International Journal of Plant & Soil Science

34(20): 270-276, 2022; Article no.IJPSS.88154
ISSN: 2320-7035

Correlation of Physico-chemical Parameters of Soil and Soil Nutrient Index Status of Kollam District, Kerala, India

Vishnu Gopan G. M. [a], Amreen Hasan [a*], Tarence Thomas [a], Arun Alfred David [a] and Iska Srinath Reddy [a]

[a] Department of Soil Science and Agricultural Chemistry, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2031151

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/88154

Original Research Article

Received 06 April 2022
Accepted 11 June 2022
Published 16 June 2022

ABSTRACT

The present investigation was carried out at Sam Higginbottom University of Agriculture Technology and Sciences in the department of Soil Science and Agricultural Chemistry lab, India In this study, a total of 27 soil samples were collected from nine different villages on 27 November 2021 in the Kollam district of Kerala, and from each village 3 soil samples were collected and analyzed for their Physico-chemical parameters by using standard laboratory techniques. According to Nutrient Index values, the villages were found to be high in Organic Carbon (2.59), Phosphorus (2.88), Calcium (3), and Magnesium (2.55). The low category was found in Nitrogen (1). The medium category was found in Potassium (1.88). According to the critical limits of soil nutrients the results observed, 100% soil samples were in low range of Nitrogen (N) (64.5 – 181.32 kg ha-1), 92.5% soil samples were in high range of Phosphorous (P) (9.40 – 56 kg ha-1), 89% soil samples were in low to medium range of Potassium (K) (100 – 403 kg ha-1), 100% of soil samples were in the high range of Calcium (Ca) (3.2 – 18 Meq/100g), 78% of soil samples were in high range of Magnesium (Mg) (0 – 7.60), 100% of soil samples were in the low range of Sulphur (S) (0.96 – 7.2). The results showed that improvement has to be one for improving soil fertility and quality by practicing improved cropping patterns, decomposition of organic wastes, mulching, and tillage practices.

**Corresponding author: E-mail: amreen.hasan@shiats.edu.in;*

Keywords: Nutrient index; physico-chemical properties; soil fertility; Kollam District.

1. INTRODUCTION

Soil is the soul of infinite life, medium for growth of land plants, and is generally refer to the loose material composed of weathered rock and other material including partly decayed organic matter. It is reservoir of nutrients and play pivotal role in supporting the growth of crops and other vegetation maintaining the earth's environment clean. It also acts as source and sinks for atmosphere gases. To improve productivity and economic condition of soil, we need to utilize it scientifically. Also, soil provides fodder, food, and fuel for living organisms. Healthy soil provides pure water and air for living organisms including plants, humans and animals. It is a reservoir of nutrients and balancing the gaseous exchanges by maintaining earth surface clean [1-3].

To increase the productivity of soil, we need to manage the soil fertility. Nitrogen, Phosphorus and Potassium as primary nutrients are the main source of sustainable agriculture production that has have the ability to control yield of crops. Calcium, Magnesium and Sulphur as secondary nutrients increases root absorption and their translocation in plants. Both the primary and secondary nutrients are called as Macro nutrients and Micro nutrients includes Cu, Mn, Fe, B, Zn…etc. In the absence of any essential nutrients render the crop production and yields. Nitrogen plays role to optimize yield by ensuring energy and helps to regulate water-nutrient uptake. Phosphorous is showing a primary role in storing and transferring of energy for growth and reproductive process and promotes root growth, hasten maturity, winter hardiness and stimulate tillering [4,5]. Potassium keeping a major role in increasing disease resistance, drought tolerance and upright growth in plants. Calcium is contributing the fertility of soil by clay flocculation led to maximum aeration in soil. Magnesium act as the core central part of chlorophyll molecule and stunted growth occurs in plants when it is deficient. Sulphur is required to make proteins for plants and its deficiency led to poor yield in crops [6,7].

Kerala is divided into three geographical regions; Highlands, Midlands, Lowlands. It is the state or narrow strip of land lies between the Western ghats mountain range on the eastern side and the Arabian sea on the western which located on the south west edge of India. The state ensuring calm and a greenery experience at all the times. Kerala is called as 'Gods own country is because of greenish forests, beaches, golden-yellowed paddy fields, various typed of foods and mainly coconut fields, cultural artforms like kathakali, chakyarkoothu *etc*. Kerala includes 44 rivers, backwaters and mangroves. bays and lots of beaches. The monsoons in June - September and October – November and Summer in February – May are the seasons experienced here. And ensuring a normal temperature at a range of 30°C. Kerala is an agricultural state which includes cash crops, like rubber, tea, coffee, pepper, cardamom, coconut, Arecanut, nutmeg, cloves cinnamon, ginger etc. The common soils visible in Kerala were coastal alluvium, laterite soils, hills soils, forest soils, black cotton soils, red soils, mixed alluvium, acid saline. The literacy rate, life expectancy is high in Kerala and child mortality rate is the lowest.

2. MATERIALS AND METHODS

Kollam or Quilon is the southern district of Kerala, located 70 km north of the state's capital Thiruvananthapuram. The headquarters of the district administration is centered at Kollam city (District capital). The district is divided into 6 taluks, 11 development blocks, 68 panchayaths and 104 villages. Paravoor, Punalur and Karunagapally are Municipal towns and Kollam has the status of a City Corporation. The district is drained by three west flowing rivers, *viz*., Achenkovil, Kallada and Ithikara, originating in the eastern hilly region. These rivers together with their tributaries exhibit dendritic pattern of drainage. The district covers an area of 73.03 km ^{2} at an elevation of 3m. The average weather at a range of 30 °C at 73% humidity.

The latitude and longitude of Kollam district showing 8.8932° N and 76.76141° E. The protocols were followed to analyses the parameter are shown in Table 1.

2.1 Soil Nutrient Index

In order to compare the levels of soil fertility of one area with those of another it was necessary to obtain a single value for each nutrient. The Organic carbon, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur Index calculated values are given in the Table 2.

The nutrient index is calculated by using the formula as given by Muhr et al. [15].

Table 1. Protocols were followed to analyses for physico-chemical parameters

S. No.	Particulars	Protocols
1.	Bulk density (Mg m^{-3})	Muthuval et al.,[8]
2.	Particles density (Mg m^{-3})	Muthuval et al., [8]
3.	Texture (Sand, Silt Clay %)	Bouyoucous,[9]
4.	Water holding capacity (%)	Muthuval et al., [8]
5.	Soil Ph	Jackson, [10]
6.	Electrical Conductivity (dS m^{-1})	Wilcox, [11]
7.	Organic Carbon (Kg ha^{-1})	Walkley and Black, 1947
8.	Available Nitrogen (Kg ha^{-1})	Subbiah and Asija, [12]
9.	Available Phosphorous (Kg ha^{-1})	Olsen et al., [13]
10.	Available Potassium (Kg ha^{-1})	Toth and Prince, [14]

Nutrient Index (N.I.) = NL × 1 + NM × 2 +NH × 3 /NT

Where,

NL: Indicates number of samples falling in low class of nutrient status
NM: Indicates number of samples falling in medium class of nutrient status
NH: Indicates number of samples falling in high class of nutrient status
NT: Indicates total number of samples analyzed for a given area.

"The nutrient index value of less than 1.5 is rated as low, 1.5 to 2.5 is rated as medium and more than 2.5 is rated as high fertility status as suggested by" Ramamurthy and Bajaj [16].

3. RESULTS AND DISCUSSIONS

The results of the chemical properties, macronutrients of soil samples, from different villages of Kollam district are given in Table 3.

The available Nitrogen content of soil samples range from 64.5 to 181.32 kg ha-1 with a mean value of 115.19, standard deviation of 31.495 and coefficient of variation of 27.34%. Based on the limits suggested by Muhr et al., [15] "out of total soil samples, 100% of the samples were in low range". Similar results were observed with Marimuthu et al., (1969). "Phosphorus content of soil samples were ranged from 9.40 to 56 kg ha-1 with a mean of 50.25, standard deviation of 11.390 and co-efficient of variation of 22.67%. out of total soil samples, 3.27% of the samples were in low phosphorus range, 3.27% of the samples were in medium range and 92.57% were in high range. Similar results were observed with Krishna et al., Potassium content of soil samples ranges from 100 to 403 kg ha^{-1} with a mean value of 206.5". Based on the limits suggested by Muhr et al., [15] out of "total soil samples, 22.2% of the samples were in low potassium range, the reason may be due to absence of elite rich potassium minerals in these soils, 66.67% of the soil samples were in medium range and 11.11% of the soil samples were in low potassium range. Similar results were observed with" Patel et al., (2014).

The exchangeable calcium content of soil samples ranges from 3.2 to 1.8 Meq/100g with a mean value of 7.3, standard deviation of 3.2 and co-efficient of variation of 43.8%. Based on the limits suggested by Ramamoorthy and Bajaj, [16] out of "total soil samples, 100% of the samples were in high range. Exchangeable magnesium content of soil samples ranges from 0 to 7.60

Table 2. Soil nutrient index values of Kollam district, Kerala

S. No	Available Nutrients	Nutrient Index Values (N.I)	Category
1	Organic Carbon	2.59	High
2	Nitrogen	1	Low
3	Phosphorus	2.88	High
4	Potassium	1.88	Medium
5	Calcium	3	High
6	Magnesium	2.55	High
7	Sulphur	1	Low

Table 3. Soil quality parameters of different villages of Kollam district, Kerala

Sample No	Name of the village	pH	EC	OC (%)	N (kg ha-1)	P (kg ha-1)	K (kg ha-1)	Ca (Meq 100-1)	Mg (Meq 100-1)	S (mg kg-1)
S_1	Puthoor	6.1	0.11	0.48	101.41	53	100.8	4.6	1.4	2.4
S_2	Puthoor	6.05	0.11	0.54	113.71	55	201.6	5.6	3.4	1.92
S_3	Puthoor	6.15	0.11	0.41	86.05	52	156.8	3.2	4.8	3.36
S_4	Neduvathoor	5.6	0.1	0.72	150.59	56	224	6.8	3.4	2.8
S_5	Neduvathoor	6.44	0.1	0.35	73.76	9.4	168	6.2	2.8	2.4
S_6	Neduvathoor	6.45	0.1	0.57	119.85	13.44	302.4	5.8	4.2	1.92
S_7	Chakkuvarakkal	6.44	0.1	0.53	110.63	51	358.4	6.2	5.6	2.88
S_8	Chakkuvarakkal	6.45	0.07	0.67	141.37	50	156.8	5.8	3.4	7.2
S_9	Chakkuvarakkal	6.1	0.07	0.31	64.54	56	190.4	6	5	2.4
S_{10}	Pattazhy	6.5	0.08	0.72	150.59	54	168	4.2	4	2.4
S_{11}	Pattazhy	6.5	0.1	0.63	132.15	53	201.6	6	0.2	1.92
S_{12}	Pattazhy	6.6	0.08	0.67	141.37	55	156.8	4.8	3.6	3.36
S_{13}	Thalavoor	6.5	0.13	0.63	132.15	52	224	9	4.6	2.8
S_{14}	Thalavoor	5.76	0.06	0.44	92.2	56	168	4.6	1.8	2.4
S_{15}	Thalavoor	6.6	0.11	0.61	129.07	51	302.4	8.4	4.2	1.92
S_{16}	Vilakudy	6.02	0.17	0.54	113.71	50	358.4	18	7.6	2.88
S_{17}	Vilakudy	6	0.08	0.47	98.34	56	156.8	6.6	2.4	7.2
S_{18}	Vilakudy	5.8	0.14	0.53	110.63	54	201	9.4	3	0.96
S_{19}	Karavaloor	6.45	0.06	0.42	89.12	53	268.8	4.4	2.2	2.88
S_{20}	Karavaloor	6.27	0.1	0.59	122.93	55	179.2	12.4	0	7.2
S_{21}	Karavaloor	5.8	0.1	0.42	89.12	52	100.8	7.8	3.8	2.4
S_{22}	Yeroor	6.45	0.09	0.37	76.83	56	123.2	8	1	2.4
S_{23}	Yeroor	6.31	0.07	0.44	92.2	51	112	10	1	1.92
S_{24}	Yeroor	6.5	0.11	0.32	67.61	50	212.8	12.8	0.4	3.36
S_{25}	Thenmala	6.49	0.11	0.76	159.8	56	100.8	8	0.2	2.8
S_{26}	Thenmala	6.23	0.08	0.8	169.02	54	403.2	4.8	5.8	2.4
S_{27}	Thenmala	6.1	0.1	0.86	181.32	53	280	6.8	1.2	1.92
N. I				**2.59**	**1**	**2.88**	**1.88**	**3**	**2.55**	**1**

Note: N.I = Nutrient Index N=nitrogen, P=phosphorus, K=potassium, EC=electrical conductivity, OC=organic carbon, Ca=calcium, Mg=magnesium, S=Sulphur

Meq/100 g with a mean value of 2.9, standard deviation of 2.2 and co-efficient of variation of 76.0%. Based on the limits suggested by Ramamoorthy and Bajaj [16], out of total soil samples, 22.22% of the samples were in low range whereas 77.78% of the samples were in high range". "Available Sulphur content in soil samples ranges from 0.96 to 7.2 mg kg^{-1} with a mean value of 2.98, 1.611 as a standard deviation and 54.11% as co-efficient of variation. Based on the limits suggested by Awanish et al., (2014). Out of total soil samples, 100% of samples were in low Sulphur content".

3.1 Correlation Matrix between Physicochemical Parameters of Soil from Kollam District, Kerala

The bulk density of the soil in negatively non-significantly correlated with WHC (r= 0.320), EC (r= -0.239), Phosphorus (r= -0.053) and positively significantly correlated with Particle density (r = 0.468) and positively non-significantly correlated with porosity(r=0.695), pH (r=0.149), Organic carbon (r=0.185), Nitrogen (r=0.182), Potassium (r=0.136), Magnesium (r=0.235), Sulphur (r=0.116) and negatively significantly correlated with calcium (r= -0.584). The particle density of the soil negatively non-significantly correlated with Porosity (r= - 0.309), WHC (r= -0.295), pH (r= 0.107), EC (r= -0.005), Phosphorus (r= -0.211), Calcium (r= -0.222), Sulphur (r= - 0.189) and positively non-significantly correlated with Organic carbon (r= 0.254), Nitrogen (r= 0.250), Potassium (r= 0.090), Magnesium (r= 0176). The porosity of the soil in negatively non-significantly correlated with WHC (r= -0.106), EC (r= -0.245), Organic carbon (r= -0.007), Nitrogen (r= - 0.006) and positively non-significantly correlated with pH (r= 0.253),

Table 4. Correlation between physico-chemical properties of soil in different villages of Kollam

parameters	Bd Mg m-3	Pd Mg m-3	Porosity %	WHC %	pH	EC dS m^{-1}	OC %	N Kg ha^{-1}	P Kg ha^{-1}	K Kg ha^{-1}	Ca Meq $100g^{-1}$	Mg Meq $100g^{-1}$	S Mg kg^{-1}
Bd	1												
Pd	*0.468	1											
Porosity	0.695	-0.309	1										
WHC%	-0.320	-0.295	-0.106	1									
pH	0.149	-0.107	0.253	0.277	1								
EC	-0.239	-0.005	-0.245	0.099	0.080	1							
OC	0.185	0.254	-0.007	*0.421	0.275	0.085	1						
N	0.182	0.250	-0.006	*0.424	0.274	0.084	1.000	1					
P	-0.053	-0.211	0.116	0.253	0.240	-0.084	0.192	0.189	1				
K	0.136	0.090	0.073	0.198	0.044	0.244	0.315	0.318	-0.141	1			
Ca	*-0.584	-0.222	*-0.451	0.356	0.166	*0.626	-0.104	-0.107	0.047	0.175	1		
Mg	0.235	0.176	0.115	-0.192	0.094	0.304	0.124	0.127	-0.124	0.594	-0.024	1	
S	0.116	-0.189	0.265	0.231	0.095	-0.223	0.023	0.020	0.144	-0.179	0.112	-0.085	1

Note: - (*) represents significant at 0.05 level

Phosphorus (r = 0.116), Potassium (r= 0.073), Magnesium (r= 0.115), Sulphur (r=0.265) and negatively significantly correlated with Calcium (r= -0.451). The water holding capacity of the soil in positively non-significantly correlated with pH (r= 0.277), EC (r= 0.099), Phosphorus (r= 0.253), Potassium (r= 0.198), Calcium (r = 0.356), Sulphur (r = 0.231) and negatively non-significantly correlated with Magnesium (r = -0.192) and positively significantly correlated with Organic carbon (r = 0.421), Nitrogen (r= 0.424). The pH of the soil in positively non-significantly correlated with EC (r=0.080), Organic carbon (r=0.275), Nitrogen (r=0.274), Phosphorous (r=0.240), Potassium (r=0.044), Calcium (r=0.116), Magnesium (r=0.094) and Sulphur (r=0.095). The electrical conductivity of the soil in negatively non-significantly correlated with Phosphorous (r= -0.084) and Sulphur (r= 0.223), positively significantly correlated with Calcium (r=0.626), positively non-significantly correlated with Organic carbon (r=0.085), Nitrogen (r=0.084), Potassium (r=0.244), Magnesium (r=0.304). The organic carbon of the soil in negatively non-significantly correlated with Calcium (r= -0.104), positively non-significantly correlated with Nitrogen (r=1), Phosphorous (r=0.192), Potassium (r=0.315), Magnesium (r=0.124) and Sulphur (r=0.023). The macronutrients of the soil i.e., nitrogen status of the soil is negatively non-significantly correlated with Calcium (r= -0.107), positively non-significantly correlated with Phosphorous (r=0.189), Potassium (r=0.318), Magnesium (r=0.127) and Sulphur (r=0.020). Phosphorous of the soil is negatively non-significantly correlated with Potassium (r= -0.141) and Magnesium (r= -0.124), positively non-significantly correlated with Calcium (r=0.047) and Sulphur (r=0.144). Potassium of the soil is positively significantly correlated with Magnesium (r= 0.594), positively non-significantly correlated with Calcium (r=0.175) and negatively non-significantly correlated with Sulphur (r=-0.179). The secondary macronutrients i.e., Calcium of the soil is negatively non-significantly correlated with Magnesium (r= -0.024) and positively non-significantly correlated with Sulphur (r= 0.112). Magnesium of the soil is negatively non-significantly correlated with Sulphur (r= -0.085).

4. CONCLUSION

According to the soil test results of villages of Kollam district clearly states that the soil is in moderately acidic to neutral in condition. 100% of soil samples are in permissible limit of EC suitable for most crops. Organic carbon is in medium to high this is because of low and high temperature and less decomposition, 100% of soil samples are low in available nitrogen, Available phosphorus is in high 90% of soil samples, Available potassium is in low to high, secondary nutrients is in low to high range. The major reason for lack of macronutrients is leaching due to higher amount of precipitation in the area and nutrient uptake by plants and inappropriate management practices. It suggests that still improvement can be done by improving cropping pattern, decomposition of organic waste, mulching, tillage practices and proper irrigation by management practices with knowledge and experience gained through studies and lead farmers to achieve quality produce and high yield through soil conservation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chesnin L, Yien CH. Turbidimetric determination of available sulphates. Proceedings of Soil Science Society of America. 1950;14:149-51.
2. Das DK. Introductory Soil Science, 2nd Edition Kalyani Publishers, New Delhi; 2004.
3. Krishna MP, Rinoy Varghese, Mohamed Hatha AA. Depth wise variation of microbial load in the soils of midland region of Kerala: a function of important soil physicochemical characteristics and nutrients. Indian Society for Education and Environment: 2277–5374.
4. Swathi G, Meera AV, Thampatti MKC, John J. Physico chemical and biological properties of post flood soils in the south-central laterites of southern Kerala. International Journal of Chemical Studies: 1829-1835.
5. Lindsay WL, Norvell WA. Development of a EDTA micronutrients soil test for Zn, Fe, Mn, and Cu. Soil Science Society of America Journal. 1978;42(3): 421-428.
6. Black CA. Methods of Soil Analysis Part – II. Chemical and microbiological properties. Agronomy Monograph No. 9. American Society of Agronomy, Inc. Madison, Wisconsin, USA. 1965;8-25.

7. Brady NC, Weil RR. The nature and properties of soils (11th edition). Prentice hall. New York; 1996.
8. Muthuaval P, Udayasooriyan C, Natesan R, Ramaswami PR. Introduction to soil Analysis, Tamil Nadu Agriculture University, Coimbatore-641002; 1992.
9. Bouyocous GJ. The hydrometer as a new method of the mechanical analysis of soil. Soil Science. 1927;23:343-353.
10. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi; 1973.
11. Wilcox LV. Electrical conductivity. American Water Works Association J. 1950;42:775-776.
12. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in the soil, Current Science. 1956;25:259-260.
13. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular No. 939; 1954.
14. Toth SJ, Prince AL. Estimation of Cation exchange capacity and exchangeable Ca, K and Na content of soil by Flame photometer technique. Soil Science an Interdisciplinary Approach to Soil Research 1949;67(6):439-446.
15. Muhr GR, Datta NP, Shankara Subraney N, Dever F, Lecy VK, Donahue RR. Soil Testing in India, USAID Mission to India; 1965.
16. Ramamurthy B, Bajaj JC. Nitrogen, Phosphorus and Potash status of Indian soils. Fertilizer News. 1969;14:25-28.

© 2022 Gopan et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/88154