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A STUDY ON THE AVAILABILITY OF MICRO AND MACRO NUTRIENTS IN RED AND BLACK AGRICULTURAL SOILS OF EKLASKHAMPETA, TELANGANA, INDIA

NEMANI GANGOTHRI* AND ANIMA SUNIL DADHICH

Department of Chemistry, Institute of Science, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India

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ABSTRACT

A study was undertaken to assess the significance and micronutrient status of Eklaskhampeta, Telangana. A total of 20 soil samples, i.e., ten from black soils and ten from red soils, were collected by grid method (325×325 interval) on a depth of 0-15 cm and analyzed for pH, electrical conductivity (EC), organic carbon (OC), phosphorus (P), potassium (K), sulfur (S) and micronutrients (Mn, Zn, Fe, and Cu). Soils remained neutral to slightly alkaline and non-saline. OC was medium to high, and among the nutrients, available N was invariably deficient, and potassium, phosphorus is in a scale of moderate to high were observed. Micronutrient availability is on a scale of medium to high, except manganese were observed in these soils. The generated nutrient status information can serve as a useful tool for farmers and policymakers in adopting site-specific nutrient management practices.

KEY WORDS : Micronutrients, Macronutrients, Organic carbon, Soil fertility and semiarid regions.

INTRODUCTION

The soil's physicochemical and biotic properties are improved with the help of organic carbon present in the soils; thus, it is considered an essential parameter. The addition of NPK (Nitrogen-phosphorous-potassium) to the soil will increase the soil's productivity, and it is the most common practice since the green revolution started. There is a necessity for ingenious technologies along these lines for sustainable agriculture and soil improvement (Bindraban *et al.,* 2015). In addition to macronutrients, the least concentrations of 500mg per kg plant dry matter like Cu (Copper), Fe (iron), Mn (Manganese), and Zn (Zinc) is considered for plant growth and nourishment. Micronutrients help in the metabolism of organic molecules like nucleic acids, lipids, etc. of plant enzymes (Barker and Pilbeam, 2015). The micronutrients like Copper, Iron Manganese, and Zinc per kg agricultural soil were reported to be on a scale of 0.002-0.01 g (Lindsay, 1979), 2-550g (Dolliver *et al.,* 2008), 0.4-4g (Dolliver *et al.*, 2008), and 0.01-0.3g (Barber, 1995) respectively. The parameters like pH, organic matter, geographical location, and microbial interactions will influence micronutrients in the soil (Pandey *et al.,* 2016). Crop productivity and sustainability of Indian agricultural lands are restricted due to the deficit of the micronutrients in the soil (Bell and Dell, 2008).

The deficiency of these nutrients is not confined to a particular location, and it is a global phenomenon in the current scenario (Monreal *et al.,* 2016; Varghese *et al.,* 2016). Nevertheless, the universal fact associated with the deficit of micronutrients in the agricultural ecosystems is the low uptake capacity of crops (Baligar *et al.*, 2001). In the Indian agrarian system using NPK fertilization for getting higher yields of rice, wheat, and cotton cultivation over decades led to the removal of micronutrients from the soil by plants to such an extent that availability of micronutrients like zinc has become so limited that it is indirectly hampering the nutrition for humans (Monreal *et al*., 2016). Telangana is a state where most farms are in semiarid regions and practices rainfed agricultural systems. Red and Black soils are most abundant in this state with moderate rainfall. The black soils in these regions are due to the presence of high titaniferous magnetites in these areas. Due to magnetite substances, soils can hold the moisture content at a higher level and help in the plants' growth. Cotton crops are commonly cultivated in these black soils as soils are retentive to moisture as well as these plants require lesser quantities of water for their development. Red soils are due to more iron content in it, and the colors of these soils may vary from dark reddish to brown based on the retentiveness of moisture in it during the seasons. The red soils are generally acidic coarse because they are derived from granite gneissic surface horizons (Rajeshwar and Mani, 2013). Gupta *et al.,* 2003, reported the textural classes of red soils bases on the parent material (granite-gneissic). The variation in these soils mainly depends on the topographic and climatic conditions. The consistency of these soils in Telangana regions are varied from loose, slightly challenging to hard, friable to firm and non-sticky and non-plastic to somewhat sticky and slightly plastic in dry, moist, and wet conditions, respectively. The present study attempts to identify and compare the availability of micro and macronutrients in the red and black soils of Eklaskhampeta, Telangana.

MATERIALS AND METHODS

Study area

Eklashkhampeta is an agro-based village with standard features of associate red and black soils and mostly sandy soils with less clay. This area a part of the Deccan plateau semi with Latitude and longitude coordinates 17.390654, 77.834694. Agriculture practice here is small holdings where farmers mostly have 1 or 2 hectares of land for cultivation. Paddy, cotton, and maize are the key Kharif (monsoon) crops in the village and vegetables like tomato and chilies in Rabi season. Paddy rice is grown under irrigated conditions, mostly using groundwater pumped from bore-wells. Cotton and maize are mostly grown as rainfed crops. Irrigation in this area is through underground water.

Sample collection

The soil samples were collected from 0 to 15 cm depth by a 20x20 m grid keeping in view the variation in soil texture and color; from 20 hectares of land, ten samples of red soil (codes R1 to R10) and ten samples of black soils (codes B1 to B10) are collected for the study (Figure 1).

Analysis of Samples

The collected samples are oven-dried to remove the moisture and sieved with the help of a 2mm sieve. The samples were tested usingthe standard procedures provided by the Methods Manual-Soil Testing in India (Table 1).

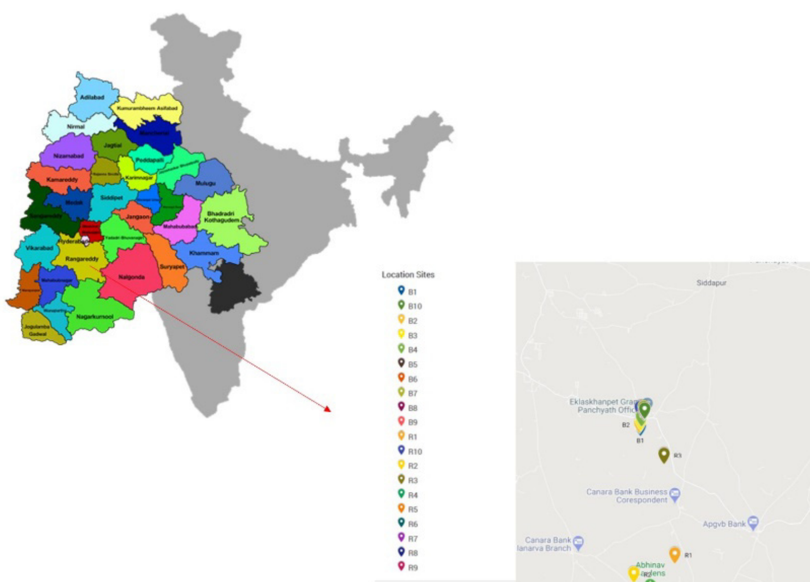

Fig. 1. Location Map and Sampling Sites

Table 1. Methods and instruments utilized.

S.No	Method	Instrument Used
1.	pH	pH meter
2.	Conductivity	Electrical conductivity meter
3.	Particle Size	Bouyoucos hydrometer method
4.	Organic carbon	Walkley and Black Method
5.	Cations and Anions	Ion chromatography
6.	Micronutrients	X-ray fluorescence spectrometer

Descriptive statistics, i.e., average, median, maximum, minimum, standard deviation, coefficient of variation, were analyzed using SPSS.

RESULTS AND DISCUSSION

pH and electrical conductivity (EC)

The pH of the soils strongly influences the availability of nutrients in the soils. The pH of the study area scales from 5.4 (moderately acidic) to 7.4 (neutral) in black soils, whereas in red soils, it is 6.9 to 7.4 with an averageof 6.66, 6.96, and median 7.4 respectively (Table 2) (Figure 2). Out of all samples, 30 % of the samples are acidic, and the remaining 70% of the samples are neutral. The variation of the pH among these soils is due to the geographical locations, fertilizers utilized, and parent material nature. Also, soil pH increase could be due to precipitation of calcium carbonate in soils and transpiration (Siegert, 2013). The EC of less than one dsm^{-1} indicates the soils in the study area are not saline. Desavathu *et al.*, 2018 and Naitam *et al.*, 2018 reported similar results in red and black soils.

Organic Carbon (OC)

The organic carbon in the black soils isscaled from 0.25 to 2.54 %, with an average value of 1.5 %, and all the soil samples had low organic carbon. Similarly, red soils are varied from 0.25 to 2.67% (Table 2). Vimal *et al.* 2017 revealed that low organic carbon in the soils is accredited to OM's slow decomposition (organic matter)(Figure 2). The temperature of these regions of Telangana is very high and decreases the topsoils' decay rate. The organic content of the soilscan be enhanced by applying organic manure, as suggested by Sharma *et al.,* (2009). Experiments conducted by Sharma *et al.,* (2003) revealed that organic content in the soils is not altered for more than 30 years; And concluded that organic carbon in the soils could be maintained by applying suitable agricultural management practices.

Moisture content

The black soils' moisture content on the scale of 0.03 to 2.15 %, with anaverage 1.2 %, whereas in red soils scale from 1.45 to 2.61 %, with an average 1.8% (Table 2). In general, healthy soils have moisture

Table 2. Physico-chemical analysis of the study area.

Red Soil	pH	EC(dsm^{-1})	% OC	Moisture %	Black soil	pH	EC	% OC	Moisture %
R1	7.1	0.27	1.5	1.45	B1	7.3	0.3	1.52	2.01
R2	7.1	0.38	1.78	1.63	B2	6.5	0.44	0.25	1.33
R3	7.2	0.36	2.03	1.77	B3	6.5	0.19	1.4	1.23
R4	6.9	0.36	0.5	2.15	B4	7.4	0.49	0.47	2.15
R5	7.4	0.52	0.47	2.03	B5	7.2	0.95	2.16	2.08
R6	7.4	0.39	0.25	1.29	B6	7.4	0.72	2.54	1.81
R7	5.5	0.33	1.91	2.61	B7	7.4	0.77	1.78	1.67
R8	7	0.36	1.78	2.03	B8	5.9	0.29	2.54	0.31
R9	6.9	0.24	2.16	1.64	B9	5.6	0.15	1.78	0.17
R10	7.1	0.32	2.67	1.77	B10	5.4	0.17	1.4	0.03
Average	6.96	0.353	1.50	1.834	Average	6.66	0.447	1.584	1.279
Max	7.4	0.52	2.67	2.612	Max	7.4	0.95	2.54	2.150
Min	5.5	0.24	0.25	1.287	Min	5.4	0.15	0.25	0.0324
Scale	1.9	0.28	2.42	1.325	Scale	2	0.8	2.29	2.117
SD	0.54	0.0755	0.81	0.382	SD	0.79	0.28	0.769	0.823

content on a scale of 10 – 45 %. The results were showing that agricultural drought may occur shortly in these locations. The deficiency of moisture in the soils will stress the plants and also reduce biomass production. Thus, there is a need to conserve the soils by proper agrarian practices. Therefore, assessing moisture content in the semiarid regions is crucial to understand the variability of soils and to support actions to mitigate the effects of water scarcity in the soils (Malavath and Mani, 2018).

Macronutrients Availability

The availability of nitrogen was deficient (< 280 kg/ha) in all the samples in the study area. Due to leaching, runoff, chemical, and microbial fixation of nitrogen availability, nitrogen availability to soils is a deficit. Results indicate that all the soil samples are consist of a low amount of available phosphorus (Table 3)(Figure 3). Comparable outcomes were reported by Desavathu *et al*., 2018 and said that low phosphorus present in the soils is due to internal phosphorus status fixation with iron and aluminum oxides and formation of calcium phosphates in these soils (Meena *et al*., 2005). Potassium availability was high > 336 kg/ha in only three sample sites, i.e., R5, R8, and R9 in the red soils, whereas B9 in black soils. The remaining soil samples have less availability of potassium. The potassium in the black soils is on a scale of 141 to 354 kg/ha, with an average of 218.7 kg/ha, whereas red soils have 150 to 480 kg/ha with anaverage of 281.5 kg/ha (Table 3). The high availability of potassium in these samples may be due to the potassium-rich materials and clay minerals. Besides, the alkalinity of these soils will help in the

Table 3. Macronutrient (kg/ha) availability of the study area.

Red Soil	Available P	Available K	Black soil	Available P	Available K
R1	247	150	B1	79	210
R2	228	163	B2	540	213
R3	277	192	B3	261	141
R4	305	321	B4	32	243
R5	179	423	B5	125	180
R6	263	264	B6	304	261
R7	231	231	B7	91	186
R8	127	366	B8	193	213
R9	117	420	B9	91	354
R10	196	285	B10	47	186
Average	217	281.5	Average	176.3	218.7
Max	305	423	Max	540	354
Min	117	150	Min	32	141
Scale	188	273	Scale	508	213
SD	62.05	100.06	SD	156.42	58.21

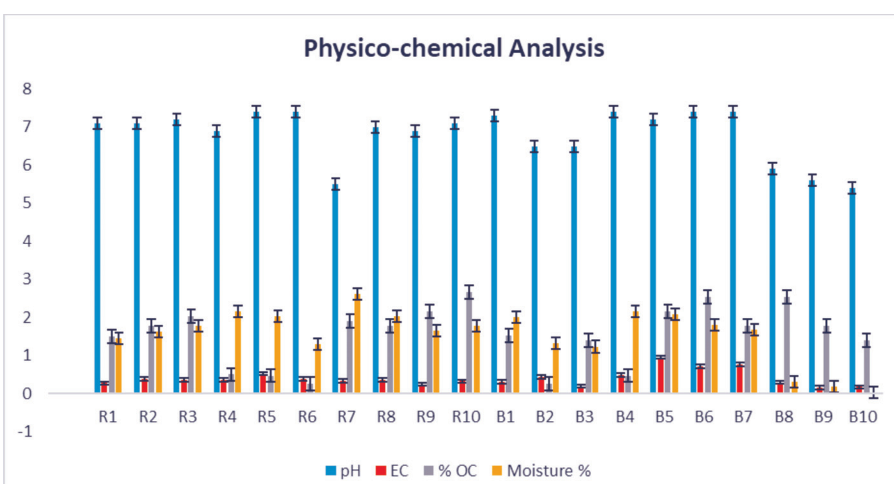

Fig. 2. Physico-chemical analysis.

dissolution of potassium, and this factor also helps in determining the availability of potassium (Talele *et al.*, 1993).

Micronutrients Availability

Copper

Copper (Cu) is an essential element for plant enzymatic activity and acts as an electron transporter. The plants in the soluble form take copper, and lack of availability may increase the redox potential in soils, which is attributed to a decrease in microbial activity. The Copper availability in the black soils is on the scale of 0.52 to 2.67 ppm with an average of 1.633, whereas in red soils, 0.78 to 2.18 ppm with a way of 1.34 ppm (Table 4)(Figure 4). Copper in these soils is significantly (>0.6), and no other practices are required to enhance the capacities (Yruela, 2009).

Manganese

Manganese (Mn) is a significant element required for the plant physiological process, especially for photosynthesis. The availability of manganese in soils depends on the alkalinity and geographical locations of the soils. The deficiency of this micronutrient may lead to a decrease in the resistance against pathogens and heat stress. The manganese in the black soils is on as cale of 1.38 to 4.04 ppm, with an average of 2.6 ppm, whereas in red soils, they are on a scale of 0.01 to 20.36 ppm with a way of 9.3 ppm. All the samples of the black soils showed latent deficiency (<7 ppm), whereas, in red soils, they are in between deficient to highly adequate (Lindsay and Norvell, 1978).

Zinc

Zinc (Zn) is highly essential for the enzymes

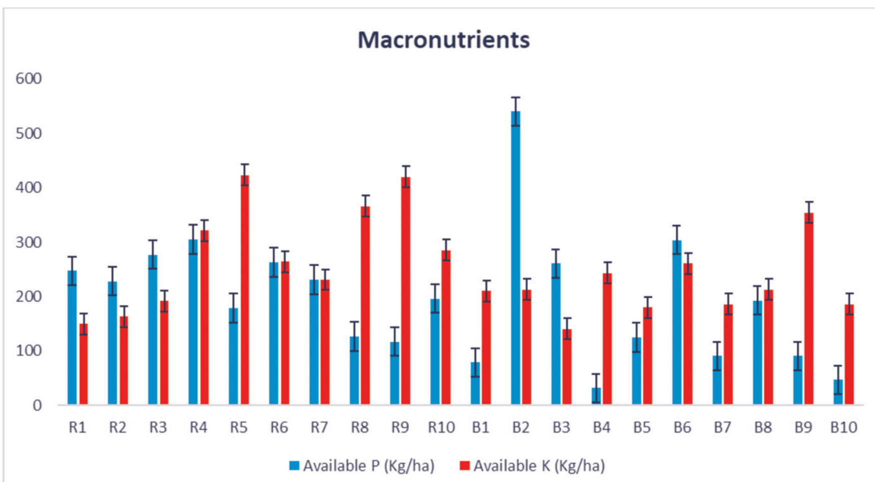

Fig. 3. Macronutrients in red and black soils.

Table 5. Micronutrient availability in ppm

Red soils	Cu	Mn	Zn	Fe	Black soils	Cu	Mn	Zn	Fe
R1	1.48	2.07	1.15	19.79	B1	1.15	2.52	0.59	10.53
R2	1.4	0.01	0.87	18.2	B2	1.11	4.04	0.48	13.38
R3	1.35	1.97	1.88	11.1	B3	2.67	2.78	0.96	27.26
R4	2.18	20.36	1.04	26.65	B4	1.98	6.27	0.77	6.79
R5	2	13.61	0.87	10.47	B5	2.6	1.49	0.93	20.92
R6	1.27	11.17	0.99	11.75	B6	2.43	1.73	1.02	17.7
R7	1.1	8.78	0.93	16.19	B7	2.51	1.38	0.86	1.13
R8	1.07	13.07	0.96	17.21	B8	0.72	2.51	1.18	20.05
R9	0.78	10.23	0.97	14.41	B9	0.64	2.21	0.89	20.17
R10	0.81	12.47	0.72	13.23	B10	0.52	1.5	1	11.95
Average	1.34	9.37	1.03	15.9	Average	1.63	2.64	0.86	14.98
Max	2.18	20.36	1.88	26.65	Max	2.67	6.27	1.18	27.26
Min	0.78	0.01	0.72	10.47	Min	0.52	1.38	0.48	1.13
Scale	1.4	20.35	1.16	16.18	Scale	2.15	4.89	0.7	26.13
SD	0.458	6.342	0.316	4.908	SD	0.88	1.505	0.207	7.72

responsible for the plant's metabolic activities. Growth of the plant mainly depends on this micronutrient, deficiency of zinc may retard the growth of plant tissues and also inhibits the synthesis of the enzymes. Thus, this leads to a decrease in the yield of the crop. The zinc in black soils is on the scale of 0.48 to 1.01 ppm with anaverage of 0.86 ppm, whereas in red soils, it is between 0.72 to 1.88 ppm with anaverage of 1 ppm. The majority of the samples are above the critical limits, and no deficiency was observed except B2 in black this may be attributed to the slightly acidic nature of the soil (Hafeez *et al.*, 2013).

Iron

Iron (Fe) is essential for the synthesis of chlorophyll, and without it, plants can not perform the photosynthetic activity. The chlorosis of plant leaves is due to the deficiency of iron content in the soils. The presence of iron is also essential for enzyme synthesis. The iron in the black soils is in the scale of 1.13 ppm to 27.26 ppm with anaverage of 14.9 ppm, whereas in red soils, 11.1ppm to 26.65 ppm with anaverage of 15.9 ppm. All the samples are adequate in iron content except the B7 sample, and this is due to alkaline pH (Paul and Lade, 2014).

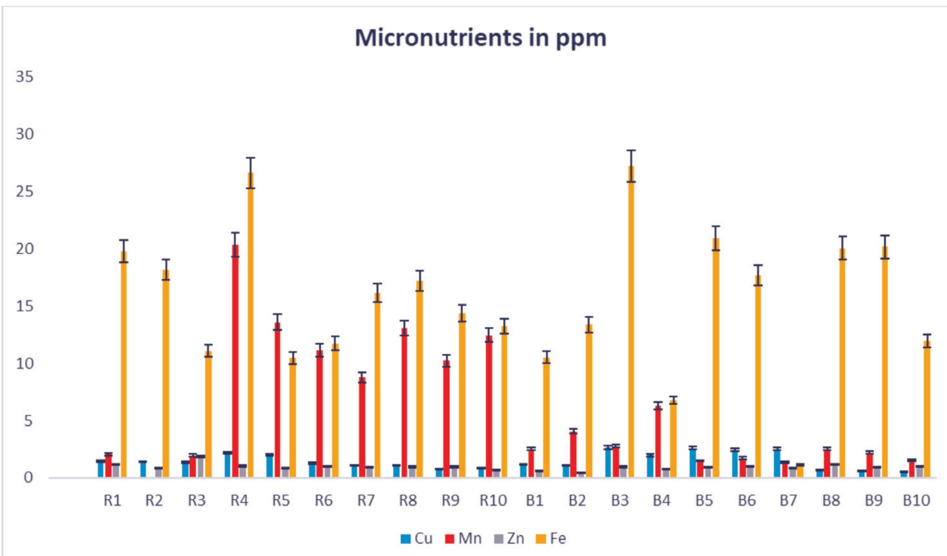

Fig. 4. Micronutrients in red and black soils.

Table 6. A and B tables represent the co-relationships of red and black soils

A) Correlation ship inred soils

	Soc	pH	Cu	Mn	Zn	Fe
Soc	1	-0.31	-0.761	-0.41	0.063	-0.152
pH		1	0.240	-0.023	0.137	-0.242
Cu			1	0.277	0.123	0.404
Mn				1	-0.416	0.244
Zn					1	-0.146
Fe						1

B) Correlation ship in black soils

	Soc	pH	Cu	Mn	Zn	Fe
Soc	1	-0.029	0.126	-0.739	0.754	0.355
pH		1	0.751	0.197	-0.33	-0.384
Cu			1	-0.033	0.071	0.036
Mn				1	-0.445	-0.201
Zn					1	0.414
Fe						1

Statistics and Variability of Soil Parameters

The statistical analysis of the soil parameters was presented in the table (Table 6 A & B). The available phosphorous, potassium, copper, manganese, zinc, iron, sodium, potassium calcium, magnesium are moderately variable. In contrast, pH and organic content were the least variables presented in the tables from Tables 1-5. A correlation coefficient values lie between "1 and +1, and a correlation coefficient around zero averages no relationship (Manoj Kumar Karnena and Vara Saritha, 2019; Saritha *et al.*, 2019). Positive values indicate a positive relationship, while negative values of r indicate an inverse relationship. The values of correlation coefficient (r) are given in Table 6 (A & B). In black soils, a robust positive relationship exhibited between pH and copper, and the remaining parameters showed relatively least relationships. Whereas, in red soils, strong negative relationships are exhibited by the soil organic carbon with copper. All the parameters showed negative and least relationships.

CONCLUSION

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The study revealed that the soils of Eklaskhampeta are neutral to slight alkaline in nature within the limit of soluble salt content. The organic carbon scales from low to medium. The phosphorus content in these areas is moderate, and potassium content is high in leading sampling sites. The micronutrient availability, i.e., manganese, is adequate and further requires enhancement using organic manures, changing the cropping pattern and crop rotations. The results of this study area have the potential to identify the site-specific availability of micro and macronutrients, which can be useful for enhancing the socio-economic status of the rural farmers by improving the usage of fertilizers and minimizing the cost of cultivation without affecting the environment.

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