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Granulometric study and phosphorus analysis from soil of Maâmora Forest (Morocco)

Abstract

The aims of this study is in the first time to characterize the granulometric composition and analyze the phosphorus content in the soil of Maâmora forest in two sites (Bled Dendonn) and (Sidi Amira) depending on the depth and location. Second time using the principal component analysis method for determine the correlations between different parameters analyzed.

Keywords: phosphorus, soil, granulometric study, correlation, principal component analysis

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Introduction

Soil is an extremely complex medium which simultaneously takes place a large variety of physical, chemical and biological interactions. These interactions at the soil-root interface are little known, but it is at this level that the minerals and trace elements are assimilated by plants.[1,2] Among these elements include phosphorus.It is an essential nutrient for normal metabolic functioning of growth plants.[3–5] It also represents a central role in all the process of photosynthesis, respiration and energy transfers.Various studies have shown the importance and efficiency of phosphate fertilizer on agricultural productivity and food security.[6] The study of mobility of phosphorus in the soil has two advantages: from a chemical point of view to understand the availability of this element for plants; from an environmental point of view, it allows estimating the risk of groundwater pollution.Against this background we are analyzed the content of assimilable P_2O_5 in the soil of Maâmora forest in two sites; (Bled Dendonn) and (Sidi Amira) depending on depth and location.

Materials and methods

Sites

Maâmora forest covers a little over a hundred thousands of hectares, very homogeneous appearance, consisting of variable thickness sands overlying a clay and sand composition of varying depth, called “red clay Maâmora”. On the forest plan, Maâmora split into three homogeneous geographical units (Maâmora Western, Central and Eastern). These units in their turn divided into five districts called A, B, C, D and E in the west-east direction (Figure 1).

Soil characteristics studied

Analysis of total bases:

The most commonly total bases present on the exchange complex are: Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}.

The results presented in Table 1, it can be concluded several points:

a. The K^{+} content is almost same for both regions (Bled Dendonn) and (Sidi Amira).

b. A low content of Ca^{2+} to zero value in Sidi Amira site.

c. Mineral nutrition of plant is conditioned by entire absorbent complex; the exchangeable ions react with one another:

d. If K/Ca or Mg/Ca is greater than unity, the calcium nutrition may become deficient; so in soils low in magnesium, it is necessary that K/Mg is less than unity.

e. For all the sites studied; K/Ca and Mg/Ca is greater than unity, so there is a nutritional deficiency in calcium.

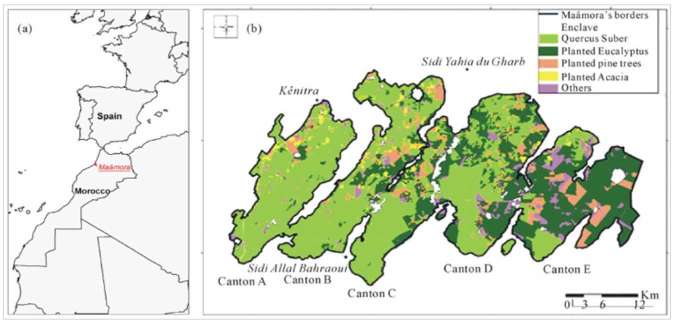

Figure1 Localisation of the study area (a) in Morocco; (b) main tree species in the Maâmora Forest [7].

Carbon-nitrogen ratio (C/N):

The ratio (C/N) (total carbon to total nitrogen) can predict the importance of immobilization or mineralization in the soil incorporation of an organic substrate.

Depending on soil repository (1995),[7–10] the norms of C/N ratio are:

a. 10<C/N<15 for active soil where mineralization of organic matter decomposes rapidly (high amount of nitrogen);

b. 15< C/N<25 need covered nitrogen to allow proper decomposition carbonaceous matter;

c. 25<C/N<40 for a very acidic soil, where the litter decomposition is very slow (incompletely decomposed humus).

In the soils studied the C/N ratio is less than 25 (Table 2 & Figures 4–7), and the reorganization of released nitrogen dominate in soil mineralization.

Table 1 Results of total bases

Samples	Total bases (mg/kg)			
	Ca^{2+}	Mg^{2+}	K^+	Na^+
BDB	100	150	250	150
SAB	0	125	200	125

With BD (BeldDendonn), SA (Sidi Amira), B (gross).

From Table 2 & Figure 6 we see that the organic material MO represents a maximum value at 5.37 in BD surface site and a minimum value at 0.22 in a depth of 80cm of BD site, and this value decreases from the surface to the depth in both SA and BD collection sites. Concerning the variation of P_2O_5 and as shown in Figure 8 notice that the maximum value is recorded in the surface of SA sample at 9.47, and the values recorded in the samples collected at depths of 20cm and 80cm does not have a large variation in the two study sites.

Table 2 Physical and chemical characteristics of Maâmora forest soils

Samples	pH water	pH KCl	N°/°°	C%	MO%	C/N%	P_2O_5 (mg/100g)
SA (surface)	5,58	5,34	1,12	2,17	3,74	19,37	9,47
BD (surface)	5,61	5,41	1,90	3,12	5,37	16,42	7,84
SA (20 cm)	5,77	5,47	0,55	0,66	1,14	12,00	7,66
BD (20cm)	5,71	5,32	0,80	1,19	2,05	14,87	6,5
SA (80cm)	6,38	5,87	0,13	0,16	0,28	12,31	6,5
BD (80cm)	6,17	5,43	0,20	0,13	0,22	6,5	6,91

Physical method

Determination of pH:

According to Table 2 & Figures 2&3, we have the $pH_{H2O}>pH_{KCl}$ with a small variation within the same site and using the classification of soil acidity we note that all samples are acidic (5<pH<6.5). Acidification is found mainly due to the implementation of resinous dead matter which is rich in acidifying compounds and the nature of the bedrock.

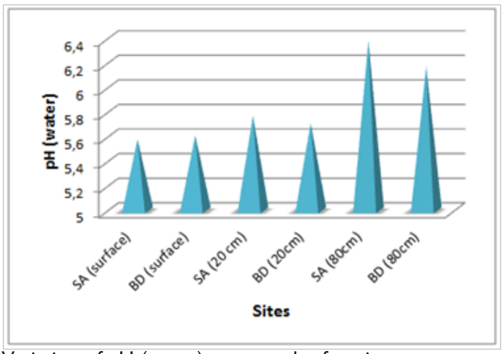

Figure 2 Variation of pH (water) as a samples function.

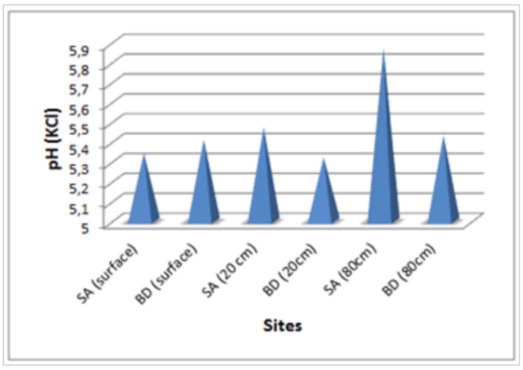

Figure 3 Variation of pH (KCl) as a samples function.

Granulometric analyzes:

For all soils studied the granulometric composition is homogeneous (Table 3), given the dominance of the sand fraction (2mm to 20µm). This sandy texture gives the soil a particulate structure and a lack of cohesion. As water reserves are low, they tend to dry out seasonally. The clay fraction takes the second position in the texture of the Maâmora soil followed by the silt.

Olsen method for assaying phosphorus in the Maâmora soil

Principle:

The extraction is carried out with an alkaline solution of sodium hydrogen carbonate at pH 8.5 for 1 hour at 20°C of temperature.

Calculations:

Depending on the sample and dilutions phosphorous, is expressed as P_2O_5°/°° as follows:

$$P_2O_5\ °/°° = [a] * \frac{V1}{P\,V_2} * 25 * \frac{1000}{1000\,000}$$

With: [a] = absolute content of P_2O_5 in γ/ml; read from the calibration curve. ($\gamma=10^{-3}$ mg $=10^{-6}$g=1µg).

V_1 = final volume in ml.

V_2 = collected volume for the spectrophotometer (in ml).

P = test sample of ground (g).

100 = coefficient to report the result to 1000 g of soil.

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1/1000 000 = coefficient to spend γ in g.

Table 4 below shows measurements quantity of the assimilable phosphorus taken in Maâmora forest at two different sites (Sidi Amira and BladDendonn)

Interpretation:

Table 4 shows the results of taking measures in two different sites of the assimilablephosphorus in soil,We therefore find that the amount of phosphorus decreases with depth in addition to that amount is larger on the Sidi Amira site surface than BladDendonn and the amount of phosphorus in soil depends on the depth and location of soil.

Correlations study:

Table 5 shows the correlation matrix between physicochemical parameters determined. From the results of this matrix we can take the following conclusions:

The pH of water (pH_{eau}) is correlated positively with pH_{KCl} by correlation coefficient of 0.812.

Nitrogen positively correlates very significantly with carbon and organic matter (MO) by a correlation coefficient of 0.988.Nitrogen also correlates significatively with the ratio C/N (total carbon to total nitrogen) and P_2O_5 which the correlation coefficients are respectively 0.718 and 0.533. Carbon is correlated with the organic matter, ratio C/N and P_2O_5 which the correlation coefficients are respectively 1.000, 0.789 and 0.618. The organic matter is positively correlated with theratio C/N and P_2O_5which the correlation coefficients are respectively 0.790, 0.618. Theratio C/N is positively correlated with $P_2O_5$by the correlation coefficient of 0.653.

Table 3 Results of granulometric analysis

Samples	% clay	% fine silt	%coarse silt	%fine sand	%coarsesand
SA (surface)	6,46	0,00	3,23	46,71	44,04
BD (surface)	8,36	3,04	4,94	42,04	41,75
SA (20 cm)	9,67	3,72	2,60	43,25	41,15
BD (20cm)	6,21	3,10	2,72	44,04	43,46
SA (80cm)	6,17	2,33	1,14	56,38	33,96
BD (80cm)	6,14	2,30	1,12	56,35	33,22

Table 4 The assimilable phosphorus (P_2O_5) content according to the depth in two sites of Maâmora forest

Samples	Depth (cm)	Assimilable P2O5(mg/100)
Maâmora Forest (Sidi Amira)	0-20	6.06
	20-40	2.81
	40-60	2.78
	60-80	3.53
MaâmoraForest (Blad Dendonn)	0-20	3.03
	20-40	3.59
	40-60	3.91
	60-80	3.78

Table 5 Correlation matrix between the parameters studied

pHeau	pHKCl	N	C	MO	C/N	P_2O_5	
pHeau	1,000						
pHKCl	0,812	1,000					
N	-0,808	-0,526	1,000				
C	-0,805	-0,508	0,988	1,000			
MO	-0,805	-0,507	0,988	1,000	1,000		
C/N	-0,724	-0,300	0,718	0,789	0,790	1,000	
P2O5	-0,650	-0,440	0,533	0,618	0,618	0,653	1,000

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The principal component analysis:

According to the graphic projection of the principal component analysis we note:

For the studied parameters the total inertia of cloud axes is selected: Axis 1:74%, Axis 2: 12%, and as shown in Figure 9 which shows the correlation of the circle, this figure shows two groups. The first group formed by: pH_{eau} and pH_{KCl}, and the second formed by P_2O_5, C/N, MO, C and N.

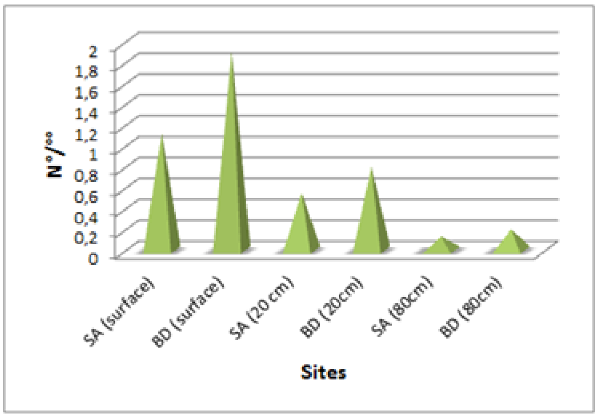

Figure 4 Variation of N°/°°as a samples function.

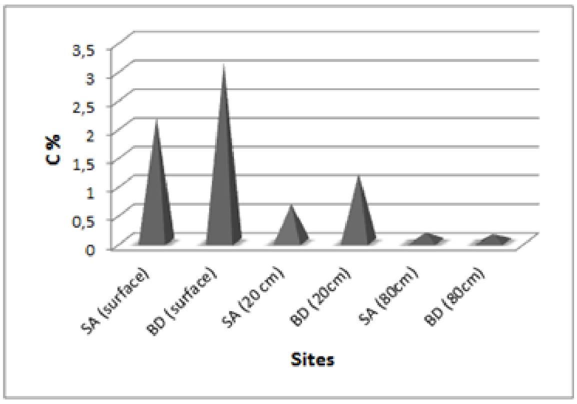

Figure 5 Variation of C%as a samples function.

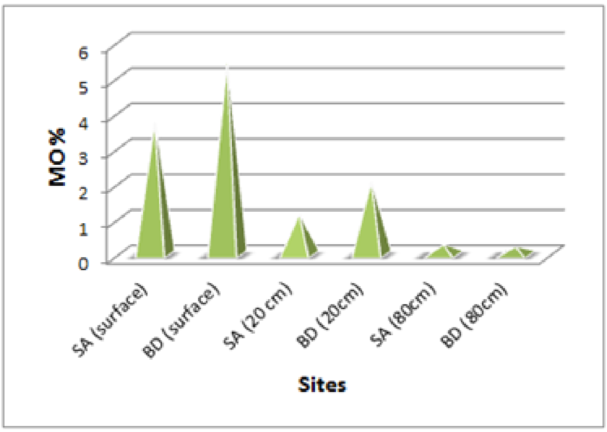

Figure 6 Variation of MO%as a samples function.

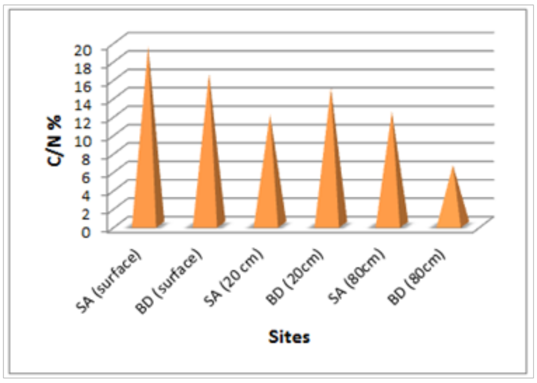

Figure 7 Variation of C/N% as a samples function.

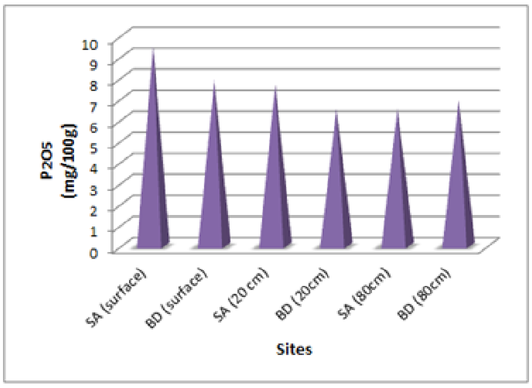

Figure 8 Variation of P_2O_5as a samples function.

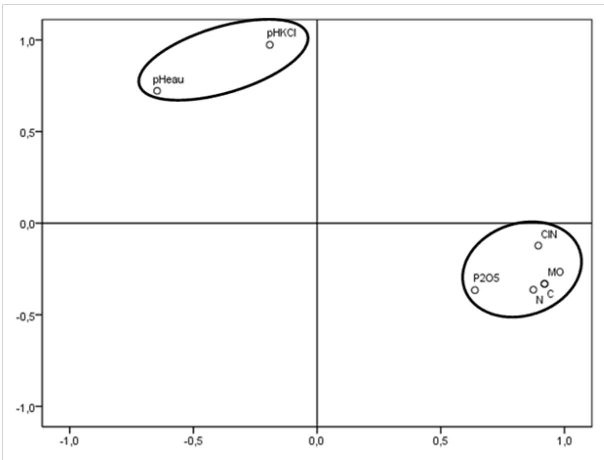

Figure 9 Plot in the plane P_1xP_2 of principal component analysis of normalized factors studied.

From Table 6, which shows the correlation matrix of the soil granulometric composition studied we notes that: the clay positively correlates with limonf and limog whose correlation coefficients are respectively 0.544 and 0.488. As well limong is correlated significantly with sableg by correlation coefficient of 0.761. The granulometric composition of soils studied is homogeneous, two axes have been selected, and the respective contributions to the total inertia of cloud are: Axis 1:61%, Axis 2:27%. And as illustrated in Figure 10, according to this figure three groups that distinguish; the

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first is formed by limonf and clay, the second is formed by limong and sableg, and the third form by sablef.

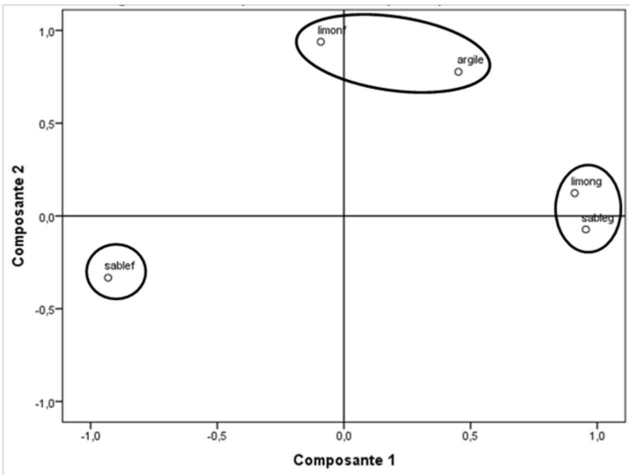

Figure 10 Principal component analysis correlation circle of granulometric composition of studied soils.

Table 6 Correlation matrix betweengranulometric compositions of the soils studied

	Argile	**Limonf**	**Limong**	**Sablef**	**Sableg**
Argile	1,000				
Limonf	**0,544**	1,000			
Limong	**0,488**	0,034	1,000		
Sablef	-0,637	-0,263	-0,850	1,000	
Sableg	0,330	-0,113	**0,761**	-0,904	1,000

Conclusion

We used the method of Olsen to follow the content of assimilable phosphorus depending on the depth for two different soils of Maâmora forest. For all soils studied the granulometric composition is homogeneous, given the dominance of the sand fraction (2mm to 20µm). This sandy texture gives the soil a particulate structure and a lack of cohesion. Such as water reserves are low, they tend to dry out seasonally. The clay fraction takes the second position in the texture of Maâmora soil followed by the silt. The quantity of phosphorus is analyzed decreases with depth in addition to this quantity is larger on Sidi Amira site surface than BladDendonn and this quantity of phosphorus depends on the depth and location of the soil. Using the principal components analysis statistical method (ACP) for the determination of different correlations between the studied parameters Maâmora soils.

Acknowledgments

None.

Conflicts of interest

Authors declare no conflict of interest exists.

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