# CHARACTERIZATION OF SOILS IN COFFEE PRODUCTIVE AREAS IN THE PROVINCES OF COCLE AND VERAGUAS-REPUBLIC OF PANAMA

.ABSTRACT

The objective of the work was to characterize the properties of the soils of coffee-producing farms in the provinces of Cocle and Veraguas that allow the preparation of regionalized fertilization cards according to the edaphoclimatic characteristics of each area.Planting robusta coffee is gaining greater interest among Panamanian farmers as an alternative for soil conservation. On 15 farms in the province of Colón and 20 in Panama Oeste, samples were taken (0-20 cm) to understand their properties and initiate a sustainable fertilization program that contributes to improving productivity. Digital maps were created using the Q-Gis v.2.2 program and regionalized fertilization cards for each zone. The soils of the province of Colón 47% presented a high percentage of aluminum saturation, average pH of 4.6, low levels of organic matter and phosphorus, and 53% low in potassium. 80% are high in magnesium, 40% in calcium. Imbalances were found in the Ca/Mg and Ca + Mg/K ratios, which causes nutritional problems. In Panama Oeste, 30% presented a high percentage of aluminum saturation, average pH of 5.3 and 1.4% organic matter, 100% are low in phosphorus, 90% low in potassium, medium and high levels of magnesium and calcium. A positive and statistically significant correlation was found between % clay, organic matter, pH, and calcium. It is expected that this soil characterization and regionalized fertilization cards will contribute to improving soil properties and achieving sustainable production.Fertilization recommendation cards have been prepared for these two provinces and they take into account this entire situation and physical problems found in the soils. Much emphasis is also placed on organic fertilization of plantations as a complement to traditional fertilization, seeking more balanced nutrition.

*Keywords:*arabica, coffee, digital maps, fertilization, robusta, soil properties

## 1. INTRODUCTION

Coffee in Panama has been cultivated since Spanish colonial times, the Coffea arabica cultivar (Típica cultivar) arrived in Panama through Portobelo, province of Colón in the year 1780 (1).

The planting of crops such as robusta (40%) and Arabica coffee (60%) is gaining more and more interest among Panamanian producers, as an alternative for the recovery of the agricultural sector and to confront the effects of climate change, the high cost of inputs, the fluctuation of product prices in the market and the shortage of labor, among others.

Most of the soils for central provinces of Panama are soils where low organic matter content, acidic pH, high levels of aluminum toxicity and low base content (K, Ca and Mg) predominate, this impacts the yields of coffee plots. According to Ministry of Agriculture (MIDA) (2)there are 17,548 ha planted nationwide, Veraguas (12%), Cocle (31%), where 5,788 producers and their families are dedicated to this task.

According to harvest data from MIDA (3) the yield of coffee plantations in the province of Cocle is around 0.33 ton/ha and in Veraguas around 0.41 Ton/ha. Considered very low yields that can be improved with good management and balanced fertilization.According to MIDA (4) the average yield in the Republic of Panama in recent years was 0.58 ton/ha.

Previously, researchers from the Panama Agricultural Innovation Institute (IDIAP) developed soil fertility maps at the national level based on soil analysis results (5), however, specifically studies to select the best site that favors the coffee cultivation has not been done in the country.

Collantes et al (6), characterized the coffee producing farms in the province of Colon, on the Caribbean coast of the Republic of Panama. They chose 40 farms in the districts of Colon, Chagres and Donoso, conducting a structured survey aimed at producers on social, technological and economic aspects related to coffee cultivation, the survey reflecting that only 67% of producers fertilized with synthetic products or used chicken manure.

The objective of the work was to characterize the properties of the soils of coffee-producing farms in the provinces of Cocle and Veraguas that allow the preparation of regionalized fertilization cards according to the edaphoclimatic characteristics of each area.

## 2. MATERIALS AND METHODS

In 16 plots of the districts of Penonomé, Olá and La Pintada of the province of Coclé and 18 plots of the Santa Fe district in Veraguas province (Figure 1), soil samples were taken at a depth of 0-20 cm to know the properties of the soils and thus initiate a sustainable fertilization program that contributes to improving productivity.

The selection of the farms was made considering that they were farms producing coffee under a shade system. Maps of texture levels, pH, organic matter, percentage of aluminum saturation, cationic exchange capacity, macroand micronutrients of the districts where the selected farms are located were prepared, using the Q-Gis v.3.32.1 free program.

In addition, recommended fertilization charts were prepared for each area according to its edaphoclimatic characteristics. Descriptive statistics analysis, Pearson correlation analysis and principal component analysis were carried out to know which elements are influencing the quality of soils for coffee cultivation (7), using the InfoStat program (8).

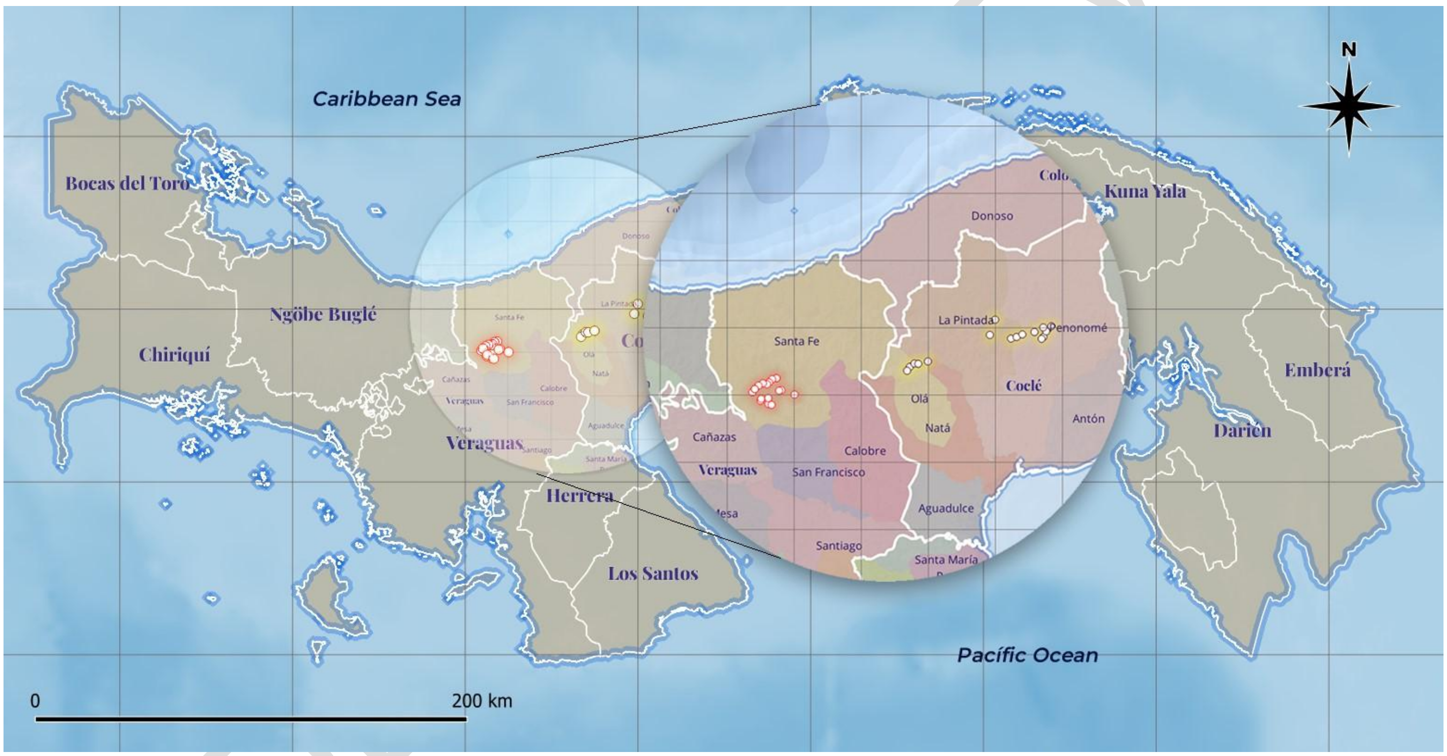


**Fig 1. Location of the sites where samples were taken on productive farms in Coclé and Veraguas provinces, Republic of Panama**

## 3. RESULTS AND DISCUSSION

The results of the characterization analysis of the soils of Coclé and Veraguas can be seen in tables 1 and 2, respectively.

In soils under coffee production. In both provinces, low levels of organic matter (< 3.0 %) are observed and, in many soils, also low porosity (<50%). The greater accumulation of organic matter improves the availability of nutrients for plants 9, 10).
Olá soils are those that show the best pH levels (>5.5), also favoring the availability of other nutrients. Like the soils of Las Trancas and Tule Arriba in Sante Fe, favoring lower levels of aluminum saturation. Miranda et al. (9) found in San Buenaventura-Colombia that in soils sampled at 0.20 m with lower levels of aluminum saturation there was better root development of coffee plantations.

**Table 1. Characterization of the soils of coffee producing farms in the province of Coclé**

| Place | District | N Lat | W Long | Bulk Dens. | Poros. | Sand | Silt | Clay | OM | pH | P | K | Ca | Mg | Al | CIC | Al Sat | Base Sat | Mn | Fe | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $g/cm^3$ | ------------------------%------------------------ - | | | | | 1:2.5 | mg/kg | | ----------$cmol_{(+)}$/kg---------- | | | | -------%------ | | --------mg/kg-------- | | | |
| Toabré | Penonomé | 8°39´34.2´´ | 80°19´28.1´´ | 1.48 | 44.15 | 32 | 24 | 44 | 1.1 | 5.4 | 1 | 76.4 | 3.7 | 1.5 | 0.2 | 5.60 | 3.57 | 96.43 | 77.8 | 30 | 0.9 | 3 |
| Toabré | Penonomé | 8°40´22.7" | 80°20´55.3" | 1.15 | 56.60 | 28 | 32 | 40 | 2.9 | 4.4 | 1 | 43.4 | 0.3 | 0.4 | 6.0 | 6.81 | 88.1 | 11.91 | 10.2 | 63.9 | 0.1 | 2 |
| Toabré | Penonomé | 8°39´16.6´´ | 80°19´45.5´´ | 1.57 | 40.75 | 32 | 16 | 52 | 1.7 | 4.7 | 1 | 62.6 | 1.7 | 2.3 | 3.7 | 7.86 | 47.1 | 52.93 | 14.0 | 47.3 | 0.1 | 2 |
| Toabré | Penonomé | 8°40´28.8´´ | 80°19´01.4´´ | 1.30 | 50.94 | 32 | 16 | 52 | 2.0 | 4.3 | 1 | 57.8 | 1.1 | 0.5 | 1.1 | 2.85 | 38.6 | 61.37 | 152 | 55.7 | 0.1 | 3 |
| Toabré | Penonomé | 8°41´06.6´´ | 80°19´29.8´´ | 1.53 | 42.26 | 24 | 24 | 52 | 3.1 | 4.6 | 1 | 38.4 | 1.6 | 0.7 | 1.4 | 3.80 | 36.9 | 63.14 | 118 | 88.7 | 0.1 | 2 |
| Toabré | Penonomé | 8° 1´18.8´´ | 80°18´09.7´´ | 1.69 | 36.23 | 44 | 16 | 40 | 2.0 | 4.6 | 1 | 67.3 | 1.9 | 0.8 | 1.5 | 4.37 | 34.3 | 65.69 | 57.6 | 42.1 | 0.4 | 4 |
| El Palmar | Olá | 8°34´46.8´´ | 80°41´12.1´´ | 1.47 | 44.53 | 40 | 32 | 28 | 2.4 | 5.5 | 1 | 92.3 | 7.9 | 2.5 | 0.3 | 10.94 | 2.74 | 97.26 | 42.8 | 35.3 | 0.6 | 8 |
| El Palmar | Olá | 8°34´08.9´´ | 80°41´38.5´´ | 1.66 | 37.36 | 44 | 28 | 28 | 1.2 | 5.5 | 1 | 32.8 | 10.1 | 4.5 | 0.2 | 14.88 | 1.34 | 98.66 | 17.3 | 23.4 | 0.0 | 3 |
| El Palmar | Olá | 8°35´18.7´´ | 80°40´28.0´´ | 1.85 | 30.19 | 40 | 32 | 28 | 1.1 | 5.3 | 1 | 83.5 | 4.0 | 1.1 | 0.4 | 5.71 | 7.00 | 93.00 | 39.1 | 8.4 | 0.6 | 2 |
| El Palmar | Olá | 8°35´16.1´´ | 80°39´49.8´´ | 1.81 | 31.70 | 48 | 24 | 28 | 0.6 | 5.5 | 1 | 41.2 | 8.5 | 4.1 | 0.3 | 13.01 | 2.31 | 97.69 | 25.5 | 18.5 | 0.0 | 3 |
| Ojo de Agua | La Pintada | 8°35´39.1´´ | 80°38´15.6´´ | 1.78 | 32.83 | 64 | 20 | 16 | 1.0 | 5.7 | 2 | 124.7 | 6.7 | 0.5 | 0.2 | 7.72 | 2.59 | 97.41 | 45.6 | 9.9 | 1.0 | 2 |
| Jagüito | La Pintada | 8°39´19.4´´ | 80°24´44.8´´ | 1.72 | 35.09 | 52 | 20 | 28 | 0.5 | 5.3 | 1 | 155.5 | 7.5 | 2.1 | 0.1 | 10.10 | 0.99 | 99.01 | 6.21 | 24.4 | 0.0 | 1 |
| Llano Grande | La Pintada | 8°39´34.1´´ | 80°23´50.1´´ | 1.52 | 42.64 | 32 | 13 | 55 | 0.7 | 4.7 | 1 | 16.8 | 0.4 | 0.3 | 0.5 | 1.24 | 40.2 | 59.77 | 57.3 | 25.7 | 0.0 | 2 |
| Las Minas | La Pintada | 8°39´59.6´´ | 80°22´53.8´´ | 1.55 | 41.51 | 32 | 16 | 52 | 1.4 | 4.6 | 1 | 40.7 | 1.1 | 0.5 | 0.5 | 2.20 | 22.7 | 77.31 | 77.2 | 20.3 | 0.0 | 2 |
| Llano Grande | La Pintada | 8°39´54.9´´ | 80°28´10.9´´ | 1.44 | 45.66 | 32 | 20 | 48 | 2.2 | 4.5 | 1 | 61.3 | 0.2 | 0.2 | 6.7 | 7.26 | 92.3 | 7.67 | 2.02 | 61.7 | 0.1 | 2 |
| Llano Norte | La Pintada | 8°42´22.7´´ | 80°27´19.3´´ | 1.51 | 43.02 | 56 | 16 | 28 | 1.7 | 4.6 | 1 | 46.7 | 0.3 | 0.01 | 9.3 | 9.73 | 95.6 | 4.41 | 4.8 | 54.0 | 0.1 | 0 |

N lat: northlatitude; W Long: west longitude; Bulk dens: bulk density; Poros: porosity; OM: Organic matter; CEC: cationic exchange capacity; Al Sat: Aluminum, saturation; Base Sat: Bases saturation.

**Table 2. Characterization of the soils of coffee producing farms in the province of Panama Oeste.**

| Place | District | N Lat | W Long | Bulk Dens. | Poros. | Sand | Silt | Clay | OM | pH | P | K | Ca | Mg | Al | CIC | Al Sat | Base Sat | Mn | Fe | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $g/cm^3$ | -------------------------%------------------------- | | | | | 1:2.5 | mg/kg | | ----------$cmol_{(+)}/kg$---------- | | | | -------%------ | | --------mg/kg-------- | | | |
| Piragual | Santa Fe | 8°32´57.4´´ | 81°02´53.2´´ | 1.31 | 50.94 | 68 | 16 | 16 | 1.4 | 5.4 | 1 | 30.0 | 3.1 | 1.1 | 0.7 | 4.98 | 14.1 | 85.93 | 81.6 | 15.8 | 0.4 | 2 |
| Piragual | Santa Fe | 8°32´57.4´´ | 81°02´53.2´´ | 1.33 | 49.81 | 80 | 12 | 8 | 0.7 | 4.9 | 1 | 47.4 | 2.6 | 0.7 | 0.4 | 3.82 | 10.5 | 89.53 | 90 | 36.8 | 4.7 | 3 |
| Narices | Santa Fe | 8°32´47.5´´ | 81°03´35.2´´ | 1.27 | 52.08 | 56 | 12 | 32 | 0.2 | 4.6 | 0 | 66.5 | 1.0 | 0.3 | 0.4 | 1.87 | 21.4 | 78.61 | 58.1 | 32 | 0.5 | 2 |
| Alto Espavé | Santa Fe | 8°32´16.7´´ | 81°04´04.6´´ | 1.51 | 43.02 | 72 | 12 | 16 | 1.1 | 5.4 | 2 | 40.5 | 3.8 | 1.5 | 0.3 | 5.70 | 5.3 | 94.74 | 61.5 | 9.7 | 2.4 | 3 |
| Pantano Abajo | Santa Fe | 8°31´58.8´´ | 81°04´24.9´´ | 1.43 | 46.04 | 52 | 16 | 32 | 2.4 | 4.9 | 8 | 95.5 | 2.3 | 1.0 | 0.5 | 4.04 | 12.4 | 87.64 | 90.6 | 25.6 | 3.7 | 4 |
| Bermejo | Santa Fe | 8°32´07.6´´ | 81°05´05.1´´ | 1.16 | 56.23 | 68 | 12 | 20 | 1.6 | 4.7 | 2 | 56.6 | 1.3 | 0.6 | 1.3 | 3.34 | 38.9 | 61.13 | 38 | 83.3 | 1 | 3 |
| La Perico | Santa Fe | 8°31´46.0´´ | 81°05´47.8´´ | 1.34 | 49.43 | 68 | 12 | 20 | 0.9 | 4.7 | 2 | 46.6 | 1.2 | 0.6 | 1.0 | 2.92 | 34.3 | 65.74 | 11.2 | 58.5 | 1.5 | 1 |
| Alto de Piedra | Santa Fe | 8°30´41.1´´ | 81°06´48.4´´ | 1.23 | 53.58 | 80 | 16 | 4 | 3.4 | 4.8 | 1 | 56.7 | 2.0 | 0.4 | 0.6 | 3.15 | 19.1 | 80.92 | 33 | 94.6 | 0.2 | 2 |
| Alto de Piedra | Santa Fe | 8°31´11.7´´ | 81°06´24.9´´ | 1.08 | 59.25 | 68 | 16 | 16 | 2.4 | 4.2 | 1 | 32.3 | 0.5 | 0.01 | 4.6 | 5.19 | 88.6 | 11.41 | 1.6 | 268.7 | 0.3 | 2 |
| Alto de Piedra | Santa Fe | 8°31´11.7´´ | 81°06´24.9´´ | 1.03 | 61.13 | 60 | 16 | 24 | 3.6 | 4.9 | 0 | 22.1 | 0.5 | 0.2 | 5.6 | 6.36 | 88.1 | 11.90 | 4.4 | 122.6 | 0.7 | 2 |
| Montañuela | Santa Fe | 8°28´47.5´´ | 81°04´11.2´´ | 1.53 | 42.26 | 80 | 8 | 12 | 2.3 | 5.6 | 3 | 72.7 | 4.6 | 2.1 | 0.4 | 7.29 | 5.5 | 94.51 | 27.9 | 23.2 | 2.6 | 1 |
| Las Trancas | Santa Fe | 8°29´43.5´´ | 81°04´13.3´´ | 1.33 | 49.81 | 64 | 8 | 28 | 0.3 | 5.7 | 0 | 33.3 | 5.0 | 1.4 | 0.4 | 6.89 | 5.8 | 94.19 | 15.1 | 10 | 0.2 | 1 |
| Tute Arriba | Santa Fe | 8°29´19.1´´ | 81°05´27.3´´ | 1.26 | 52.45 | 52 | 8 | 40 | 2.7 | 5.5 | 1 | 25.8 | 3.9 | 0.7 | 0.5 | 5.17 | 9.7 | 90.32 | 53.5 | 7.5 | 0.2 | 1 |
| TuteArriba | Santa Fe | 8°29´36.5´´ | 81°05´22.0´´ | 1.40 | 47.17 | 24 | 24 | 52 | 2.9 | 5.5 | 1 | 26.6 | 1.7 | 1.0 | 0.4 | 3.17 | 12.6 | 87.37 | 19.3 | 14.8 | 1.1 | 1 |
| El Alto | Santa Fe | 8°31´01.3´´ | 81°02´05.6´´ | 1.38 | 47.92 | 48 | 20 | 32 | 2.0 | 4.7 | 1 | 31.6 | 1.8 | 0.3 | 1.4 | 3.58 | 39.1 | 60.90 | 40.7 | 52.7 | 1.6 | 2 |
| El Alto | Santa Fe | 8°30´56.6´´ | 81°02´26.8´´ | 1.32 | 50.19 | 56 | 12 | 32 | 3.3 | 4.6 | 0 | 18.0 | 0.7 | 0.5 | 6.7 | 7.95 | 84.3 | 15.68 | 50.7 | 73.9 | 0.01 | 2 |
| Piura | Santa Fe | 8°30´18.3´´ | 80°59´56.9´´ | 1.09 | 58.87 | 68 | 12 | 20 | 10.3 | 4.4 | 1 | 37.4 | 1.7 | 0.5 | 7.8 | 10.1 | 77.3 | 22.74 | 68.5 | 65.2 | 0.2 | 2 |
| El Puente | Santa Fe | 8°28´39.2´´ | 81°03´41.5´´ | 1.28 | 51.70 | 68 | 16 | 16 | 1.9 | 4.9 | 1 | 101.1 | 3.8 | 1.9 | 0.7 | 6.66 | 10.5 | 89.49 | 46.2 | 11.8 | 1.5 | 1 |

Tables 3 and 4 present the correlations with high statistical significance ($p < 0.05$) in soils from Coclé and Veraguas, respectively. In Coclé soils, the percentage of clay negatively affects porosity and organic matter improves the bulk density of the soil. The negative relationship between the percentage of aluminum saturation with pH and Ca content is also observed.

In relation to the soils of Veraguas, a positive and statistically significant correlation is observed between Ca and Mg with pH and a negative correlation between the percentage of aluminum saturation with pH and Mg content. Organic matter has a high positive correlation with CEC and Fe with percentage of aluminum saturation. Yageta et al. (11 ), found similar results in soil characterization studies for coffee cultivation in Kenya, suggesting that it is necessary to supplement with chemical fertilizers to improve soil and plant nutrition.

**Table 3. Pearson correlations between properties of Coclé soils (0-20 cm)**

| Variable (1) | Variable (2) | Pearson | p-Value |
|---|---|---|---|
| % Clay | % Porosity | -0.54 | 0.03 |
| Organic Matter | Bulk Density | -0.65 | 0.007 |
| pH | % Clay | -0.75 | 0.001 |
| Ca | pH | 0.89 | 0.001 |
| Mg | Ca | 0.83 | 0.001 |
| Al | pH | 0.57 | 0.022 |
| Al | P | -0.73 | 0.001 |
| Fe | Bulk Density | -0.67 | 0.005 |
| Fe | pH | -0.71 | 0.002 |
| % Al Sat | pH | -0.80 | 0.001 |
| % Al Sat | Ca | -0.78 | 0.001 |
| % Bases Sat | pH | 0.79 | 0.001 |
| % Bases Sat Sat | Al | -0.93 | 0.001 |

**Table 4. Pearson correlations between properties of Veraguas soils (0-20 cm)**

| **Variable (1)** | **Variable (2)** | **Pearson** | **p-Value** |
|---|---|---|---|
| pH | % Porosity | -0.58 | 0.01 |
| Ca | % Porosity | -0.56 | 0.02 |
| Ca | pH | 0.80 | 0.001 |
| Mg | pH | 0.70 | 0.001 |
| Al | pH | -0.58 | 0.01 |
| % Al Saturation | pH | -0.71 | 0.001 |
| % Al Saturation | Mg | -0.66 | 0.001 |
| CEC | Organic Matter | 0.62 | 0.01 |
| % Bases Saturation | pH | 0.71 | 0.001 |
| % Bases Saturation | Ca | 0.75 | 0.001 |
| % Bases Saturation | Al | -0.93 | 0.001 |
| Fe | pH | -0.67 | 0.001 |
| Fe | Ca | -0.64 | 0.001 |
| Fe | % Al Saturation | 0.76 | 0.001 |
| Fe | % Bases Saturation | -0.76 | 0.001 |

Figure 2 shows the result of the principal component analysis for the Coclé soils that are very influenced by the pH and Ca content (El Palmar-Olá),percentage of clay and SOC (Llano Grande and Las Minas) and by the percentage of base saturation (El Palmar). It is also observed how the organic matter content influences the porosity of the soil.El Palmar and Jagüito are soils highly influenced by Mg content and bulk density.

In Figure 3, for soils from Veraguas,a great influence of the aluminum saturation percentage and the iron content is observed in places such as Alto Piedra and El Alto, the content of organic matter and SOC affect much more in Piura. However, in the soils of the Santa Fe district there is a lesser influence of clay content. These results coincide with those obtained by Silva-Parra et al (7) for soils in coffee plantations in Mexico.

In this area, the soil of Las Trancas, Tute Arriba, La Perico y Narices, appears to be very dependent on pH.The Ca and Mg content greatly affects the soils of Montañuela, Alto Espavé and Pantano Abajo.

Cupper, phosphorus, potassium, manganese and zinc content, and the % sand, present less direct influence on soils, similar to those obtained by Castro-Tanzi et al. (12 ).

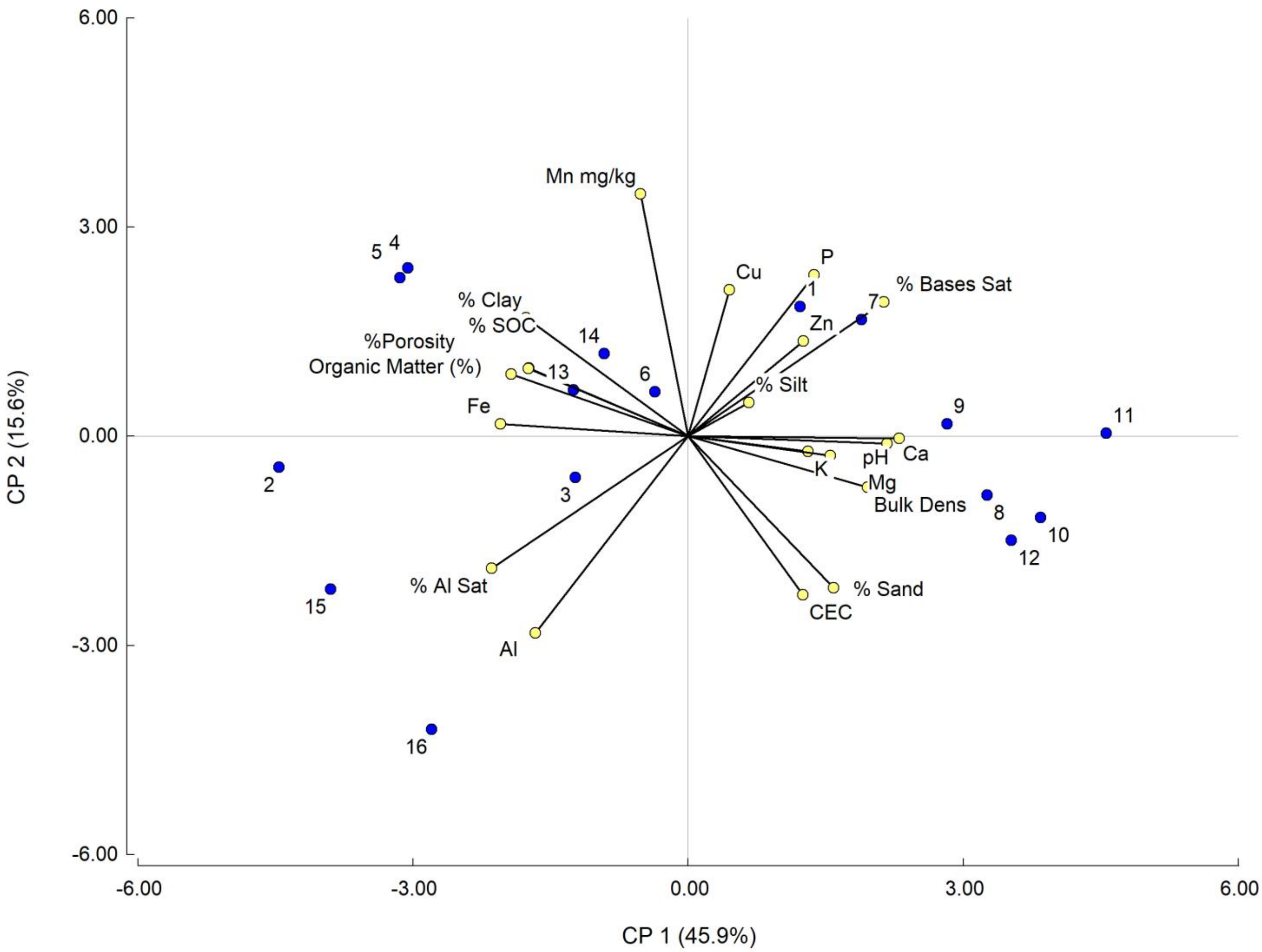


**Fig 2. Analysis of principal components of Coclé soils planted with coffee.**

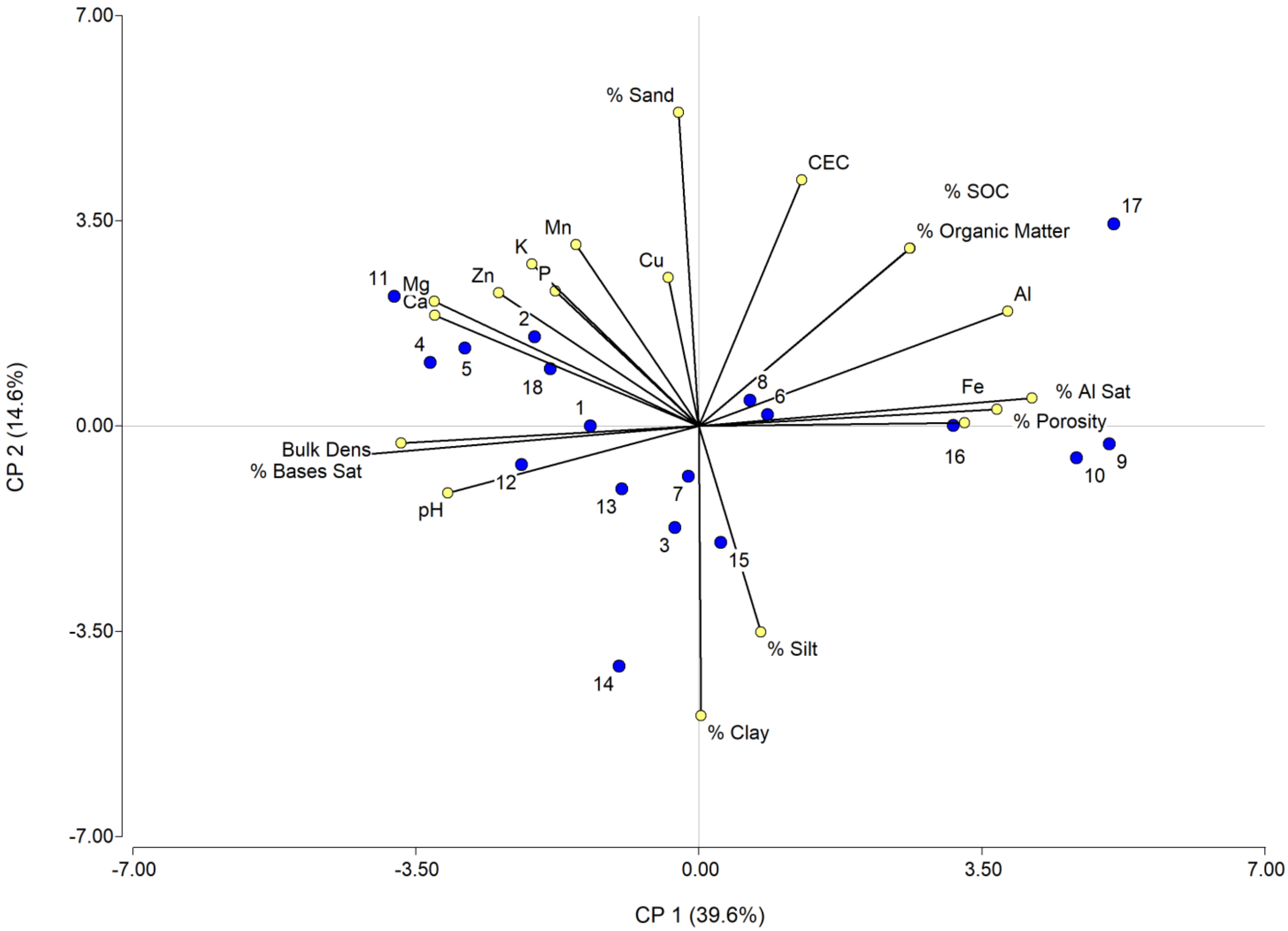


**Fig 3.Analysis of principal components of Veraguas soils planted with coffee.**

Maps of properties were prepared, such as pH (Figure 4), Organic Matter (Figure 5) and aluminum levels (Figure 6) for Coclé soils and pH (Figure 7), organic matter (Figure 8) and aluminum levels (figure 9) for Veraguas soils. These maps reflect the results presented in the principal components analysis.

Considering the analysis results of the soil samples, the climate, and the height of the site, regionalized fertilization cards were prepared for the sampled areas in the two provinces (Table 5). These recommendations include doses of organic fertilizer, bioles, phosphate rock, application of low doses of chemical fertilizer, agricultural lime for soils with high % Al saturation and use of urea in low doses, applied at the beginning and end of the rainy season in Panama (April-May and October-November respectively).

T**able 5. Example of regionalized fertilization card for soils with N low, P low, K low, Ca medium, Mg high and S low.**

| **Formula** | **Quantity** | **Time of Application** |
|---|---|---|
| 10 – 30 - 10 | 100 kg/ha | May (start of rainy season) |
| Organic compost | 225 g/tree | june |
| 10-30-10 | 50 kg/ha | august |
| Organic compost | 225 g/tree | october |
| Urea (40%) + S (6%) | 100 kg/ha | november |

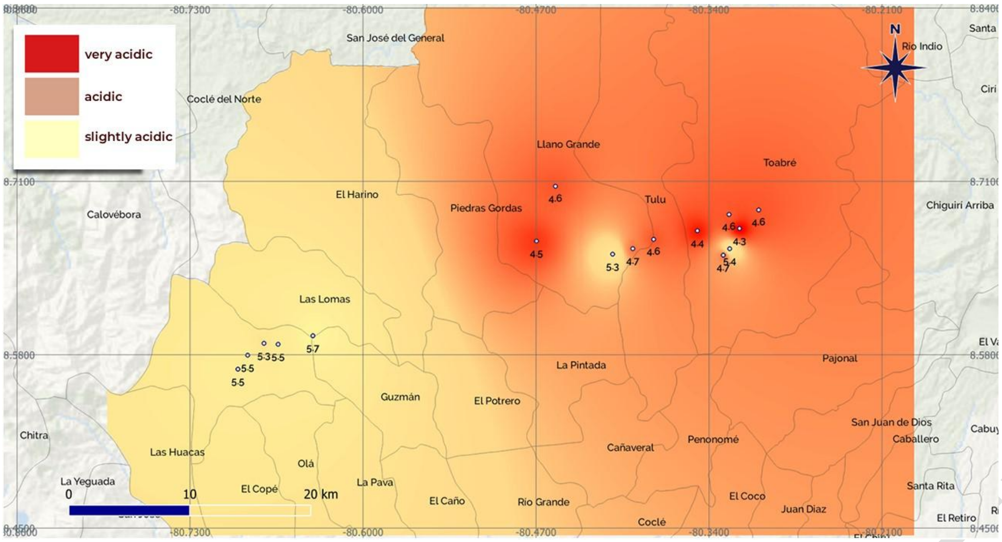


Fig 4. pH levels in soils of Coclé province

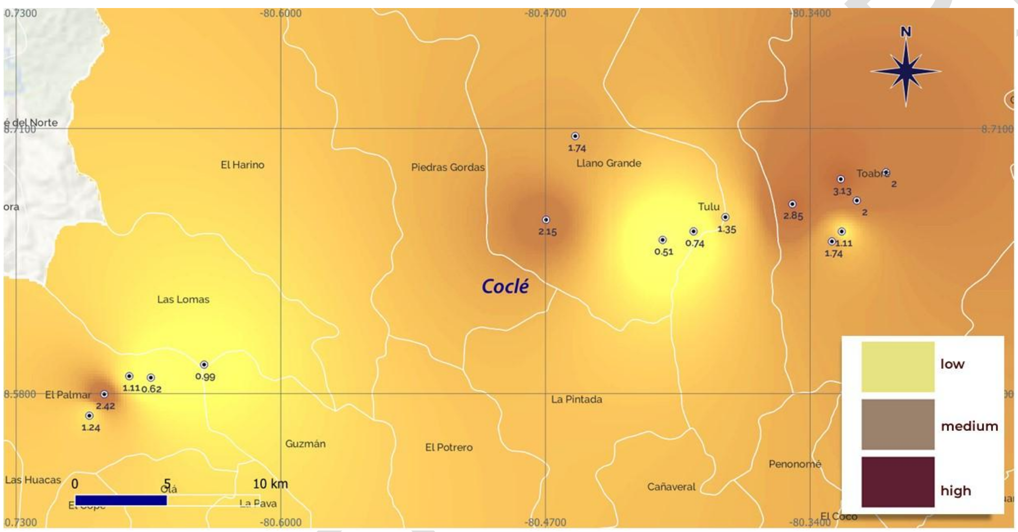


Fig 5. Organic matter levels in soils of Coclé province

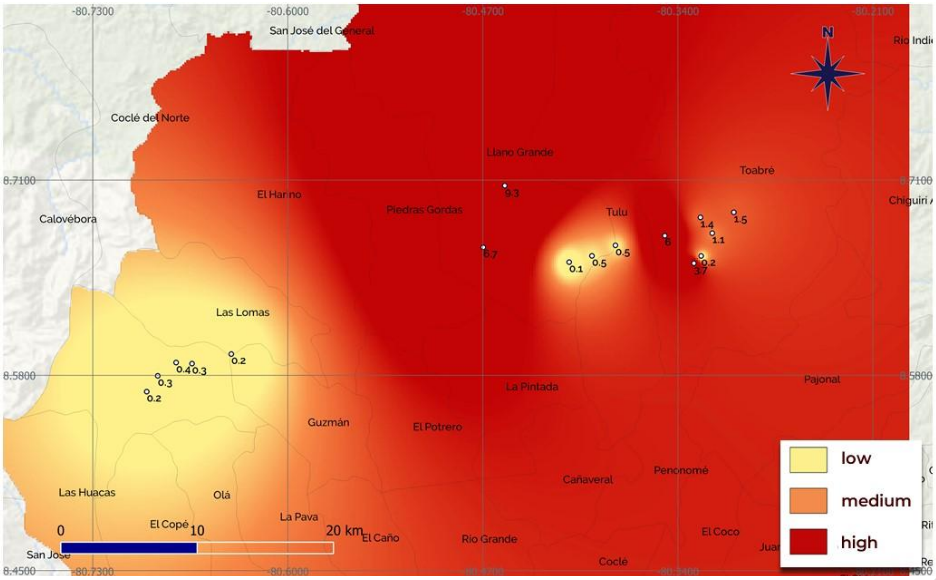


Fig 6. Aluminum levels in soils of Coclé province.

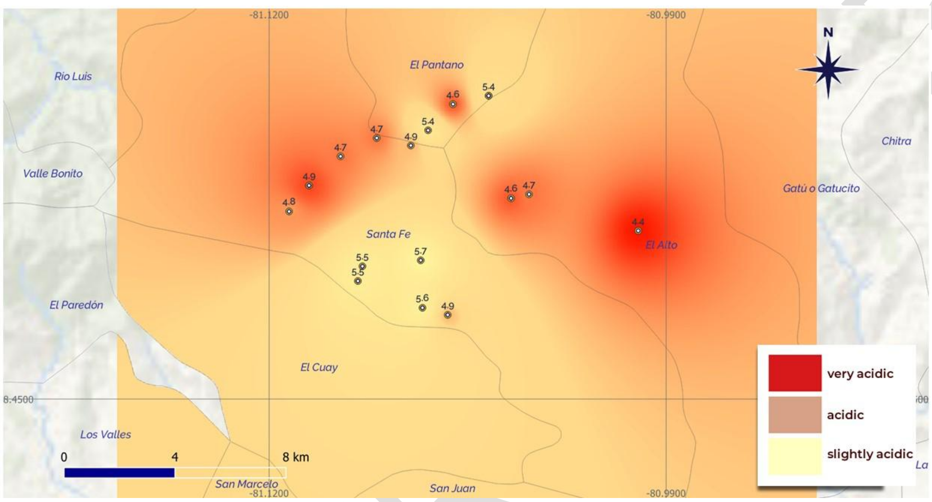


Fig. 7. pH levels in soils of Veraguas province

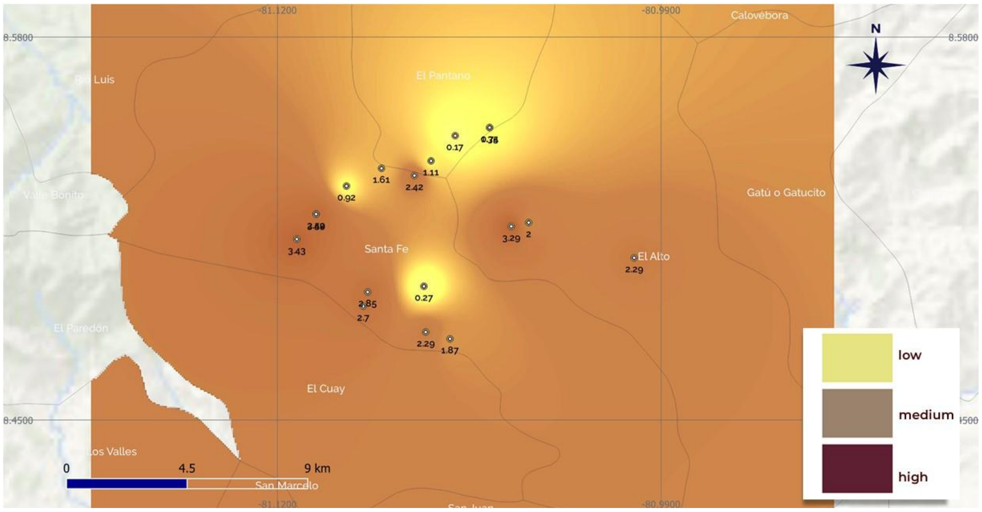


Fig. 8. Organic matter levels in soils of Veraguas province

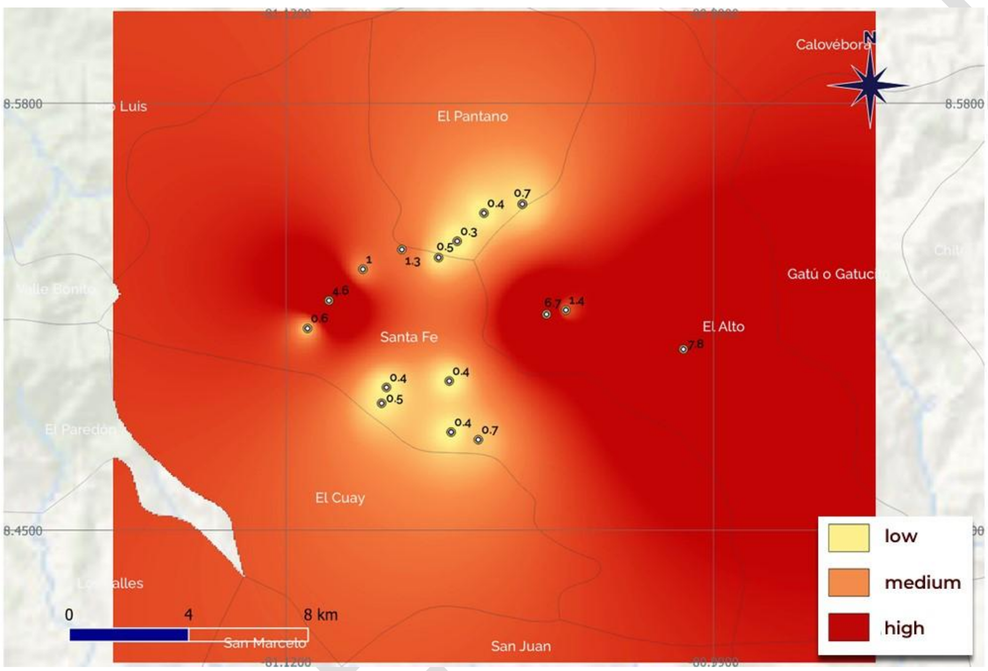


**Figure 9. Aluminum levels in soils of Veraguas province.**

## 4. CONCLUSIONS

The soils studied in the coffee producing areas of the provinces of Coclé and Veraguas have generally shown very acidic pH, low content of organic matter, high percentage of aluminum saturation, some areas with high calcium and magnesium content, problems of compaction and consequently low porosity, making the circulation of water and air difficult for the plantations. Fertilization recommendation cards have been prepared for these two provinces and they take into account this entire situation and physical problems found in the soils. Much emphasis is also placed on organic fertilization of plantations as a complement to traditional fertilization, seeking more balanced nutrition.

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