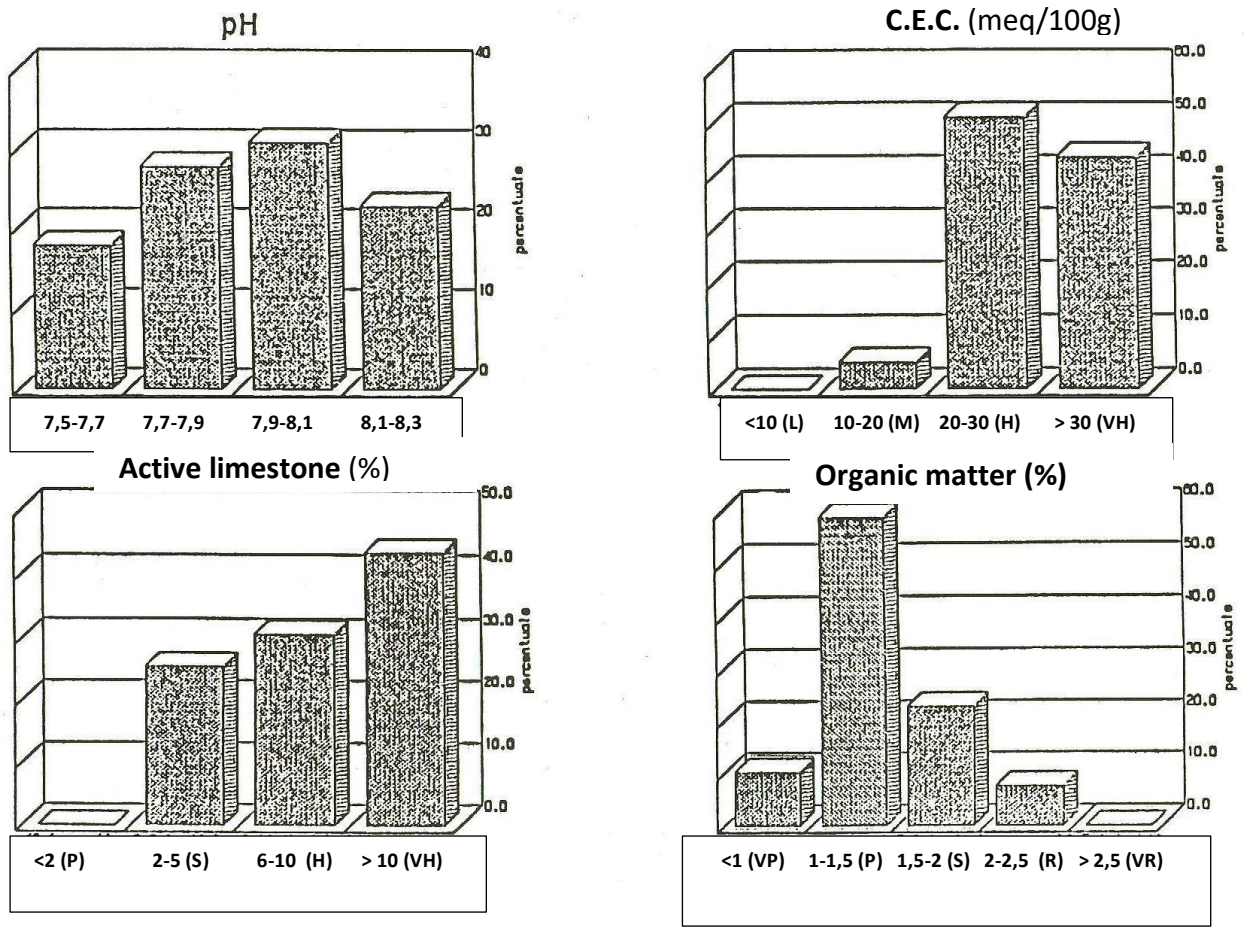
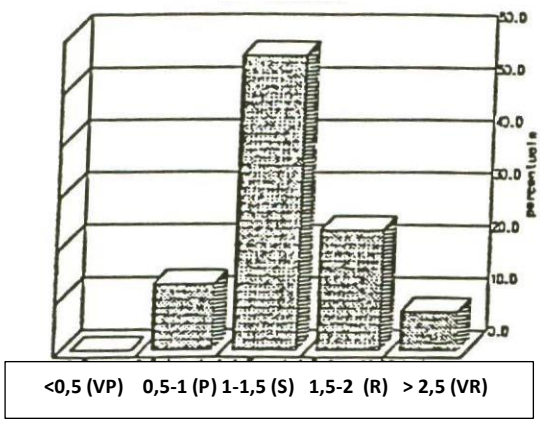
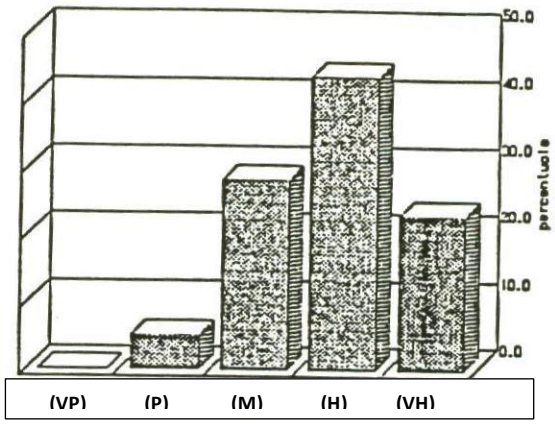


Figure 3 - Frequency histogram of the percentage values of nitrogen (N), phosphorus (P), sulphur (S), potassium (K), magnesium (Mg) and calcium (Ca) (M = medium, H = high, V = very, P = poor, S = sufficient).

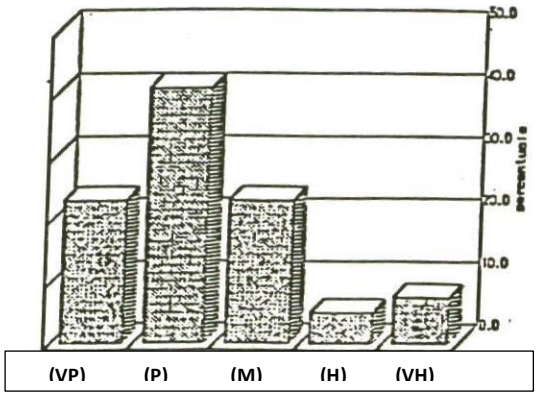
Total N (‰)



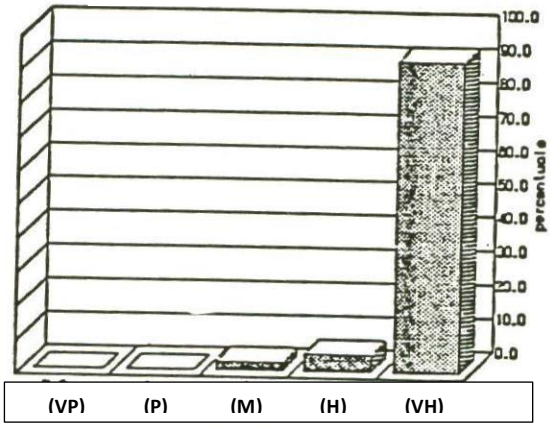
Exchangeable K



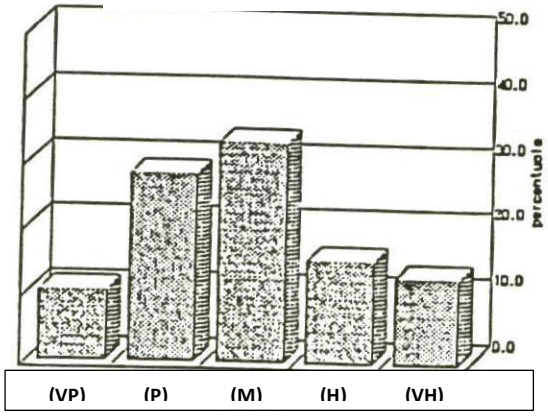
Assimilable P



Exchangeable Mg



Total S



Exchangeable Ca

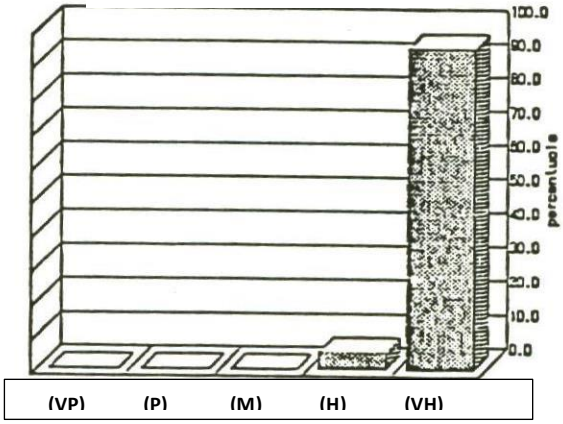


Figure 4 - Frequency histogram of the percentage values resulting from leaf analysis, with reference to the limits reported in Table 3 (p = poor, sd =scarce, n=normal, md = medium, r = rich).