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Rodrigues Lima, Tatiane; Dias Nunes, Dorisvalder; Moreira da Silva, Joiada; Pereira Linhares, Déborah; Mansur Mendes, Angelo; Freire Azevedo Silva, Danielle
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Tatiane Rodrigues Lima, Universidade Federal de Rondônia-UNIR, tatilima@unir.br
Dorisvalder Dias Nunes, UNIR, dorisval@unir.br
Joiada Moreira da Silva, UNIR, joiada@unir.br
Déborah Pereira Linhares, UNIR, deborah@unir.br
Angelo Mansur Mendes, Sistema de Proteção da Amazônia-SIPAM, angelo@cpafro.embrapa.br
Danielle Freire Azevedo Silva, UNIR,labogeo@unir.br

ABSTRACT: This work evaluates natural soil fertility on plain and flooded terrace areas, at Madeira River-RO fluvial plain, based on physics and chemicals analyses, (pH, OM, Al^{+2} + H^{+}, exchange bases K^{+}; $Ca^{+2;}$ Mg^{+2} e Al^{+3}), physic-chemical (CEC, m% and V%), from the city of Porto Velho-RO to the city of Humaitá-AM. This kind of soil analysis is accomplished based on the percentage of base saturation (V%), which consists on physic-chemical phenomenon of ion absorption on clay and organic matter (OM) minerals. The soil samples were collected from temporary flooded plain strips and fluvial terraces with 20 km of intervals and 10 profiles described along the way, totalizing forty one (41) horizons. Using the EMBRAPA (1997) methods, the horizons A and B of each profile were considered. The results indicate four profiles with natural fertility deficiency: the Yellow Latosols at profile 1 and 2, Plintosols at profile 6 and Fluvic Neosols at profile 10, which may be related to the soil acidity, associated with high values of Al^{+3}, as well on plain soils (Plintosols and Fluvic Neosols), as fluvial terrace (Latosols). Soils under the influence of flooding regime present high V%. The potential CEC values of analyzed horizons, were found low in consequence of the mineral composition of the clay, its values were correlated to the OM activities. However, the highest clay samples activities have been found on the superficial horizon of Plintosols at profile 6 (Cavalcante Community), where the potential CEC has arisen despite of reduction of OM content. The CEC varies from soil to soil, and what determine its values are the organic colloid/clay structures and the quantity of OM.

Key Words: Soil Chemistry; CEC; Natural fertility, Madeira River.

INTRODUCTION

The present work brings to discussion the physical and chemical properties associated to the cationic exchange capacity (CEC) and bases saturation percentage (V%), in soils natural fertility identification found in flooded and fluvial terrace environment between Porto Velho's and Humaitá-AM. municipal district. The CEC represents the soil capacity in retain positively charged ions (cations), being the total sum of these ions which can be absorbed in colloidal surfaces, allowing its utilization as nutritious by the vegetables. The ion absorption property is arising in clay and organic matter minerals (OM), which are soil colloidal particles that generate negatives electric charges providing absorption or charged positively ions retention. The soils under tropical regions where the predominant clay minerals are pH dependent, OM presents generally the biggest participation in CEC's value, because of this CEC pH 7,0 has been being moreover used to the natural fertility evaluation.

In the physical and chemical properties study of a soil, some parameters determination have vital importance, because of being the soil, a dynamic component which receives several contributions, for a instance: vegetation, predominant climate, geological inheritance, dynamism geo-morphological, as well as the time factor. This interaction is reflected in the natural fertility, which basically exchanges several product properties which compose its physical and chemical structure, as the mineralogy, texture, organic matter and pH proportion (VALE, 1997; LUCHESE; FAVERO; LENZI, 2002). Thus, the research development aims to contribute as a study concerning to the soils physical and chemical properties in Amazon environments, especially in the alluvial plain, where the season rain system of Madeira River is characterized by water level periodic oscillation, defining an inundation period and other of ebb. Soils with genesis in environment with water excess, corresponding to flood, has as one of the main formation process, the hydro-molded surfaces, conditioned by topographical aspects locations. Yet the soils found in fluvial terrace, without direct influence of the fluvial water, presents processes tied to weather biological conditions. According to these dominant conditions, the soil groups will present differences in its formation, in the physical and chemical properties, reflecting in natural fertility different standards (RESENDE, 1982).

METHODS AND MATERIAL

SAMPLES

The soil samples were collected in flood strips periodically flooded and fluvial terrace. A total of ten profiles have been described and analyzed on field, performing forty-one (41) horizons (Table I). The collections obeyed the intervals of approximately 20 Km of distance in a total stretch of 250 Km.

Evaluated Parameters

Soil Morphological Description

The morphologic description record were performed according to the characteristics presented in each soil profiles horizon or layer according with the methodology indicated in LEMOS & SANTOS (1996). The samples collected in each horizon or layer corresponded for approximately 2 kg, which were stored and handled to the laboratory for analysis.

Physician Analyses – Granulometric analysis

The lab procedures used at the granulometric analysis are described in the Soil Analysis Methods Manual (EMBRAPA, 1997) and been executed in the laboratory *Agro Análise* in Cuiabá-MT. The pipette method was used for the determination of the percentile of sand, silt and clay.

In the natural fertility evaluation of a soil, the fraction clay earns highlight, because its mineralogical and chemical composition influences its ion exchange capacity, whose principle is established when the negative charges they accumulate in its surface, allowing the clay particle to present properties of a weak acid, being soon neutralized by ions in soil solution (DEMATTÊ, 1988 ; FONTES; CAMARGO; SPOSITO, 2001). In Table I, are presented the soil samples relation.

TABLE I - SOIL SAMPLES RELATION

PROFILE	GEOGRAPHYC POSITION	PLACE	LAYER or HORIZONS
01	8° 35’ 26’’ S – 63° 42’ 46’’ WGr.	Cujubim Grande	A; AB; BA; B; B_2
02	8° 35’ 54’’ S – 63° 35’ 37’’ WGr.	Itacoã	A; BA; B; B_2; B_3
03	8° 29’ 35’’ S – 63° 35’ 53’’ WGr.	Primavera	A; A_2; B
04	8° 26’ 17’’ S – 63° 30’ 02’’ WGr.	São Carlos	A; AB; B; B_2
05	8° 18’ 12’’ S – 63° 22’ 58’’ WGr.	Curicaca	A; AB; B
06	8° 22’ 40’’ S – 63° 24’ 57’’ WGr.	Cavalcante	A; BA; B
07	8° 11’ 00’’ S – 63° 05’ 34’’ WGr.	Papagaios	A_p; A; A_2; A_3
08	8° 03’ 36’’ S – 62° 56’ 07’’ WGr.	Calama	A; BA; B; B_2; B_3

09	7° 45’ 03’’ S – 62° 56’ 13’’ WGr.	Ponta Pelada	A; A_2; B; B_2
10	7° 30’ 28’’ S – 62° 53’ 40’’ WGr.	Humaitá	A_p; BA; B; B_2; B_3
TOTAL			**41**

Chemical analysis

The chemical parameters determination occurred in the Soils Laboratory rooms of EMBRAPA – RO and for all the performed chemical analyses EMBRAPA’s (1997) method had been used. The pH set in water, the exchangeable bases: calcium (CA^{+2}), magnesium (Mg^{+2}) and potassium (K^{+}), the aluminum (Al^{+3}), the potential acidity (H^{+} + Al^{+3}), as well as organic matter’s proportions (OM). The certain properties physicist-chemical went to CEC potential or CEC the pH 7,0, percentiles of aluminum (m%) and bases (V%) saturation.

For the evaluation of a soil natural fertility, physical and chemical properties of its sub superficial horizon (B) are considered. However, taking, the soils which don't present horizon B, as Fluvic Neosols, we opted for evaluating the superficial horizons and sub-superficial physical and chemical properties, corresponding respectively to the horizons (A) and (B).

RESULTS AND DISCUSSION

The morphologic description added to the grain analysis enabled the identification of four soils classes, according to the soils Classification Brazilian system of EMBRAPA (1999). The profiles 1 (Cujubim Grande) and 2 (Itacoã), were classified as Yellow Latosols. This class presents lack in primary and secondary minerals with smaller resistance to the time factor, because it has evolved plenty soil. Reflecting in a low CEC with values lower than 17$cmol_c$/Kg of clay. According with the literature, Yellow Latosols they present much texture, profound with horizon B latosolic, with texture varying among average to very loamy and little differentiation between horizons. In the latosolic B horizon, there is *sesquioxid* and clay predominance 1:1, with high degree of flocculation, what complicates the clay settlement and sub horizons differentiation (RODRIGUES, 1996).

The profiles 3 (Primavera), 7 (Papagaios), 9 (Ponta Pelada) and 10 (Humaitá), has been identified with Fluvic Neosols, characteristically formatted by pedogenesis mineral or organic material little expressive, stratified in layers of relation texture incipient, not presenting horizon B diagnosis. In the Madeira alluvial plain, the periodic floods limit or hinder the decomposition and evolution of the deposited sedimentary, materials, which form Fluvic Neosols.

Gleisols, identified in the profiles 4 (São Carlos), 5 (Curicaca) and 8 (Calama) are constituted by mineral little developed, its pedogenetic formation is influenced by the periodic flood regime, or even by the under ground water oscillation. For such characteristics, they present usually badly drained, composed by clay of low or high activity.

Only in the profile 6 (Cavalcante), Plintosols characteristic had been identified. Sediments sand-loamy and present in general, low natural fertility.

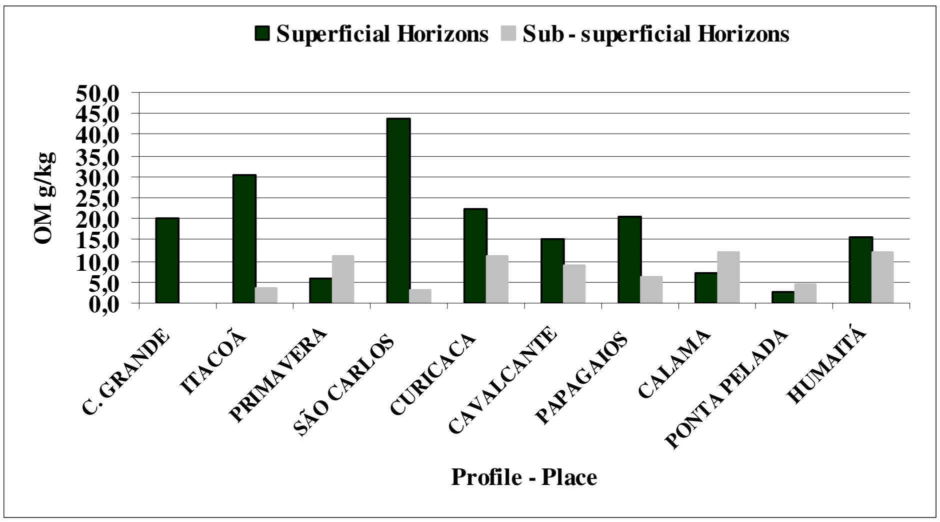
The Table II gathers all the soil classes identified in the samples points, as well as the percentile of the texture clay in the superficial and sub-superficial horizons.

TABLE II – CLASSIFICATION OF SOIL PROFILES AND PERCENTAGE OF CLAY FRACTION AT THE SUPERFICIAL AND SUB-SUPERFICIAL HORIZONS

Profile	Place	% Clay Fraction		Classification
		Superficial Horizon	Sub-Superficial Horizon	
1	Cujubim Grande	29	45	Yellow Latosols
2	Itacoã	32	30	Yellow Latosols
3	Primavera	25	65	Fluvic Neosols
4	São Carlos	42	49	Gleisols
5	Curicaca	39	35	Gleisols
6	Cavalcante	39	64	Plintosols
7	Papagaios	17	15	Fluvic Neosols
8	Calama	25	27	Gleisols
9	Ponta Pelada	25	32	Fluvic Neosols
10	Humaitá	22	30	Fluvic Neosols

From the chemical analysis, OM's horizon contents had been obtained A (superficial) in each profile, and, 50% of the same presented OM’s contents below 17,0 g/Kg, what indicates that half the analyzed soil classes present OM's short proportion in the superficial horizons (Illustration 01). The minor’s proportions had been obtained in the profiles 3 (Primavera) and 9 (Ponta Pelada) with Fluvic Neosols, as well as in the profile 8 (Calama) with Gleisols. However 40 % of the profiles reveal OM’s proportions among 17,1 and 35,0 g/Kg, qualified as average. Just 10% presented an OM's top proportion, above 35,0 g/kg, being classified by Gleisols of loamy texture. The location of this profile was in São Carlos, where exists banana planting.

OM’s contents in depth (sub-superficial horizons) were relatively smaller than OM’s proportions found in the superficial horizons; being verified a significant reduction, mostly, in the profiles 1 (C. Grande), 2 (Itacoã), 4(São Carlos). The exceptions had been registered in profiles 3 (Primavera), 8 (Calama) and 9 (Ponta Pelada), in which it was verified OM's larger proportion in depth, despite these values be below 17 MO's g/Kg (Illustration 01). This data reflects the deposited materials diversity (organic and inorganic) in the formation of these soils or yet, composition organic residues different stages.

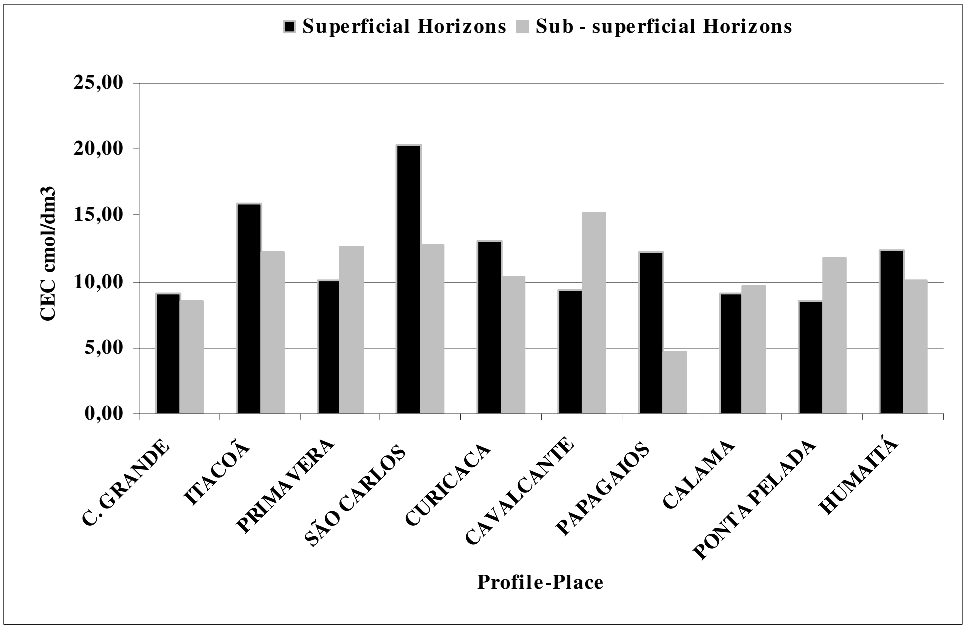


Picture 01 – Organic Matter Proportions – OM in g/kg of samples at superficial and sub-superficial horizons

OM, together with the fraction clay, perform fundamental role in which tells cations exchangeable presents retention in the soil (CIOTTA *et. al.*, 2003). The surface of these particles acts as “sponges” by allowing cations exchangeable retention by difference in electric charges effect. However, the activity of one, can overcome other, when accomplishing with larger efficiency the function of complicating the fast texture of the nutrients. The organic matter contents are related to the component physicist-chemistry CEC potential, by presenting narrows interaction, because the organic matter helps presence to retain the exchangeable bases, and in local conditions, it shows directly related to the soil fertility levels (MOREIRA and COSTA, 2004).

In this context, CEC's values in the superficial horizons and sub-superficial, are presented in the Illustration 02. The profile 4 (São Carlos) outstands for presenting the biggest value of OM, which was 44 g/Kg, as well as CEC, 20,35 cmol/dm^3 being classified as

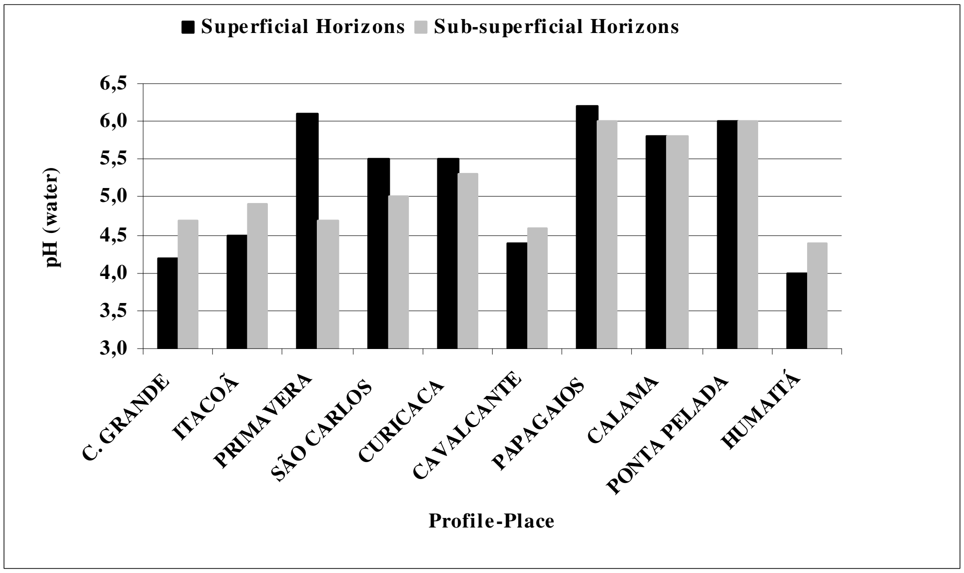
Gleisols of loamy texture. The exchange capacity of ions probably was superior in the superficial horizons in 60% of samples to OM's due its larger quantity.



Picture 02 – CEC cmol/dm^3 Sample Values
Of superficial and sub-superficial horizons

OM's proportion in depth in flooded soils respective to the profiles 3 (Primavera), 8 (Calama) and 9 (Ponta Pelada), contributes in the ion exchange capacity, however, outstands the profile 6 (Cavalcante), composed by Plintosols, for presenting CEC's value in sub-superficial horizon among all of the studied profiles, 15,23 cmol$_c$/dm^3, what can be related due the clay absortion activity, whose percentage belonged to 64% (very loamy), yet OM's content was 9,1 g/kg (lower and smaller regarding the superficial horizon).

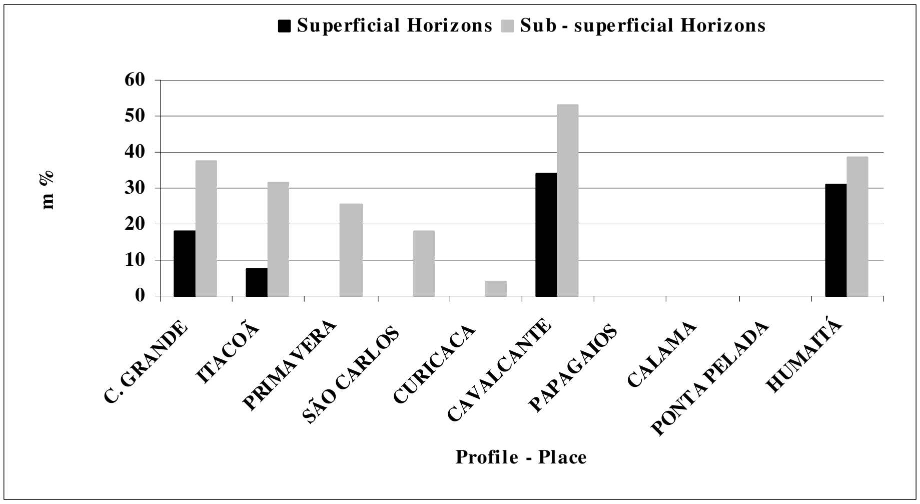
Regarding the acidity, it had been verified that 60% of the superficial horizons samples present pH varying among 5,4 to 6,5, values that denote moderated acidity. However, Yellow Latosols, profile 1 (Cujubim Grande) and 2 (Itacoã), presented very elevated acidity (smaller than 5,0), as well as in the superficial horizon, as much in depth, predominating the exchangeable acidity, what turns them strongly acid with saturation of (Al^{+3}) very elevated. The soils under acidity or excessive alkalinity tend to present lowers availability of nutrients (VALE, *et. al.*, 1997). The class Fluvic Neosols presented mainly values of neutrality, except for the profile 10 (Humaitá), with superficial extremely acid horizon (Illustration 03).



Picture 03 - pH Value of Sample at Superficial and Sub-superficial Horizons

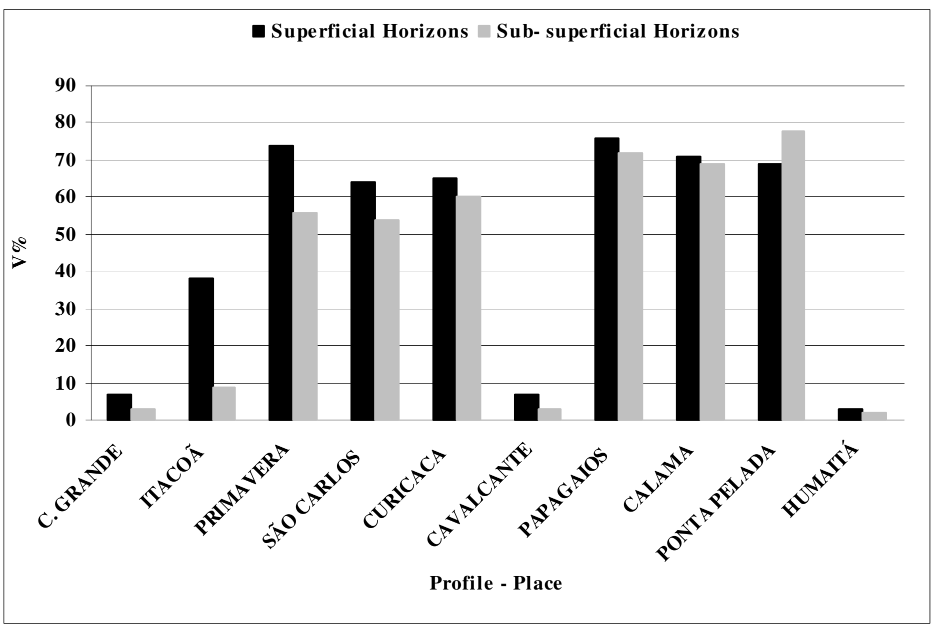
One of the main chemical limitations to the Amazon soils for agricultural use is the aluminum toxicity, which reaches about 77 % of the soils of the Amazon region (SÁNCHEZ & COCHRANE *Apud* SCHAEFER *et. al.*, 2000). In this meaning, this has great importance to evaluate the exchangeable aluminum content, being the best parameter to express its toxic potential, the saturation percentage of $Al^{+3.}$ According to the literature, above 50% of saturation, exists an accentuated increase in Al^{+3}'s activity, checking to the soils the aluminum character, negative condition to the agricultural cultures development (ABREU Jr.; MURAOKA; LAVORANTE, 2003).

. The percentile of aluminum saturation was high in 40% of the analyzed profiles, corresponding to Latosols profiles 1 and 2, Plintosols in the profile 6 and Fluvic Neosols in the profile 10, being the percentile relatively larger in the horizons sub-superficial. In these profiles the exchangeable aluminum is cation dominant in the change complex (Illustration 04).



Picture 04 –Samples Percentage of Al^{+3} saturation at Superficial e Sub-superficial Horizons

The bases saturation of CEC in pH 7,0, represented by the symbol V%, presented the minors values (Illustration 05), below 50%, in the profiles 1 (Cujubim Grande), 2 (Itacoã), formatted with Yellow Latosols. These profiles also registered pH low values in superficial horizons, being classified as strongly acid. According with references cited in DEMATTÊ (1988), these profiles are highlighted for presenting serious limitations to agricultural usage



Picture 05 – Bases Saturation (V%) of samples at superficial and sub-superficial horizons

In the profile 6 (Cavalcante), Plintosols had been found where a CEC's registration was the biggest in depth, 15,2 $cmol_c/dm^3$, presenting a larger potential for retention of nutrients, however, the same soil was classified with low fertility. Such result reflects Al^{+3} dominance in the retention complex of cations, which close to the elevated acidity checks its limitations natural fertility. The profile 10 (Humaitá), in spite of be a Fluvic Neosols, presented V% very low, characterizing it as dystrophic also by the limiting effect of Al^{+3}, 88% in superficial horizon and 96% in sub-superficial, larger percentile among profiles with Fluvic Neosols**.**

The profiles which presented high natural fertility, classified for presenting V % greater than 50%, as eutrophic are composed by Gleisols, profiles 4 (São Carlos), 5 (Curicaca) and 8 (Calama) and *Fluvic Neosols*, profiles 3 (Primavera), 7 (Papagaios) and 9 (Ponta Pelada), characterized by an acidity moderated and low percentage of aluminum saturation.

CONCLUSIONS

The final results expose four profiles with low natural fertility, being they correspondents to the soil classes: Yellow Latosols in the profiles 1 and 2, Plintosols in 6 and Fluvic Neosols in 10. This natural fertility deficiency can be related to very elevated acidity of its superficial and sub-superficial samples, associated to the high value of exchangeable Al^{+3}, correspondent as well as the flooded soils (Plintosols and Fluvic Neosols), as fluvial terrace (Latosols). The elevated acidity of these samples related to the exchangeable aluminum high saturation has influenced the particles surface electric charge, what affects directly the cations retention and the availability to the short period of nutritious availability

The formation soils classes under flood regime influence (flooded environment) present high V%, however, CEC's values and texture present variation, reflecting the deposited materials diversity (organic and inorganic) in the formation of these soils or yet, composition organic residues of different stages.

CEC's superficial and sub-superficial horizons potential values were low due to the clay mineral nature, (caolinite and sesquioxid predominance), being its corresponding values to activity contribution of OM. However, the colloid clay biggest activity in depth had been identified in Plintosols sub-superficial horizon in profile 6 (Cavalcante), where CEC potential increased in spite of the proportion reduction of OM.

The cation exchange capacity varies from soil to soil, and what sets its values is the complex clay / colloid organic structure and OM's quantity. There was identified OM's contribution for CEC's increase in sixty percent of the samples, including the soil classes: Latosols, Gleisols and Fluvic Neosols.

BIBLIOGRAPHICAL REFERENCES

ABREU Jr. C. H.; MURAOKA, T.; LAVORANTE, A. F. Relationship Between Acidity and Chemical Properties of Brazilian Soils. **Scientia Agricola**, v.60, n.2, p.337-343, Abr./Jun., 2003. Available at: <http://www.scielo.br/pdf/sa/v60n2/15337.pdf>. Accessed in : 13 de jan. de 2005.

CIOTTA, M. N.; BAYER, C. ; FONTOURA, S. M. V. ; ERNANI, P. R. ; ALBUQUERQUE, J. A.. Matéria orgânica e aumento da capacidade de troca de cátions em solo com argila de atividade baixa sob plantio direto. *In*: **Ciência Rural,** v. 33, n. 6, p.1161-1164. Santa Maria, 2003.

DEMATTÊ, J. L. I. **Manejo de Solos Ácidos dos Trópicos Úmidos, Região Amazônica**. Campinas: Fundação Cargill, 1988.

EMBRAPA. **Manual de métodos de análise de solo.** Rio de Janeiro: Centro Nacional de Pesquisa de solos. – 2. ed., 1997.

EMBRAPA. **Sistema Brasileiro de Classificação de Solos**. Brasília: Embrapa Solos, 1999.

FONTES, M. P. F.; CAMARGO, O. A. de; SPOSITO, G. Eletroquímica das Partículas Coloidais e sua Relação com a Mineralogia de Solos Altamente Intemperizados. **Scientia Agricola**, v58, n.3, p.627-646, jul./set, 2001. Available at: <http://www.scielo.br/pdf/sa/v58n3/a29v58n3.pdf> Acesso em: 03 de ago. 2001.

LEMOS, R. C. & SANTOS R. D. dos. **Manual de Descrição e Coleta de Solos no Campo**. Campinas: SBCS, 1996.

LUCHESE, E. B. , FAVERO, L. O. B. , LENZI, E. **Fundamentos da Química do Solo**. Rio de Janeiro: Freitas Bastos, 2002

MOREIRA, A. e COSTA, D. G. Dinâmica da Matéria Orgânica na Recuperação de Clareiras da Floresta Amazônica. **Pesquisa Agropecuária Brasileira**. Vol.39 no.10. Brasília, 2004. Available at : http://www.scielo.br/pdf/pab/v39n10/22323.pdf. Acessed in : 02 de set. de 2004.

RESENDE, M. **Pedologia**. Viçosa: Oficinas Gráficas da Imprensa Universitária da Universidade Federal de Viçosa, 1982.

RODRIGUES, T. E. Solos da Amazônia. In: **O Solo nos Grandes Domínios Morfoclimáticos do Brasil e o Desenvolvimento Sustentado**. Edited by V. A. V. H. ; FONTES, L. E. F. ; FONTES, M. P. F. Viçosa, 1996.

SCHAEFER, C. E. R. ; LIMA, H. N. ; JUNIOR, J. F. do V. ; MELLO, J. W. V. de. Uso dos Solos e Alterações da Paisagem na Amazônia: cenários e reflexões. *In*: **Série Ciências da Terra 12**, 2000.

VALE F. R. do; GUILHERME, L. R. G. ; GUEDES, G. A. de A. ; NETO, A. E. F. **Fertilidade do solo: dinâmica e disponibilidade dos nutrientes de plantas**. Lavras: UFLA/FAEPE, 1997.