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Evaluation of Soil Physico-chemical Parameters of Peruvannamuzhi Forest (Kozhikode District, Kerala, India)

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Abstract: Peruvannamuzhi forest is a part of Malabar wildlife sanctuary in Kozhikode district, Kerala, India. Soil samples were collected from twenty sampling sites with 200 m distance. The most common parameters such as pH, electrical conductivity, temperature, organic carbon, total nitrogen, calcium, magnesium, iron, phosphorous and potassium were analyzed for each sampling sites. Triplicate samples from each site were estimated and results were statistically analyzed. The observed results were significantly (P<0.05; P<0.01) within the permissible limits of the water samples recommended by the international committees. The physicochemical parameters of the soil controlled the morphological and biochemical parameters of the flora which implies on the metabolic mechanism of fauna which eventually acts as a natural controlling agents.

Keywords: Peruvannamuzhi forest, Physical parameter, Chemical parameter, BOD, COD

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Introduction

Soil lies between the lithosphere and the atmosphere, a sophisticated heterogeneous biological system. It is a necessary silicate mineral that displays bio-productivity (Basic 2013). Different bio-communities vary in nature and distribution, depending on the soil characteristics (Iwara *et al*., 2011). The fertility and chemistry management of Kerala's tropical soils are influenced by the soil factors (Byju and Varghese, 2001; Paudel and Sah, 2003). The lateritic ferruginous and acidic soil represent the South Indian Western Ghats, Kerala.

Research on the nature and characteristics of soil in forest ecosystems are crucial for effective resource management and environmental management (Byju, 2005).When the vegetation changes with respect to environmental calamities, the qualities of the soil alter. According to reports, the rooting and litter-fall features of perennial plants on more or less the same soil material are the main causes of geographical variations in soil qualities (Lin and Han, 2001). The chemical components from a significant amount of soil are absorbed by roots, which is then concentrated in the biomass. The majority of this biomass is subsequently transferred through litterfall into the canopy, where it decomposes and releases its chemical components into the soil (Balagopalan *et al*., 1993; Mvungi *et al*., 2003; Chang 2008).

Trees receive water, nutrients, and anchoring from the soil. Plants play a crucial part in the creation of new soil when leaves and other vegetation die and decompose (Gebre and Gebremedhin, 2019). The structure, distribution, and variety of wild flora as well as the dynamics of carbon, nitrogen, and other nutrients (K, P, Mg, Ca) are all impacted by the topographic aspect, which is a crucial component (Fu *et al*., 2004). The topographic feature impacts biotic and abiotic elements in a direct or indirect manner, which contributes to the spatial variability of plant cover and soil conditions (Li *et al*., 2018; Bhattrai *et al*., 2022).

Many environmental variables, including landscape elements like location, topography, slope gradient and aspect, parent material, climate, and vegetation have a substantial impact on the spatial variation of soil properties (Singh, 2018). Depending on the aspect and slope angle, there are substantial differences in the water availability. When plants take up certain minerals and then release them back into the soil, this has an impact on the nutritional content of the soil (Jie *et al*., 2002). The main objective of this study was to collect the top soil samples from the 20 sampling sites in the Peruvannamuzhi forest (Kerala). Various physicochemical parameters of the soil were analyzed by standard procedures.

Materials and Methods

Study area:

Kozhikode is one of the coastal districts of Kerala, India. It is bounded on the north by Kannur district, on the east by Wayanad district, on the south by Malappuram district and on the west by Lakshadweep Sea. The district is drained by six rivers of which one is of medium nature and all others are minor ones namely Chaliyar, Kuttiyadi, Mahe, Kadalundi, Kallayi and Korapuzha. Peruvannamoozhy or Peruvannamuzhi belongs to Kozhikode district (Kerala, India). It forms part of the newly inaugurated Malabar Wildlife Sanctuary and is rich in flora and fauna. The Average summer and winter temperature are 35°C (95°F) and 18°C (64°F), respectively. The present study was conducted during February to April (2019).

Sample Collection:

20 sampling sites with the distance of 200 m apart was selected for this study. Using a sterilised blade, soil samples from the top 1-2 cm layer were obtained for examination. Soil samples were put in sterile press-seal bags and transferred to the laboratory (Siu *et al*., 2022).

Physico-chemical analysis:

Standard procedures for soil sampling and physico-chemical analysis were used (Jackson 1973). The soil's pH, electrical conductivity, temperature, organic carbon content, phosphorus (P), potassium (K), total nitrogen (TN), magnesium (Mg), iron (Fe) and calcium (Ca) levels were examined. pH and temperature of the soil were analysed at the sampling sites with the help of portable unit Systronics 324 for pH and Systronics Conductivity Bridge 303 for EC. From 1:2 (neutral distilled water) soil pastes of an air dried sample, TSS were determined. A thermometer was used to gauge the soil samples' temperature out there in the field.

Statistical analysis:

Triplicate results from each site were statistically analysed and scatter diagram described the ranges of the estimated parameters of the twenty sampling sites.

Results

Soil samples collected from the twenty different sampling sites from Peruvannamuzhi forest were analyzed for ten physic-chemical parameters. Table 1 and Figures 1 and 2 illustrate the pH, temperature, electrical conductivity, organic carbon, total nitrogen, calcium, magnesium, phosphorous, potassium and iron at various sites.

pH: The pH of the samples ranged between 6.18 and 6.28. pH values were observed as 6.18 for Site 2 and Site 18; 6.19 for Site 7 and Site 19; 6.20 for Site 4, Site 12 and Site 20; 6.21 for Site 16; 6.22 for Site 1 and Site 8; 6.23 for Site 6 and Site 13; 6.24 for Site 14 and Site 17; 6.25 for Site 5 and Site 15; 6.26 for Site 10 and Site 14; 6.27 for Site 9; 6.28 for Site 3.

Temperature: Temperature of the soil ranged between 27.3 and 28.5°C. Minimal temperature was observed at the Sites 2, 5, 8, 13 and 20 as 27.3°C whereas the maximal temperature observed at Site 4 as 28.5°C.

Electrical Conductivity: The electrical conductivity (EC) of the sampling sites ranged from 0.28 to 0.35 µS/cm. The minimum and maximum EC levels were observed at the sites 2, 5, 8, 13, 20 as 0.28 µS/cm and at site 4 as 0.35 µS/cm, respectively.

Organic Carbon: Organic carbon levels of the sampling sites ranged between 1.56 and 1.58 ppm. The minimum and maximum EC levels were observed at the sites 1, 6, 7, 10, 11, 12, 15, 16, 17, 18 as 1.56 ppm) and at sites 2, 5, 8, 13, 20 as 1.58 ppm, respectively.

Total Nitrogen: Total nitrogen (TN) levels of the sampling sites ranged from 1.24 to 1.27 ppm. The minimum and maximum TN levels were observed at the sites 2, 5, 8, 13, 20 as 1.24 ppm and at sites1, 7, 11, 15 as 1.27 ppm, respectively.

Calcium: Calcium of the sampling sites ranged between 0.83 and 0.95 ppm. The minimum and maximum calcium levels were observed at the sites 2, 7, 18, 19 (0.83 ppm) and at sites 3, 9 as 0.95ppm, respectively.

Magnesium: Magnesium levels of the sampling sites ranged from 0.61 to 0.67 ppm. The minimum and maximum Mg levels were observed at the sites 2, 5, 8, 13, 20 as 0.61 ppm and at sites 1, 6, 7, 10, 11, 12, 16, 17, 18 as 0.67 ppm, respectively.

Phosphorous: Phosphorous (P) levels of the sampling sites ranged between 9.04 and 9.12 ppm. The minimum and maximum phosphorous levels were observed at the site 13 as 9.04 ppm and at sites 1, 12 as 9.12 ppm, respectively.

Potassium: Potassium of the sampling sites ranged from 109.4 to 113.5 ppm. The minimum and maximum potassium levels were observed at the site 6 as 109.4 ppm and sites 3, 9 as 0.95 ppm, respectively.

Iron: Iron levels of the sampling sites ranged between 0.51 and 0.57 ppm. The minimum and maximum iron levels were observed at the sites 2, 5, 8, 13, 20 as 0.51 ppm and at sites1, 6, 7, 10, 11, 12, 16, 17, 18 as 0.67 ppm, respectively.

Discussion

Figures 1 and 2 illustrates the scatter plot diagrammatic description about the ten physico-chemical parameters of soil collected from the Peruvannamuzhi forest. The pH of the tropical soil (4.6) is somewhat acidic, which is consistent with earlier results from other parts of the region (Soil Survey Staff, 2007). In general, it has been discovered that these soils are more suited than alkaline soils to sustain a variety of plant life (Diaz-Maroto and Vila-Lameiro, 2007).

The current study is helpful to evaluate the ecology of soil fertility of tropical laterite soils in general because soil pH affects how fertile tropical soils are managed, and knowledge of its variations in soils enables understanding of the rate at which laterisation occurs in a specific land use system (Byju and Varghese, 2001).

The development of soil is mostly influenced by climate (Byju, 2005). There is information on the fertility characteristics of various types of soils (Maro *et al*., 1993; Bhojavid and Timmer, 1998; Schroth *et al*., 2002; Ashagrie *et al*., 2004; Kara and Bolat, 2008), however, on the moist tropical soils of south India, there is no information accessible.

Table 1: Physico-chemical parameters of the soil samples collected from 20 sampling sites from Peruvannamuzhi forest

Stations	**pH**	**Temp. (°C)**	**EC (µS/cm)**	**OC (ppm)**	**TN (ppm)**	**Ca (ppm)**	**Mg (ppm)**	**P (ppm)**	**K (ppm)**	**Iron (ppm)**
Site 1	6.22	28.1	0.31	1.56	1.27	0.91	0.67	9.12	112.4	0.57
Site 2	6.18	27.3	0.28	1.58	1.24	0.83	0.61	9.05	110.1	0.51
Site 3	6.28	28.4	0.34	1.57	1.25	0.95	0.63	9.10	111.2	0.53
Site 4	6.20	28.5	0.35	1.59	1.23	0.84	0.60	9.09	112.7	0.50
Site 5	6.25	27.3	0.28	1.58	1.24	0.94	0.61	9.08	110.8	0.51
Site 6	6.23	28.1	0.31	1.56	1.26	0.94	0.67	9.10	109.4	0.57
Site 7	6.19	28.1	0.31	1.56	1.27	0.83	0.67	9.11	110.3	0.57
Site 8	6.22	27.3	0.28	1.58	1.24	0.91	0.61	9.09	113.5	0.51
Site 9	6.27	28.4	0.34	1.57	1.25	0.95	0.63	9.07	112.9	0.53
Site 10	6.26	28.1	0.31	1.56	1.26	0.94	0.67	9.08	112.4	0.57
Site 11	6.24	28.1	0.31	1.56	1.27	0.94	0.67	9.11	113.7	0.57
Site 12	6.20	28.1	0.31	1.56	1.26	0.84	0.67	9.12	110.9	0.57
Site 13	6.23	27.3	0.28	1.58	1.24	0.94	0.61	9.04	110.6	0.51
Site 14	6.26	28.4	0.34	1.57	1.25	0.94	0.60	9.05	112.4	0.50
Site 15	6.25	28.1	0.31	1.56	1.27	0.94	0.65	9.06	111.8	0.55
Site 16	6.21	28.1	0.31	1.56	1.26	0.84	0.67	9.08	113.2	0.57
Site 17	6.24	27.8	0.32	1.56	1.26	0.94	0.67	9.07	112.7	0.57
Site 18	6.18	28.1	0.31	1.56	1.26	0.83	0.67	9.09	112.6	0.57
Site 19	6.19	28.4	0.34	1.57	1.25	0.83	0.63	9.10	112.3	0.53
Site 20	6.20	27.3	0.28	1.58	1.24	0.84	0.61	9.11	110.8	0.51
Min-Max	6.18-6.28	27.3-28.5	0.28-0.35	1.56-1.58	1.24-1.27	0.83-0.95	0.61-0.67	9.04-9.12	109.4-113.7	0.51-0.57

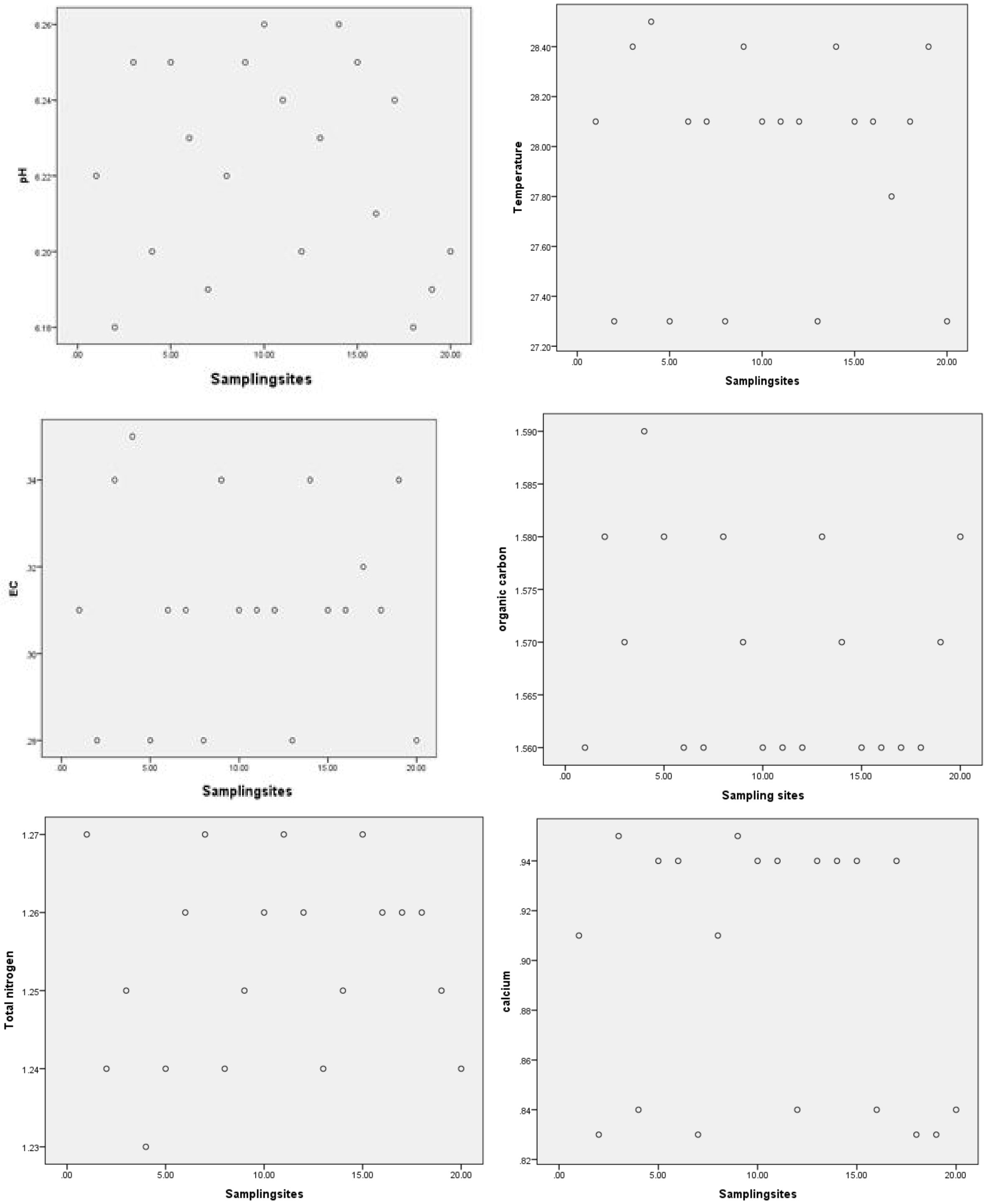

Fig 1: Physico-chemical parameters (pH, Temperature, EC, Organic carbon, Total nitrogen and Calcium) of the soil samples collected from 20 sampling sites from Peruvannamuzhi forest.

In soil, Nitrogen was identified as a limiting nutrient especially in terrestrial ecosystems (Fenn *et al*., 1998). According to Jha and Singh (1990), patch development in tropical dry deciduous forests is primarily caused by disturbance and environmental variability. Many species' habitat fitness may vary as a result of frequent human interventions for the harvesting of fuel wood and minor forest products as well as the activities of grazing and trampling. Research on soil factors found that the diverse combinations of edaphic conditions in different seasons are crucial in the

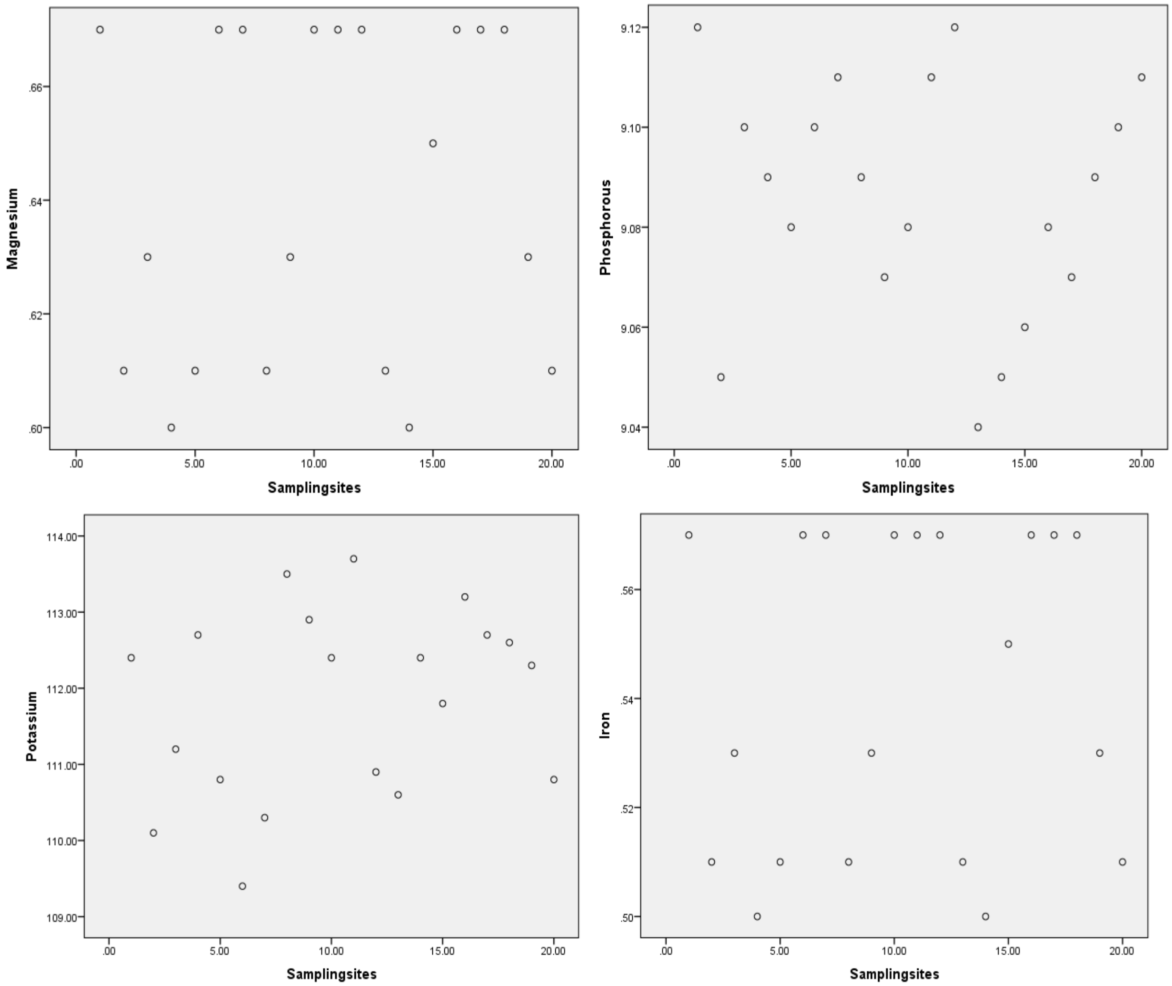

Fig. 2: Physico-chemical parameters (Magnesium, Phosphorus, Potassium and Iron) of the soil samples collected from 20 sampling sites from Peruvannamuzhi forest.

distribution of the dry tropical forests groups in Chhota Nagpur (Pandey and Shukla, 1999).

According to Drinkwater and Snapp (2007), phosphorus is the primary nutrient that limits production in tropical areas, particularly in the laterite soils of Kerala (Jessy *et al*., 2009).The rate of accessible phosphorus (34 kg/ha^{-1}) was essentially constant throughout the year in the forest soil (Choudhury *et al*., 2006). Moreover, phosphorous very slowly leaches out of laterite soils (Mathew and Thampatti, 2007; Jessy *et al*., 2009) because larger amount of phosphorus that is readily available might be due to the rapid mineralization of litter during the rainy season. According to Pandey and Srivastava (2009), excessive rainfall would increase the amount of phosphorus that plants could absorb.

Comparatively more differences in soil organic carbon have been detected by Karthikakuttyamma *et al*. (1998). Nevertheless, Sheikh *et al*. (2009) contend that the decreased litter input and broader spacing between trees are the causes of the low levels of organic carbon in soils. Higher levels of organic carbon and exchangeable bases in soils are dependent on vegetation as well as temperature, altitude, and soil minerals (Balagopalan *et al*., 1992).

Conclusion

Analysis of soil physico-chemical parameters explains the nature of the soil texture and fertility which favours the growth of the terrestrial (forest) ecosystem especially the flora. Peruvannamuzhi forest soil samples physical and chemical values were within the permissible ranges which indicated the suitable environment for the organism sustainability.

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