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Soil fertility evaluation of agricultural areas of cashew community of Catolé Rocha-PB

Josimar N. Silva[1*], Jean C. D. Oliveira[1], Ênio K. L. Martins[2], Edivan S. Nunes Júnior [2], Toni H. S. Irineu, Aridênia P. Chaves[1] and Andpaulo C. A. Linhares[3]

[1]*Federal Rural Semi-Arid University, Department of Plant Sciences, Mossoró-RN, 59625-900, Brazil*
[2]*State University of Paraíba, of Catolé Rocha-PB, Department of Plant Sciences, 58884-000, Brazil*
[3]*Federal University of Lavras, Department of Biology, Lavras-MG, 37200-000, Brazil*
[*]*Corresponding author:* josimar2160@hotmail.com

Abstract

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The overuse of the soil by intensive cultivation of agricultural activities has caused severe damages on farms, due to depletion of their fertility. Thus, it becomes increasingly necessary that farmers make a soil pre-analysis physical and chemistry, in order to be able to diagnose which soil class it will be using, as well as to diagnose possible deficiency or excess of nutrients. Thus, the aim of this study was to evaluate the chemical and physical characteristics of 10 farms in Cashew community site, Catolé of Rocha-PB. A survey was performed by removing soil samples in a zigzag, at layers of 0-20 cm and 21-40 cm in the period from July to August 2013; an auger type probe was used. The soil chemical analyses were performed in the soil analysis laboratory, water and plant of Rural Federal University of semi-arid – UFERSA consisting of: pH (1:2.5) in water; calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na). Based in these measurements were calculated the sum of base (SB). In addition the electrical conductivity (EC) in the saturation extract obtained from the saturated paste. The textural classes from the properties were classified according to the triangle soil classification. Farms of tree in the community have good conditions for the development of agricultural activities. Potassium (K) was the nutrient found in lesser amounts in the evaluated properties. The sandy loam textural classification predominated in areas and depths sampled.

*Key words: s*oil; fertility; semi-arid
Abbrevations: UFERSA – Federal Rural Semi-Arid University; pH – hydrogen potential; K – potassium; Ca – calcium; Mg – magnesium; Na – sodium; M.O. – organic matter; N – nitrogen; S.B. – sum of bases; E.C. – electrical conductivity

Introduction

The overuse of the soil by intensive cultivation of agricultural activities has caused severe damage on farms due to depletion of soil fertility, since for the most part there is no replenishment of nutrients, becoming increasingly unproductive, bringing to limitations on the agricultural development. Among these limitations, the high acidity and low fertility, which usually occur together, are among the most constant in Brazil soil, those are largely responsible for the low productivity in both freshly grown areas and in areas in use for a long time.

Knowledge of physical and chemical soil properties such as texture, pH, macronutrients content and micronutrients are very important factors for the management of agricultural soils. These factors are the ones that will provide good conditions to the producers to improve productivity, and decrease expenses with inputs by using it rationally, improving the nutritional balance for plants and hence their productivity, generating income to the producer (Martins et al., 2008).

However, it is necessary to make a soil physical and chemical pre-analysis it allows to diagnose what soil type you are using and also to diagnose possible deficiency or excess of nutrients, such information will support you toward to make shortcomings corrections, in order to achieve a better use of soil. Thus it will be possible to determine the necessary corrections before the deployment of crops for the rational exploitation of the soil (Fernandes, 1991). In this context, chemical analysis constitutes a quick and efficient way of evaluating the fertility of soil, predicting the probability of a positive response to the use of adjustments and fertilizers (Ferreira et al. 1990).

Due to this lack of information, the assessment of soil texture and fertility is the first step to define the measurements necessary for their fertility correction and management. In addition, allowing determining an implementation of any culture also it may become an important tool for public and private action programs linked to the productive sector, enabling the evaluation of soil fertility in the states and their mesoregion. As well, comparisons can be made between those results looking for the critical levels of nutrients to the main crops grown in each state (Fixen et al., 2010), thus becoming a significant tool for analyzing variability and improve the productivity management in agricultural areas, taking into account the specific soil and crop information (Amado et al. 2009).

However, due to the soil analysis provide accurate information of its textural class and its fertility arises the need for developing work with soil chemical pre-analysis that may provide to the farmers information about soil quality by fulfilling them with best conditions to conquer a positive response in the agriculture by the use of adjustments and fertilizer. Given the above, the aim of this work was to evaluate the chemical and physical properties of soil in 10 farms of the community site tree, located in the municipality of Catolé Rocha-PB.

Material and Methods

A survey was conducted from July to August 2013 in 10 farms located in the community Cashew site, municipality of Catolé Rocha-PB. The municipality is at 272 m altitude, under the geographical coordinates of 6° 20′38″S and 37 ° 44′48″W. The region is located in the backlands of Paraiba, with a BSWh climate type, according to Koppen classification, hot and dry climate, with average annual temperature of 27°C.

Soil samples were collected from 10 farms, were collected layers at 0-20 cm and 21-40 cm by using an auger type probe. Were collected 10 single samples in zigzag randomly on the property to get a representative composite sample of each area?

For this survey were considered only the samples of surface horizons and the first subsurface of each profile. Chemical analysis of soil samples were performed in the Soil Analysis Laboratory, water and plant of Rural Federal University of semi-arid – UFERSA/Mossoró – RN, consisting of: pH (H2O); potassium (K), sodium (Na), calcium (Ca) and magnesium (Mg) in accordance with the recommendations proposed by (Embrapa, 1997) and as a function of these determinations was calculated sum of bases (SB). Besides these, it also calculated the electrical conductivity (EC) in the saturation extract obtained from the saturated paste, according to the recommendations proposed by (Embrapa, 2015).

Adopted levels in the interpretation of chemical parameters determined with their respective units adjusted to the International System of Units are given in Tables 1 and 2.

Table 1. Reference values for interpretation of the analytical results of chemical analysis of the soil for potassium (K), calcium (Ca), magnesium (Mg) and base sum (SB)

Classification				
Very low	Low	Medium	Good	Very good
Content Mehlich K^{-1} (mg/dm^3)				
≤ 15	16 to 40	41-70	71-120	> 120
Ca^{2+} content (cmolc/dm^3)				
≤ 0.40	0.41 to 1.20	1.21 to 2.40	2.41 to 4.00	> 4.00
Mg^{2+} content (cmolc/dm^3)				
≤ 0.15	0.16 to 0.45	0.46 to 0.90	0.91 to 1.50	> 1.50
base sum (cmolc/dm^3)				
≤ 0.69	0.61 to 1.80	1.81 to 3.60	3.61 to 6.00	> 6.0
pH classification				
Very low	Low	Good	High	Very high
Soil pH (soil: water 1:2.5)				
≤ 4.5	4.5 to 5.4	5.5 to 6.0	6.1 to 7.0	> 7.0

Table 2. Reference values for interpretation of analytical results of chemical analysis of soil for electrical conductivity (EC) and sodium (Na)

Classification	EC dS m^{-1}	At
Saline	≥ 4.0	<15
Sodium	<4.0	≥ 15
Salt – Sodium	≥ 4.0	≥ 15

Soil texture refers to the relative proportion of particles of size classes of the soil. Each class size (sand, silt and clay) can contain mineral particles of the same class.

Physical analysis was evaluated and compared using Soil classification triangle (Figure 1).

Results and Discussion

By analyzing the soil chemical attributes (Tables 3 and 4) can be seen that according to the analytical results from the soil samples in the depth 0-20 cm and 21-40 cm of the 10 analyzed properties was found that 70% and 60% of properties presented values classified as “Good” for the pH parameter, respectively, as recommendations of the (Embrapa, 1997).

The highest electrical conductivity (EC) was observed in the property number 10 in both depth of 0-20 cm and 21-40 cm, with values of 3.35 dS m^2 and 6.38 dS m^2 respectively (Tables 3 and 4), however according to the methodology of Embrapa (2015), must be considered as a saline soil only the values 6.38 dS m^2 observed at depth 21-40 cm.

To the sodium content, the observed values are classified as low according to Embrapa (2015). In terms of calcium and magnesium in the soil samples from the properties under study at depth 0-20 cm and 21-40 cm received classification very good and good, respectively (Tables 3 and 4).

The results presented pH between 5.1 and 5.9 for both the analysis of soil at depth of 0-20 cm and 21-40 cm. According to Marschner (2002), in nutritional terms, the optimum pH range for plants are between 5.6 and 6.2, being this pH range which provides greater availability of nutrients in the soil solution.

An important factor is that increasing the pH of the soil can provide various beneficial effects to plants by reducing the contents of Al and H+Al, providing a greater availability of nutrients (Pires et al., 2008). However, there are several species which tolerate pH in the range from 4.2 to 5.0 (Coast & Zocche, 2009). Thus can be inferred that depending on the crop to be planted in these properties the results of pH observed in the two soil depth 0-20 cm and 21-40 cm, will not impair the production development of those cultures.

For electrical conductivity just the property 10, presented the higher levels, these results demonstrate that most site properties has appropriate conditions for the development of agricultural activities. This is because there is a direct relationship between the electrical conductivity of the soil and its water content, since change in water content causes dilution of the soil solution (Bernert et al., 2015), being necessary to have a balance of the water volume and the amount of nutrients in each phase of the crop cycle, this concentration should be sufficient to provide absorption of nutrients by plants without causing accumulation of fertilizers in the soil (Zhang et al., 2013).

The electrical conductivity is directly related to the ability of the plant to absorb nutrients, affecting their availability when it

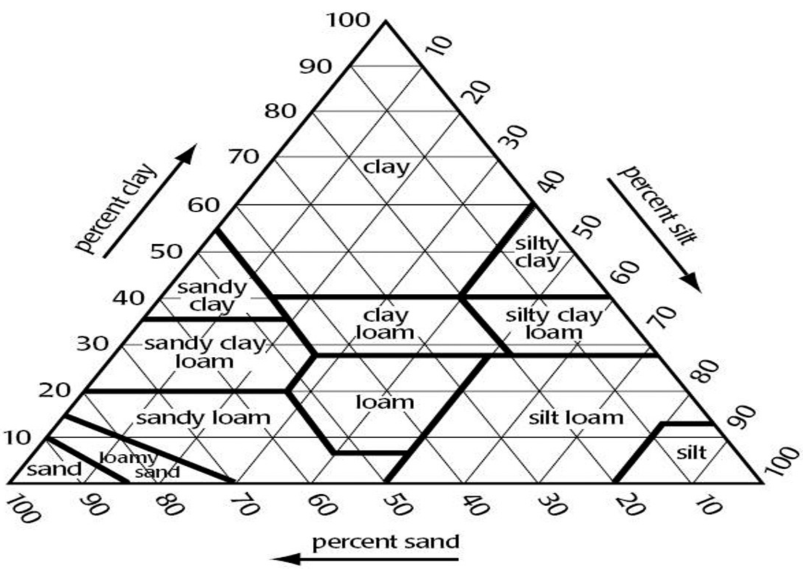

Fig. 1. Triangle adopted by the Brazilian Society of Soil Science for classification of textural classes of soil

is very high (Bernert et al., 2015). Among the nutrients that are greatly affected are Ca^{2+}, Mg^{2+} and K^{+}, in addition, with the increase in the electrical conductivity also increases the solubility of toxic cations (H^{+}, $Al3^{+}$) that negatively affects root development and plant growth (Rosolem, 2001).

Although higher levels of salts (Tables 2 and 3) being observed in the property 10 at both depths, was observed that between these properties, the highest variation was recorded at a depth of 21-40 cm. These results corroborate with observed by Serrano et al. (2010) studying the spatial and temporal variability of electrical conductivity of a soil under pasture, observed that higher values in the electrical conductivity at a depth of 0-30 cm, exceeding the deepest layer of 0-80 cm.

For the results observed in K (Table 3) were classified as below for the first 07 properties and very low for the last 03 properties at a depth of 0-20 cm, while a depth of 21-40 cm in all properties (10), the K contents were classified as very low (Table 4).

Similar results were observed by Silva et al. (2016), in the survey of soil fertility in the South Center of Ceará region, was recorded soils with low fertility. They report that potassium fertilizer is needed for crop growth.

This low concentration of potassium in the soil of the Site properties is related to text classification of these properties, since in both depth soils of this municipality have a high sand content. This information is confirmed by Dadalto & Fullin (2001), who claim that potassium is easily leached in soils very sandy. Another factor that may have contributed to this achievement of low levels of K is that the soil sampling for chemical analysis were carried out after the rainy season of this municipality.

Thus, it is necessary to make an adequate supply of this nutrient, since this has several functions in the metabolism of plants, such as control of water absorption, enzyme activation, growth of meristematic tissues, synthesis of protein and carbohydrate, translocation of assimilated and opening and closing of stomata (Veiga et al., 2010).

Table 3. Analytical results of the fertility of the 10 farms from the soil site for (pH) electrical conductivity (EC), potassium (K), sodium (Na), calcium (Ca), magnesium (Mg) and sum base (SB) in 0-20 cm depth, of Catolé Rocha – PB 2013

Properties	pH	EC	K^{+}	Na^{+}	Ca2+	Mg^{2+}	SB
		dS m^{2}	- mg dm-^{3}-	--------------- cmolcdm^{-3} ---------------			
1	5.5	1.08	28.0	0.4	2.7	2.0	4.77
2	5.8	2.15	26.0	0.6	7.5	1.8	9.37
3	5.4	2.22	27.0	0.8	4.7	2.3	7.07
4	5.4	1.80	17.0	1.0	4.3	1.9	6.24
5	5.7	1.62	21.0	1.2	2.4	1.8	4.25
6	5.1	1.18	17.0	1.4	5.3	2.7	8.04
7	5.5	1.21	16.0	1.6	3.9	2.3	6.24
8	5.5	1.15	11.0	1.8	3.0	2.4	5.43
9	5.8	1.36	9.0	1.2	2.6	1.8	4.42
10	5.6	3.35	7.0	2.2	3.6	2.1	5.72

* All properties are inserted in site

Table 4. Analytical results of the soil fertility of the 10 farms site for (pH) electrical conductivity (EC), potassium (K), sodium (Na), calcium (Ca), magnesium (Mg) and sum base (SB) in 21-40 cm depth, of Catolé Rocha – PB, 2013

Properties	pH	EC	K^{+}	Na^{+}	Ca^{2+}	Mg^{2+}	SB
		dS m^{2}	- mg dm-^{3}-	--------------- cmolcdm^{-3} --------------			
1	5.9	0.61	15.0	0.5	3.2	1.4	4.64
2	5.4	1.55	12.0	0.7	5.8	2.5	8.33
3	5.7	2.93	21.0	0.9	3.6	2.3	5.95
4	5.5	1.69	10.0	1.1	4	2.2	6.23
5	5.1	1.74	14.0	1.3	3.7	1.6	5.34
6	5.4	2.05	9.0	1.5	5.0	2.4	7.42
7	5.9	1.19	10.0	1.7	3.4	1.7	5.13
8	5.2	1.61	7.0	1.9	3.1	2.6	5.72
9	5.8	2.46	6.0	2.1	4.4	1.9	6.32
10	5.7	6.38	5.0	2.3	4.3	1.8	6.11

*All properties are inserted in site

About the amount of sodium (Na^+) found in the soil of Site, in two depths these levels are considered low, which indicates that these amounts present do not interfere with the development of crops. This nutrient has significant importance when present in adequate amounts in the ground, as even, not exercising the criterion of essentiality for crops, their presence in the soil solution can promote higher yields of some crops.

Moreover, this nutrient may partially replace the potassium (K) acting on enzymatic activation of ATPase, in the osmoregulation, in the absorption of macronutrients, in the permeability of cells, in the carbohydrate synthesis, in the conversion of fructose to glucose, in the stomatal opening and closing, vigor of plants and carbon dioxide transport (CO2) into the cells of C4 plants (Korndorfer, 2007). However, when present in the soil in large quantities, may cause symptoms of toxicity: as wilting, yellowing, reduced growth and crop yield (Inocencio et al., 2014.). However, due to the quantities found being consider low, the soil of Site has no restrictions on the development of agricultural activity because an excess of this nutrient.

For calcium (Ca) and magnesium (Mg) was observed in (Tables 3 and 4), good and very good classification. This classification indicates that the Cashew Site soil presents good levels for the development of agricultural activities. This proper ratio of calcium and magnesium results in a good nutritional balance, providing suitable conditions for good development and growth of plants.

For Salvador et al. (2011), when occurs discrepancy between the amounts of calcium and magnesium present in the soil, there may be a competition by the sites of adsorption in the soil and root adsorption. However it can be noticed that both Ca as Mg were found in ideal amounts in the soil, which shows the real balance in the availability of nutrients in the soil and the absorption of them by plants.

The chemical analysis values for the sum of the base of depths 0-20 cm and 21-40 cm ranged between 4.25 and 9.37 and 4.64 and 8.33, respectively. These values are classified as good or very good.

These results indicate that these soils there are a good availability of Ca and Mg, except only for K, which were obtained lower values at both depths. The basic sum values obtained in very good and good mainly are due to the amounts of Ca observed in this soil analysis, since this nutrient was what was observed in greater quantity in the analysis.

Salvador et al. (2011) comments that between the nutrients present in the soil, calcium is usually in low concentrations in acidic soils. However, as the soils of Site, acid soils were not registered, all their values were above 5, and it provided higher Ca concentrations in these soils, which thus resulted in an increase of the sum basis of these soils.

The physical analysis of soil in 0-20 cm depth, can be noticed that 6 of the 10 sampled presented textural properties rating Sandy franc, 01 Sandy clay Franc 03 and Sandy franc (Table 5). In the other hand, according to the results of the physical tests the soil at a depth of 21-40 cm is possible to realize that 07 of the 10 sampled showed textural properties rating Loam sandy, 01 Sand loam, Sandy Clay loam and sand, respectively (Table 6).

Soil texture refers to the relative proportions in which they are, in particular soil mass, the different particle sizes. It refers specifically to the relative sand proportions or particles of sand, silt and clay in the dried soil in the air (TFSA). It is the physical property of soil that suffers less change over time. It is very important for irrigation because it has a direct influence on water infiltration rate, aeration, water holding capacity, nutrition, as well as in adhesion or cohesive force between the soil particles. The sand content, silt and clay in the soil directly influence the adhesion point to tillage implements and planting, facilitating or hindering the work of machines. The sand content influences also in the choice of irrigation method to use.

Among the chemical properties studied, the general trend was increase of the concentrations of calcium and sodium, with decreasing clay content in the texture class. In this case the highest levels were observed in sandy loam class. Therefore in function of the textural characteristics, these soils have limited water storage capacity. However, this effect can be mitigated through management practices that provide maintenance and increased contents of organic matter.

With respect to soil class of the site properties, both at the depth of 0-20 cm and 21-40 cm, the predominant class was sandy loam. The sandy soil, the soil is quite common especially in the Northeast; it is a soil that has good porosity permeability. Thus, water penetration to the deeper layers occurs more rapidly, which makes it dries more easily.

Table 5. Physical analysis results of the agricultural properties of 10 soil site, depth 0-20 cm, of Catolé Rocha – PB, 2013

Properties	Granulometry, %			Class Textural
	Sand	Silt	Clay	
1	72.57	14.00	13.43	Sand loam
2	56.34	21.06	22.68	Sandy Clay Loam
3	57.34	24.14	18.18	Loam Sandy
4	63.04	19.72	17.25	Loam Sandy
5	79.75	8.87	11.38	Sand loam
6	59.30	20.69	20.02	Loam Sandy
7	64.16	20.78	15.06	Loam Sandy
8	67.42	19.14	13,14	Loam Sandy
9	76.19	11.42	12.39	Sand loam
10	65.99	18.03	15.98	Loam Sandy

* All properties are inserted in site

Table 6. Results of physical analysis of agricultural soil of 10 properties site, depth 21-40 cm, of Catolé Rocha – PB, 2013

Properties	Granulometry, %			Class Textural
	Sand	Silt	Clay	
1	71.32	13.72	14.96	Sand loam
2	62.21	16.61	21.17	Sandy Clay Loam
3	65.16	15.28	19.59	Loam Sandy
4	65.97	14.39	19.64	Loam Sandy
5	74.73	10.68	14.59	Loam Sandy
6	70.29	12.03	17.69	Loam Sandy
7	65.81	17.81	16.38	Loam Sandy
8	70.79	24,70	4.91	Loam Sandy
9	59.29	22,50	18.31	Loam Sandy
10	69.10	27.66	3.23	Sand

* All properties are inserted in site

Understanding of this textual class is very important, then when the farmer is planting some culture under irrigation systems, this information of soil permeability and porosity, can provide information very accurate so that the producer can make a good soil management, and as a result, a good crop of his or their cultures.

Conclusions

Farms of site community have good conditions for the agricultural activities development. Potassium (K) was the nutrient found in lesser amounts in the evaluated properties. The sandy loam textural classification predominated in areas and depths sampled.

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