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Chemical Characterization of Soil of the Agropastoral Farm B29, along a Toposequence in the Departement of Aboisso Comoe Southeast of Cote D'ivoire

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ABSTRACT

A soil survey was carried out on a B29 agricultural plot in Mamlanso, located in the Aboisso Comoé region (south-east of Côte d'Ivoire) in the period from November to January.

The objective of this study is to evaluate the chemical potential of the Mamlanso B29 agropastoral farm study plot.

The approach consisted in the opening of a track in the N290 ° direction along which rock and soil samples are taken from soil pits.

The results of the chemical and physical analyzes associated with landscape observations revealed browned soils (Cambisols) derived from the sandy-dominated volcano-sedimentary complex formations, which are low in exchangeable bases (Al3 +, Fe2 + Fe3 +, Mn2 + and Na +), strongly desaturated, very weak cation exchange capacity.

They have a good rate of mineralization and low organic matter content.

In addition, the skin is acidic and their content of major elements (N, P and K) is not able to increase crop yield.

The description of the soils highlights clay-silty-sandy textures with a high clay content.

On the other hand, the laboratory analysis shows sandy soils with a low clay content on the same site.

The chemical properties have a great influence on the quality of the soils, but the predominantly polyhedric structure from H2 and lumpy at the level of H1 and the coarse texture, seems to be the character that conditions the drainage and the work of these soils.

In view of these results, it would be interesting to enhance the organic matter content of B29 soils by the practice of organic amendment. This would help improve its physical properties and mobilize certain chemical elements needed for agricultural production.

Key words: Cambisol, Volcano-sedimentary, Mamlanso B29.

1. INTRODUCTION

The rapid and sustained growth of the world's population has the immediate consequence of an increasing demand for food. This state of affairs leads to an intensification of agricultural production, the corollary of which is the depletion of soil nutrients.

In response to this deficiency, farmers resort to extensive farming. This technique, in addition to being devouring space has had little impact on production yields that decline irreversibly.

The decline in productivity, once observed in Ivorian cocoa farming (Aguilar et al., 2003, Dufumier, 2016), is similar to that of other agricultural products in the country. This situation is caused by numerous constraints that undermine Ivorian agriculture, including the fall in soil fertility (Snoeck et al., 2006 and 2016, Snoeck, 2010).

The most obvious negative aspects attributable to poor agricultural practices are the decline in soil fertility due to reduced nitrogen levels, acidification, iron toxicity associated with decreased organic matter levels, and flooding. land cultivated by weeds (Bationo et al., 2004).

In the forest zone of Aboisso Comoé (SE of Côte d'Ivoire), a zone of high agricultural production (food and industrial), the land is under strong pressure.

The degradation of the latter causes the decline in their fertility (Stoorvogel and Smaling, 1990, Albergel et al., 1993). In Aboisso Comoé, and especially in the B29 village of Mamlanso, people who have invested in the decommissioned surrounding forest, practice various crops (rubber, cocoa, oil palm, yam, maize, plantain, taro, peanut, rice, pepper , eggplant, pistachio, okra, etc.). Unfortunately, the yields obtained remain below expectations.

This situation calls for questioning. What is the real chemical potential of these soils? Should we consider these soils differently to meet the needs of the actors? This situation, which is not an isolated case, would threaten food security in Côte d'Ivoire if we are careful. Faced with this, the community of specialists in soil science of the UFR STRM of the University Félix Houphouët-Boigny has implemented a community approach to develop and update the chemical and physicochemical characteristics of the agricultural lands of Ivory Coast.

It is with this in mind that the present study, entitled "Chemical characterization of the soil of the B29 agropastoral farm, along a toposequence in Aboisso Comoé department in the south-east of the Ivory Coast" was initiated.

The main objective of the study is to evaluate the chemical potential of soils of the B29 N290 ° toposquence. Specifically, the aim was to characterize the chemical and physico-chemical properties of soils and to determine the fertility indicators of the soils studied.

2. MATERIALS AND METHODS

2.1 . Study areas

The research was carried out in Aboisso comoé (humid dense forest area), located in the south-east of Côte d'Ivoire. The community of Aboisso comoé bathes in the equatorial transition climate of Attiean type, characterized by four (4) seasons including two (2) dry seasons and two (2) rainy seasons.

The work was done at B29, located about 20 km from the town of Mamlanso. This village is located in the square Grand Bassam (sheet 4a, 4b, 4d), geographically bounded by coordinates 5 ° 45'49.6 " N and 3 ° 18'17.7 "W (MINAGRI Report, 2017) .

The soils of this zone are derived from the alteration of materials of the volcano-sedimentary complex consisting essentially of microgabbro and amphibolo-pyroxenite. Most of the soils of this locality belong to the class of ferrallitic soils (Ferralsols), hydromorphic soils and brown soils.

2.2- Field technical equipment

The technical material consists of a measuring tape, a Garmin GPS, a clinometer, spades, picks, scissors, indelible markers and a TOPOCHAIX compass.

The equipment used to observe the environment and describe the soil profiles consists of machetes, milestones, stakes, geologist's hammer, pedological knife, plastic bags, 1 meter designer's tape, a Munsell code, a 2 mm diameter mesh screen, IRD glossary floor description sheets (ex ORSTOM) and an Infinix Hot 4 mobile phone for shooting (figure 1).

GPS Garmain

Mesureing tape

Code Munsel

Sieve two millimeters in diameter

Pickaxe

Figure 1: Some soil prospecting materials

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2. 3. Laboratory chemical analysis

Soil samples were first dried on newsprint at room temperature (25 to 30 ° C). Granulometric analysis was done using the densimetric method using Robinson's pipette (Gee and Bauder, 1986).

Five granulometric classes will be identified: clays (0-2 Nm); fine silt (2-20 Nm); coarse silt (20-50 Nm); fine sand (50-200 Nm); coarse sands (200-2000 Nm). Water pH was measured by electrometry in a soil suspension in a ratio of 1: 2.5.

Organic carbon (C) was determined according to the method of Walkley and Black (1934), the result was converted to organic matter (MO) using the factor 1,724 (MO = C x 1.724). Total nitrogen was determined by the Kjeldahl method (Bremner, 1996).

The exchangeable bases and the cation exchange capacity were assayed in an ammonium acetate extraction solution (CH 3 COOH 1N) buffered to pH 7 (Thomas, 1982). The assimilable phosphorus was determined by the modified Olsen method Dabin. Total phosphorus was determined by colorimetry after extraction with perchloric acid (Olsen and Sommers, 1982).

2.4. Statistical analyzes

The comparison of the averages of the granulometric, physicochemical and chemical data of the soil of the study site was carried out by analysis of the variance (ANOVA), at the probability threshold 5%. When a significant difference is noted between the factors considered for a given character, the Student Newman Keuls test was performed.

Finally, a standardized Principal Component Analysis (PCA), applied between the different soil variables, made it possible to highlight the different interactions that exist between them. The projection of all the individuals on the planes of the axes 1 and 2 made it possible to appreciate the dispersion of the individuals and to better compare their variability. All these statistical tests were performed using XLSTAT.2014.5.03 software.

3. RESULTS

3.1. Chemical characteristics

3.1.1. soil pH

Soils of Parcel B29 (Tables I), very strongly acidic to weakly acidic, pHH2O - pHKCl, generally <1 (horizons 0-20 cm), indicate acidity related to H + protons. But for horizons more than 20 cm deep, pH H2O - pHKCl> 1.

The Student Newman Keuls (SNK) test indicates that along the N290 ° track, water pH values are statistically different between S (5,16) vs BF (6,15), with p <0,0029; S (5,16) vs 1/3 inf. MV (6.03), with p <0.0120 and HV (5.50) vs BF (6.15), with p <0.0360. 1/3 Sup. MV, with a water pH value of 5.68, did not show any significant links with the other studied variants of the N290 ° layon.

Table I: pH of soils in Parcel B 29

		pH_{H2O}	pH_{KCl}	$pH_{H2O} - pH_{KCl}$
		Line N290°		
Profile 1	P1-H1	5,1	4,2	0,9
	P1-H2	4,9	4,0	0,9
	P1-H3	5,1	4,0	1,1
	P1-H4	5,3	4,1	1,2
	P1-H5	5,4	4,1	1,3
Profile 2	P2-H1	6,3	5,5	0,8
	P2-H2	5,2	4,1	1,1
	P2-H3	5,3	4,2	1,1
	P2-H4	5,3	4,2	1,1
	P2-H5	5,4	4,3	1,1
Profile 3	P3-H1	5,8	4,5	1,3
	P3-H2	5,5	4,4	1,1
	P3-H3	5,5	4,4	1,1
	P3-H4	5,8	4,7	1,1
	P3-H5	5,8	4,8	1,0
Profile 4	P4-H1	5,1	4,6	0,5
	P4-H2	6,6	5,8	0,8
	P4-H3	6,4	5,3	1,1

3.1.2. Elements of soil organic matter

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Soils have a good rate of mineralization of organic matter (OM), whose carbon and nitrogen contents remain low (except in H1 horizons).

According to the SNK test, the five variants of the N290 ° layon are statistically different for soil levels of assimilable phosphorus (Pass.) And C / N values. However, the organic matter content, as well as the nitrogen content, do not differ significantly from the top to the bottom (Table II). Soil contents of assimilable phosphorus (Pass.) Are lower at the upper 1/3 in mid-slope, while the top is more filled. The rate of mineralization of organic matter is faster at 1/3 lower in MV and BF than that observed at the top.

Table II: Distribution statistics of OM of soils of the N290 ° track

Average Threshold Value	28,8	11,5	0,3	12,5
Topographic position	MO	P ass.	N	C/N
S	19,50a	21,4b	1,15a	9,84c
HV	10,94a	15,4ab	0,65a	9,48bc
1/3SupMV	13,21a	8,6a	0,78a	9,70bc
1/3 inf MV	15,02a	12,67ab	0,93a	7,98a
BF	27,13a	15,5ab	1,66a	8,55ab

S: summit; HV: top of slope; 1 / 3Sup. MV: 1/3 higher in mid-slope; / 3 inf MV: 1/3 lower in half-slope; BF: shallow

3.2. Physicochemical characteristics:

3.2.1. Cation exchange capacity and equilibrium ratios of exchangeable soil cations

Soils on farm B29 are low in base, highly desaturated and have very low cation exchange capacity, for cocoa (<21cmolkg-1) and cassava (15 cmolkg-1), (Tables III).Specifically, along the N290 ° track, CEC, Ca / Mg, K / Mg, K / Ca ratios are not statistically different (SNK test). Ca / Mg between 1.8 and 15, is better provided than the optimum (1.5 <Ca / Mg <5): there is a balance between calcium and magnesium.

On this same layon, K / (Ca + Mg) <2: K deficient in relation to the sum of calcium and magnesium on the adsorbent complex of the soil. Generally, K / Ca * 100 is very much greater than 4 (K / Ca * 100> 4): the soils observed at the top, at the top of the slope at the lower 1/3 in MV are sufficiently filled with potash.

The lowland and the upper 1/3 in MV where we observe values of K / Ca * 100 less than 3, the needs of crops are appreciable on these soils.

Table III: Cation exchange capacity and equilibrium ratios of exchangeable cation of N290 ° floor

VSM	Variables	S	HV	1/3Sup. MV	1/3 inf. MV	BF
15 à 21	CEC	2,68a	3,18a	3,18a	6,73a	6,02a
2,8	Ca/Mg	9,01a	15,62a	3,16a	1,85a	2,56a
0,0086	K/(Ca+Mg)	0,19b	0,19b	0,02a	0,08ab	0,01a
	Ca/K	7,20a	10,60a	64,20ab	72,38ab	115,92b
	K/Ca	0,34a	0,75a	0,02a	0,26a	0,01a
	K/Ca*100	34,11a	75,13a	1,99a	26,43a	1,38a

S: summit; HV: top of slope; 1 / 3Sup. MV: 1/3 higher in mid-slope; / BF: shallow

3.2.2. Sum of exchangeable bases (S) of soils

Table IV presents the values of the sum of the exchangeable bases (S) and the saturation rate (V) along the toposquences. The exchangeable bases (S) at the level of the toposquence N290 ° are between 0.10 and 2.13 cmol / kg, therefore very low in depth and low in area at the top. They are very shallow in depth and average in the upper slopes, low and medium in the lower slopes and very low to very good in the shallow waters, ranging from 0.39 to 17.05 cmol / kg.

DOI: 10.31695/IJASRE.2018.32943

Table IV: Value of the sum of Exchangeable Bases (S) and Soil Saturation (V).

		Toposéquence N290°.	
Segment topographique	Profondeur	(S) en cmol/kg	V (%)
Sommet	H1	2,13	62,59
	H2	0,23	9,67
	H3	0,21	7,46
	H4	0,21	9,32
	H5	0,24	9,31
Haut versant	H1	4,94	85,22
	H2	0,35	15,04
	H3	0,15	6,77
	H4	0,1	3,68
	H5	0,2	7,25
mi-versant	H1	4,5	73,8
	H2	1,37	48,75
	H3	0,59	34,82
	H4	1,15	54,62
	H5	1,88	58,81
Bas-fond	H1	7,73	85,88
	H2	1,77	63,04
	H3	3,17	68,96
	H4	10,59	89,71
	H5	17.01	93.70

3.2.3. Exchangeable soil bases

The average threshold value of potassium is 0.7 cmol / kg; 2.45 cmol / kg for magnesium and 11 cmol / kg for calcium.

• Potassium (K +)

The potassium content is normal (between 0.15 and 0.4 cmol.kg-1) at the depth H1 along the toposéquences. On the other hand, it is very weak (less than 0.1 cmol.kg-1) at low (between 0.1 and 0.15 cmol.kg-1) in the depth horizons along the toposequence.

• Calcium (Ca2 +)

Calcium levels are generally very low to low, ranging from 0.012 to 9.16 cmol / kg, in soils along the N290 ° toposequence.

• Magnesium (Mg2 +)

The magnesium level is generally very low for values below 2.45 cmol / kg in soils from the top to the bottom. It ranges from 0.004 to 7.82 cmol / kg, so from very low to very high at the N290 ° toposequence.

• Sodium (Na +)

The sodium content is very low along the toposéquences, with a content lower than 1 cmol / kg.
The distribution of exchangeable base contents in soils is shown in Figures 2 and 3.

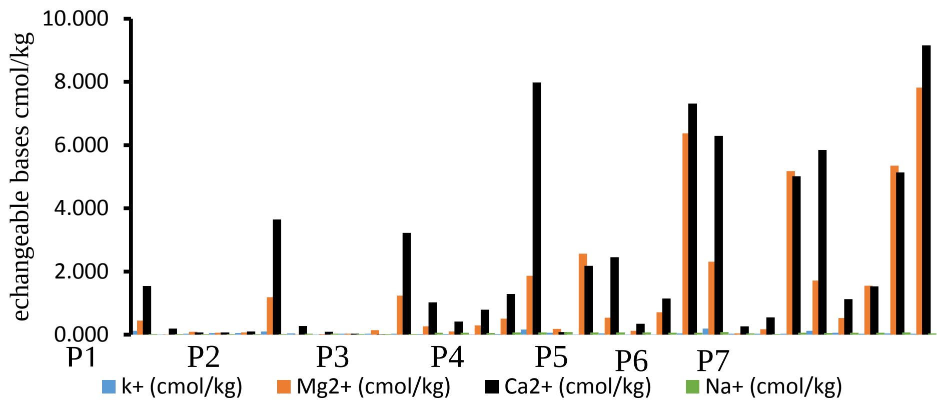

Figure 2: Distribution of bases contents exchangeable along the toposquence N290 °.

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3.3. Correlation between physico-chemical parameters and soil fertility

Principal component analysis (PCA) correlated some of the soil fertility parameters studied. The distribution of chemical and physico-chemical parameters in the factorial plane (1-2) made it possible to distinguish several groups. The axes (1) and (2) have, respectively, 48.64% and 20.44% affinity between chemical elements of the soil (Figure 3).
The axis (1) isolates sand (S), pH (H2O-KCl), Mg2 +, Ca2 +, sum of exchangeable bases (S) and saturation rate (V). In fact, it isolates almost all the variables on its positive part (effect size). It is a pH axis and complex exchange of all kinds. It contrasts the high (top) and low (bottom) parts of the N290 ° channel, characterized by the clay to the soils located in the intermediate parts of the channel (1/3 in. MV N290 ° and HV N290 °).
Axis 2 isolates nitrogen (N), phosphorus (assimilable and total), potassium ion (K +), equilibrium ratios (Ca / Mg, K / Mg, K / Ca and K / (Ca) + Mg)). There is also effect size on its positive part, while on its negative part, is, only, the sodium ion (Na +). It is an organic material axis and equilibrium ratios characteristic of the high parts of the N290 ° track (S N290 ° and BF N290 °).
These results show an influence of the clay on the results of the N290 ° track, which confirms the validity of the effect of the slope on the clay content. The N290 ° layon, characterized by its organic matter, can maintain at best an active microbial life and be favorable to the culture.

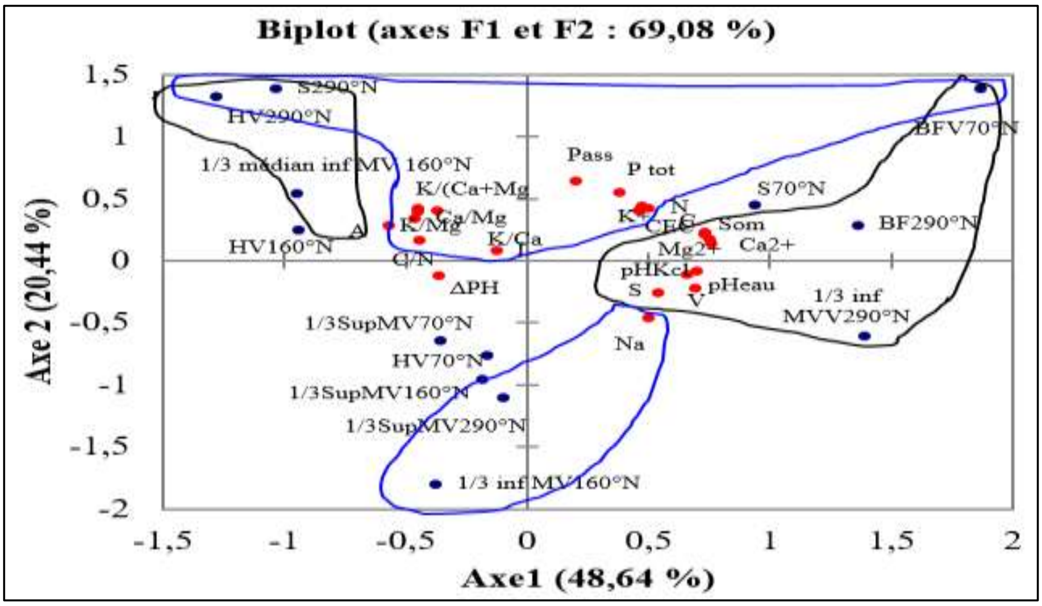

Figure 3: Analysis of the main components of the physico-chemical variables of soil fertility in the 1-2 plan

4. DISCUSSION

Physical, chemical and physicochemical properties of soils: Soils observed throughout the site are very stable or stable. The stability of the structure is considered a good indicator of soil quality and their sensitivity to runoff and erosion.
PH is a key element in the chemical composition of soils and determines the availability of nutrients for soil plants and microorganisms (Doucet, (2006) Borah et al., (2010). strongly acidic to acidic is an unfavorable element for perennial crops (Dabin, (1985); Yemefack et al., (2006).) When pHH2O - pHKCl> 1, the acidity of soils would be related to the acidifying ions Al3 +, Fe2 +, Fe3 +, Mn2 +, likely to cause phenomena of aluminous, ferrous or manganic toxicities.
Soils are less well supplied with total nitrogen, organic matter. This poverty in total nitrogen and organic matter could be explained by the imbalance between organic inputs and the mineralization that determines the content of organic matter. Organic matter is one of the main drivers for improving soil fertility and cassava yield in crops by playing a cohesive role or storing water (Hubert and Schaub, (2011).
The assimilable phosphorus values are also lower than the reference value. These results could be explained by the fact that the soils studied are quite poor in organic matter, whose action on the immobilization of phosphorus has already been reported by Bertrand and Gigou (2000) and Luciens et al. (2012).
The soils studied showed a marked lack of exchangeable bases compared to the threshold values. In addition, potassium is deficient in relation to the sum of calcium and magnesium. These results are similar to other studies that have shown that decreasing potassium in a nutrient solution increases the absorption of calcium and magnesium (Kawano, 2000). Indeed, the clay content of a soil influences the physico-chemical properties and therefore the results.
The values of the sum of the exchangeable cations and the cation exchange capacity are low, compared to the reference values (Snoek et al., 2010). This may be due to the strong association between organic carbon and

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CEC (Brady and Weil, 2002).
Soils are desaturated. These results are similar to those obtained by France et al., (2012); Giroux and Audesse, (2004), during their studies by comparing two methods for determining organic carbon content, total nitrogen and the C / N ratio showed that in this case, various organic amendments and farm fertilizers allow to correct the content of the chemical elements.
The K / Mg ratio is higher compared to the reference values in light soils. This behavior causes magnesium deficiency in soils. A high value of the ratio is favorable to the absorption of potassium in the presence of clay, since in clay soils, a ratio K / Mg too low slows the absorption rate of potassium, thus limiting yields (Giroux and Audesse, 2004); (Pypers et al., 2011).
Principal Component Analysis (PCA) has highlighted the importance of fertility indicators for soil quality: pH, Corg, nitrogen and total P., clay, complexes Absorbents and the sum of the cations and cation exchange capacity, these fertility indicators attest to the average soil quality obtained from the different descriptions. Similar results from the soil fertility indicators were obtained by Ballot et al., (2016) and allowed him to report the agronomic value of soils.

5. CONCLUSION AND OUTLOOK

The aim of the study on the chemical characterization of soils along the toposequence was to evaluate the chemical potential of soils in the B29 N290 ° toposequence. This study conducted in the department of Alépé contributed to an understanding of the soil as well as their chemical characteristics.
The study of Mamlanso B29 toposéquences revealed the presence of Cambisols throughout the site. These soils develop on materials derived from basic rocks rich in amphibole, pyroxene, green Hornblende and plagioclase and on a rugged model. The description of the soils in the fresh state indicates sandy-clay-sandy-loam textures on the surface (0-20 cm), whose laboratory analysis shows predominantly sandy soils on the same horizon. Soils of such texture and pH very strongly acidic acid are not favorable to crops, the most practiced are cocoa, rubber and cassava sometimes.
Regarding the chemical properties, we note that the soils are less well provided with organic matter, whose rate of mineralization remains good. The balance of nutrients reveals, deficiencies in mineral elements. In addition to the content of organic matter, the major elements (nitrogen, phosphorus and potassium) are not sufficient to optimize crop yields in the Mamlanso area.
Thus, before installing a crop on these types of soils, we recommend neutralizing the soil acidity of the B29 experimental site and providing organic manure or applying fertilizers with adequate nitrogen maintenance. (N), phosphorus (P) and potassium (K) soils.

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