

Original Research Article

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

ABSTRACT

The present investigation was carried out at Indian Sam Higginbottom University of Agriculture Technology and Sciences in the department of Soil Science and Agricultural Chemistry lab. 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 done for improving soil fertility and quality by practicing improved cropping patterns, decomposition of organic wastes, mulching, and tillage practices.

Key words: *Nutrient Index; Physico-chemical properties; Soil Fertility; Kollam District.*

INTRODUCTION

Soil is the soul of infinite life, medium for growth of land plants, and is generally referred 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.

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 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. 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 [you need to give a references here for all explanation of the elements; where did you find these?:-](#)

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, mangroves, ~~b~~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.

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 5 taluks, 11 development blocks, 73 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 km² at an elevation of 3 m. The average weather at a range of 30 °C at 73% humidity.

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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

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.* (1963).

$$\text{Nutrient Index (N.I.)} = \frac{NL \times 1 + NM \times 2 + NH \times 3}{NT}$$

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 (1969)

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RESULT 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.* (1963), out of total soil samples, 100% of the samples were in low range. Similar results were observed with Marimuthu *et al.* 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.*, 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.*

The exchangeable calcium content of soil samples ranges from 3.2 to 1.8 Meq/100 g 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, 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 Meq/100g 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, 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.

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Correlation Matrix between Physicochemical Parameters of Soil from Kollam district, Kerala

The bulk density of the soil is 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 is 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 ($r=0.176$). The porosity of the soil is 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 ($r=0.253$), 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 is 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 is positively non-significantly correlated with EC ($r=0.080$), Organic carbon ($r=0.275$), Nitrogen ($r=0.274$), Phosphorus ($r=0.240$), Potassium ($r=0.044$), Calcium ($r=0.116$), Magnesium ($r=0.094$) and Sulphur ($r=0.095$). The electrical conductivity of the soil is negatively non-significantly correlated with Phosphorus ($r=-0.084$) 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 is negatively non-significantly correlated with Calcium ($r=-0.104$), positively non-significantly correlated with Nitrogen ($r=1$), Phosphorus ($r=0.192$), 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 ($r = -0.085$).

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 DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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Table 1: Protocols were followed to analyses for Physico-chemical Parameters

| S. No. | Particulars | Protocols |
|--------|--|-------------------------------|
| 1. | Bulk density (Mg m^{-3}) | Muthuval <i>et al.</i> ,1992 |
| 2. | Particles density (Mg m^{-3}) | Muthuval <i>et al.</i> , 1992 |
| 3. | Texture (Sand, Silt Clay %) | Bouyoucous,1927 |
| 4. | Water holding capacity (%) | Muthuval <i>et al.</i> , 1992 |
| 5. | Soil Ph | Jackson,1958 |
| 6. | Electrical Conductivity (dS m^{-1}) | Wilcox, 1950 |
| 7. | Organic Carbon (Kg ha^{-1}) | Walkley and Black,1947 |
| 8. | Available Nitrogen (Kg ha^{-1}) | Subbiah and Asija,1956 |
| 9. | Available Phosphorous (Kg ha^{-1}) | Olsen <i>et al.</i> ,1954 |
| 10. | Available Potassium (Kg ha^{-1}) | Toth and Prince,1949 |

| Sl. 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 2: Soil Nutrient Index values of Kollam district, Kerala

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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 | Karavaloore | 6.45 | 0.06 | 0.42 | 89.12 | 53 | 268.8 | 4.4 | 2.2 | 2.88 |
| S ₂₀ | Karavaloore | 6.27 | 0.1 | 0.59 | 122.93 | 55 | 179.2 | 12.4 | 0 | 7.2 |
| S ₂₁ | Karavaloore | 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

| 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 |
|----------|-------|--------|-------|-------|-------|--------|-------|-------|-------|--------|-------|--------|---|

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

Note: - (*) represents significant at 0.05 level

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