International Journal of Plant & Soil Science

33(13): 17-22, 2021; Article no.IJPSS.69017
ISSN: 2320-7035

Nutrients Status in Arabica Coffee (*Coffea Arabica* L) Soils of Non-Traditional Area (NTA)

S. A. Nadaf[1*] and A. R. Bora[1]

[1]Regional Coffee Research Station, Narsipatnam, Andhra Pradesh, India.

Authors' contributions

This work was carried out in collaboration between both authors. Author SAN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author ARB managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i1330490
Editor(s):
(1) Dr. Hon H. Ho, State University of New York, USA.
Reviewers:
(1) Kiran D. A., Siddaganga Institute of Technology, India.
(2) Nazanin Khakipour, Islamic Azad University, Iran.
(3) Kadri Karim, Regional Institute of Research in Oasis Agriculture, Tunisia.
Complete Peer review History: http://www.sdiarticle4.com/review-history/69017

Original Research Article

Received 18 March 2021
Accepted 28 May 2021
Published 10 June 2021

ABSTRACT

Coffee growing areas in Andhra Pradesh and Orissa (non-traditional area - NTA) are characterized by undulating topography with terraced slopes having narrow valleys with scattered coffee farms across the elevation of the Eastern Ghats of Vishakhapatnam (Andhra Pradesh) and Koraput (Orissa) districts. Under this situation plant available nutrients will become non-available and the nutrients are stored in several pools as inorganic and organic forms in soil exchange complex are very much essential for coffee plants for its growth and development. Hence, a study was conducted to know the soil nutrient status of coffee growing region of NTA. A total of 693 surface soil samples were collected at depth of 22cm randomly from each coffee growing mandals of NTA and assessed the nutrient status (soil pH, OC, available P and K) at Regional Coffee Research Station, Narsipatnam. Results of the soil test results indicated that most of the Arabica coffee soils of NTA are acidic in reaction (72 %) and soil pH > 6.0 in these soils was 28 % in the tested soils. Plant available phosphorous (P) in the soil is low with 33 % soils and 46 % of the soils are medium in range. However, only 21 % of the soils tested are high in available phosphorous content in these soils. The majority of the soils of this region are high in available potassium about 54 % and 31 % of the soils are medium in range but only 15 % of the soils are low in available K status. Coffee

**Corresponding author: E-mail: drsanadaf@gmail.com;*

soils of NTA are rich in organic carbon status and almost 47 %. 33 % of the tested soils are medium in range but 19 % of soils were low in organic carbon status. Soils are slightly acidic in reaction and were rich in organic carbon and available potassium status.

Keywords: NTA; coffee; soil fertility; Andhra Pradesh; Orissa.

1. INTRODUCTION

Coffee growing area in Andhra Pradesh and Orissa (non-traditional area- NTA) under two tire shade trees [1], with high rainfall across the elevation 900 to 1100 m above MSL [2] are characterized by undulating topography with terraced slopes having narrow valleys with scattered coffee farms are cultivated by the local trebles under natural habitat of Eastern Ghats of Vishakhapatnam (Andhra Pradesh -AP) and Koraput (Orissa) districts. The coffee grown in higher elevation under extreme high and low annual temperature along with high rainfall may affect the available nutrients status in soils and these essential plant nutrients will become non available [3]. Under this situation nutrients present in soil are stored in several pools as organic and inorganic forms in soil exchange complex and are very much essential for coffee plants for their growth and development. The available nutrients status in coffee soils plays a very important role in the sustainable yield of the treble coffee growers. Nutrient status in the soil is one of the indicators for soil health and good soil health provides good coffee yield. Hence, knowing the soil nutrient status of NTA region is most important. Therefore, a study was carried out to know the soil pH, organic carbon, plant available phosphorus and potassium status in coffee plantation soils of NTA during 2019 and 2020.

2. MATERIALS AND METHODS

Coffee plantations of Andhra Pradesh and Odisha were established in the major coffee-growing areas adjusting to the forest along the Eastern Ghats in South India (Fig. 1). Randomly six hundred seventy-three soil samples in coffee plantations of Andhra Pradesh and twenty soil samples from Odisha were collected in the major *Arabica* coffee-growing areas along the Eastern Ghats in South India. The coffee area includes Chinthapalli, G.K Veedi, Kooyuru, Hukumpeta, G. Madugula, Paderu, Peddabyallu, Muchinaputtu, Arakuvalley and Anathagiri mandals of Vishakhapatnam district (Andhra Pradesh) and Koraput of Odisha state. Vishakhapatnam district lies in the north-eastern hills of the Eastern Ghats and Regional Coffee Research Station (RCRS), RV. Nagar belonging to the Vishakapatnam district, receives an average annual rainfall of 2,000 mm, mainly from the south west monsoon during June to September (Fig. 2). Similarly, the Technology Evaluation Center (TEC), Koraput (Coffee Board of India) belongsbelongs to Koraput district of Odisha which receives an average annual rainfall of 1800-1900 mm (Fig. 2) during the monsoon season. Soils developed under the temperature regime is 'isohyperthermic,' and most of the soils moisture regime is 'ustic' and a very small portion belongs to xeric in the study area. These two districts experience higher rainfall and hot per-humid, hot moist sub-humid and hot humid tropical climates, respectively.

A total of 693 surface soil samples were collected (Table 1) at depth of 22 cm randomly from each coffee growing mandals of the major coffee-growing villages. All the collected soil samples were first air-dried in shade/ then powdered gently with a wooden mallet and sieved through 2 mm sieve then stored in clean polyethylene containers for further analysis. Soil Testing Laboratory (STL), RCRS, Narsipatnam is having a facility to analyze for soil pH, OC, available P and available K and these parameters were analyzed with following standard procedures. The soil pH was measured in 1:2.5 soil water suspension using pH meter [4]. Organic carbon was estimated by Walkley-Black wet oxidation method [4], available P by Brays extraction [4]. Available potassium was determined by extracting the soil with neutral normal ammonium acetate and the contents of K in solution and was estimated by flame photometer [4] at STL, RCRS, Narsipatnam.

All soil samples were first air-dried in shade,/ then powdered gently with a wooden mallet and sieved through 2 mm sieve then stored in clean polyethylene containers for further analysis. The samples were analyzed for pH, EC, OC, CaCO3, available P, zinc, iron, copper manganese and boron. The soil pH and EC (dS m-1) was measured in 1:2.5 soil water suspension using pH meter and EC using conductivity bridge [4]. Organic carbon was estimated by Weakly and

Black wet oxidation method [4]. Available phosphorus was extracted with Olsen's reagent and the amount of P in the extract was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wavelength of 660 nm [4]. All soil samples were first air-dried in shade, then powdered gently with a wooden mallet and sieved through 2 mm sieve then stored in clean polyethylene containers for further analysis. The samples were analyzed for pH, EC, OC, CaCO 3, available P, zinc, iron, copper manganese and boron. The soil pH and EC (dS m -1) was measured in 1:2.5 soil water suspension using pH meter and EC using conductivity bridge [4]. Organic carbon was estimated by weakly and Black wet oxidation method [4]. Available phosphorus was extracted with Olsen's reagent and the amount of P in the extract was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wavelength of 660 nm [4].

Table 1. Number of random soil samples collected from different mandals of Andhra Pradesh and Odisha

Mandals	No. of random Soil samples collected
Chinthapalli – (Andhra Pradesh)	89
G.K Veedi - Andhra Pradesh	67
Kooyuru - Andhra Pradesh	61
Hukumpeta - Andhra Pradesh	72
G. Madugula - Andhra Pradesh	74
Paderu - Andhra Pradesh	64
Peddabyallu - Andhra Pradesh	52
Muchinaputtu - Andhra Pradesh	46
Arakuvalley - Andhra Pradesh	84
Anathagiri - Andhra Pradesh	64
Koraput – (Odissa)	20
Total	**693**

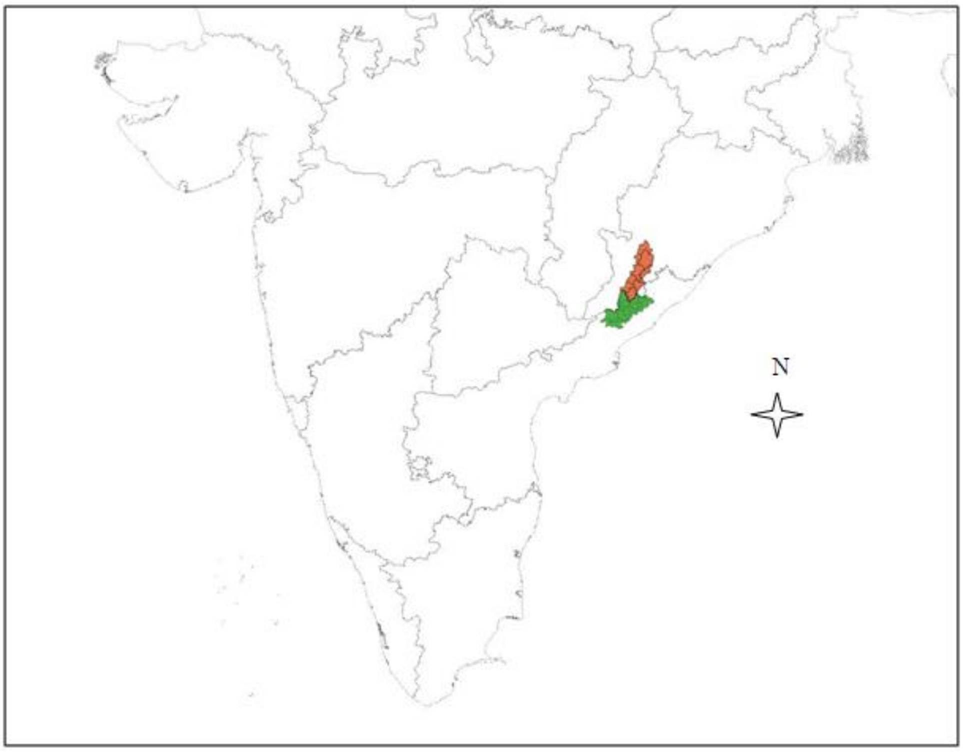

Fig. 1. Coffee plantations of Vishakhapatnam district (Andhra Pradesh) and Koraput district (Odisha) along the Eastern ghats in South India

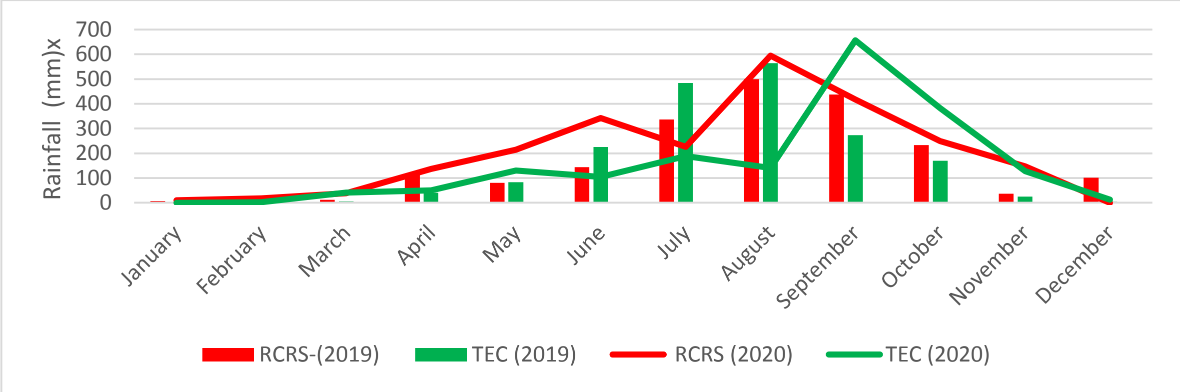

Fig. 2. The climatic condition of RCRS, RV, Nagar (Andhra Pradesh) and TEC, Koraput (Odisha) for the year 2019 and 2020

3. RESULTS AND DISCUSSION

Soil nutrients status coffee growing region of NTA are presented in Table 2 (sufficiency/optimum range categorization) [5]. The study indicated that a total of 72 % of the tested soils belongs to coffee soils of NTA are slightly acidic in reaction for coffee (Table 2). The soil pH of more than 6.0 in the tested soils are only 28 percent of samples (Fig. 3). Further, the detailed investigation indicated that 50 percent of the tested soils for pH are in range of 5.6 to 6.0 (Table 2). However, the critical soil pH for coffee plantations in south India is 5.8 to 5.9 [6] and soil pH of these regions is ideal for coffee plantations. The ideal soil pH for coffee plantation of the studied region may be due to the coffee being grown as natural by the local tribal community without any external input of high analysis fertilizer (acid farming fertilizers) and also these soils are rich source organic matter. The higher organic carbon status (Fig. 3) of the soil acts as buffer agent for the coffee soils. Similar results reported by Subrahmanyam [7] and Subrahmanyam and Gopal [8] in coffee growing of Andhra Pradesh are acidic in reaction and high in organic carbon status in hilly tracks of NTA [9].

A total of 47 % of the tested soils belongs to NTA are high in organic carbon (Fig. 3). Further, it was observed that 33 % and 19 % of the soils are medium and low in organic carbon status respectively (Table 2). However, the higher organic carbon content in coffee soils of NTA is might be due to shade trees. The Indian coffee plantation is known for its shade grown coffee in the world and the majority of the soils of this region are organic rich soils. Coffee plants and also shade trees contribute a huge quantity of organic inputs by leaf letters and which leads to improving the organic carbon status in coffee soils. Anil Kumar [10] has reported soil organic carbon enrichment under coffee plantations, indicating the indirect effect of soil organic carbon status on the sustainability of the ecosystem. Similar results reported by Chandrappa [11] that, shade trees in coffee plantation contributes a total of 09-13 t/ha/year to the soils. In addition, it improves the plant available N, P and K through leaf litter fall was 172 to 292 kg N, 21 to 34 kg P and 74 to 162 kg K /ha/year.

The coffee soil of this region are low in available phosphorous (P) about 33 % and 46 % of the soils are in the medium in range (Table 2). But only 21 % of the soils are high in available phosphorous content in the soils (Table 2). Further, a detailed investigation has shown that a total of 79 % of available P status in the soils are low to medium in range (Fig. 3). The low and mediumrange of available P in these soils may be due to the presence of exchangeable aluminum and iron oxides and these chemical complex in soil fix the plant available P and will not make available for the plants. Similar results of Shivaprasad et al., [12] and Nair et al., [13] were reported in coffee soils of Karnataka and Subrahmanyam [7] and Subrahmanyam and Gopal [8] Andhra Pradesh.

Available potassium status in soils of NTA is revealed that 54 % of the tested coffee soils are higher in available potassium. However, 31 % and 15 % of the soils are medium and low in the status of available potassium respectively (Table 2). In addition, a total of 85 % of the soils are high to medium available potassium status (Fig. 3). Similar results were reported by

Subrahmanyam [7] and Subrahmanyam and Gopal [8] in coffee soils of Andhra Pradesh and Nair et al., [13] observed in coffee soils of Karnataka. However, shade trees in coffee plantation contribute a substantial amount of leaf litter every year which, not only contributes to the humus content of the soil but also helps in recycling the available nutrients from the deeper layers and improves the plant available K through leaf litterfall about 74 to 162 kg K /ha/year [11].

Table 2. Categorization of soil pH, OC, and available phosphorus and potassium nutrient status in coffee soils of NTA

Soil parameters	No. of samples	Acidic (< 6.0)		Neutral (>6.0)
Soil pH	693	(<5.5) 153 * (22%) 72 %	(5.6 - 6.0) 346 * (50 %)	(> 6.0) 194* (28 %) 28 %
Organic Carbon (%)	693	Low < 1.0 (%) 131* (19%)	Medium 1.0-3.0 (%) 236* (34%)	High >3.0 (%) 326* (47%)
Soil available phosphorus	693	Low < 09 (kgha^{-1}) 229* (33%)	Medium 10-22 (kgha^{-1}) 318* (46%)	High >22 (kg ha^{-1}) 146* (21%)
Soil available potassium	693	Low <125 (kgha^{-1}) 104* (15%)	Medium 125 - 250 (kgha^{-1}) 215* (31%)	High >250 (kgha^{-1}) 374* (54 %)

** Number of samples [5]*

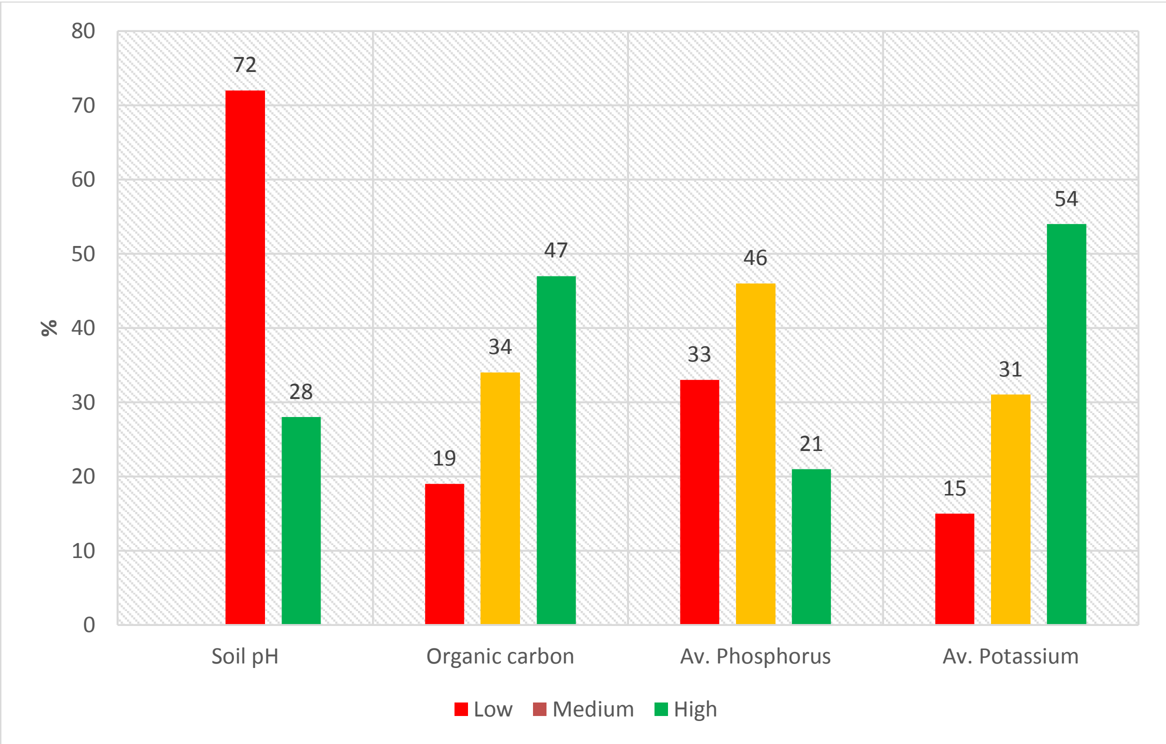

Fig. 3. Graphical representation of the frequency of soil pH, organic carbon, available phosphorus and potassium classes in soils of NTA

4. CONCLUSSION

Arabica coffee soils of NTA are slightly acidic in reaction and need to be corrected by using appropriate liming materials wherever the soil pH is low based on the soil test. Plant available phosphorous status in the soil is low to medium. Available potassium and organic carbon content of these soils are high in range. Hence, application of bio fertilizers (phosphorus solubilizing bacteria viz., *Pseudomonas striata*, *Asperigillus awamori*, *Candida sps*. Or *Bacillus sp*) after enriched with compost is beneficial for coffee soils for nutrients mineralization and sustainable natural coffee production in NTA.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Reddy AGS, Raju KVVSN, Naidu KC. Coffee shade in Andhra. *Solanum Verbascifoliu* Linn. As mixed shade plant. Indian Coffee. 1982;XLVI(12):337-341.
2. Anonymous. Araku Valley Arabica, Geographical Indications Journal No. 2018;110(3):36.
3. Van der Vossen HAM. A Critical analysis of the agronomic and economic sustainability of organic coffee production. Experimental Agriculture. 2005;41:449–473.
4. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi. 1973;485.
5. Anonymous. Annual Report of Coffee Board Research Department. 2020;2019-20:14.
6. Raju T. Calibration of soil test values for coffee. Journal of Coffee Research. 1988;18(1):28-35.
7. Subrahmanyam DVS. Fertility status in Andhra Pradesh: Proceeding of the second workshop on coffee. CCRI, Chikmagalur District of Karnataka. Journal of Coffee Research. 1985;15:18.
8. Subrahmanyam SDV, Gopal NH. Fertility status of coffee soils of A- A preliminary survey. Indian Coffee LI. 1987(2):8-15.
9. Nadaf SA, Atiqur Raheman Bora, Sunil Babu. Soil Health management for coffee estate of Non–traditional area. Indian coffee, (NO.9-September). 2019;LLXXXIII:4-7.
10. Anil Kumar KS. Characterization, classification and suitability evaluation of coffee-growing soils of Karnataka, Ph. D. Thesis. University of Agricultural Sciences. GKVK, Bangalore. Karnataka, India; 2002.
11. Chandrappa K. Nutrient recycling and carbon sequestration in selected coffee growing soil. Ph.D Thesis submitted to University of Agricultural Sciences, Bengaluru Karnataka, India; 2005.
12. Shiva Prasad P, Nagaraja JS, Nadaf SA, Souza MVD'. Buildup of soil phosphorus in coffee plantations of Karnataka over three decades. Journal of Plantation Crops. 2017;45(1):66-71.
13. Nair KM, Anil Kumar KS, Maria Violet D'Souza, Raghuramulu Y, Rajendra Hegde, Singh SK. Fertility of Coffee Growing soils of South India Technical bulletin, NBSS and LUP, Bengaluru; 2017.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/69017