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Physico-Chemical Analysis of Soil during Summer Season in Lentic Fresh Water Ecosystem: Nakki Lake-Mount Abu (Rajasthan), India

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ABSTRACT

The objective of the research is to identify the status of physico-chemical parameters of the soil in the surrounding area of Nakki-Lake, Mount Abu, Rajasthan, India. Soil parameter plays a major role in determining the planktonic and plant biodiversity, which determines the portability of water and their inter-relationship among zooplanktons and other animals; balances the environmental equilibrium in a lake-ecosystem. The physico-chemical parameters were studied and the result confirms that the soil in the surrounding area of Nakki-Lake can be classified as moderately alkaline soil with (pH 7.11), Average Sand Content (75.12%), Silt Content (11.23%), Clay Content (6.25%), Organic Matter (3.36%), Permeability (27.66 mm/hr), Air Filled Porosity (14.33%) and other parameters showed low mean values including Nitrogen (0.23 mg/L), Phosphorus (52.33 mg/L), Potassium (732.67 mg/L), Magnesium (153.67 mg/L), Chloride (4108.33 mg/L), Sulphur (244.33 mg/L). The soil samples showed an average of Bulk Density (1453 kg/m^3), Specific Gravity (2.62), Fusion Point (1245.67 °C), Total Combustible (0.22%), Exchangeable Sodium (0.91%), Calcium Carbonate (1.48%), Effective Temperature of Destruction (971.33 °C), Electrical Conductivity - $CaSO_4$ Extract (2447 μS/cm) while average nitrate and sulphate levels were 31.19 mg/l and 123.73 mg/l respectively. Based on the result of the quality parameters of the soil analysis, the nature of the soil in Nakki Lake and the surrounding area is alkaline.

***Keywords*:** Physico-chemical, Lentic, Deflocculating, Lake-Ecosystem, Alkaline, Water ecosystem

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1. INTRODUCTION

Mount Abu is a hill station, located at 24.596140°N, 72.703066°E in the Aravali mountain range of Rajasthan. It is a major tourist centre of the state, and has been notified as a Wildlife Sanctuary and Eco-Sensitive Zone (ESZ) or Ecologically Fragile Area (EFA) by the Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India.

Nakki-Lake (Fig. 1) has an important tourist spot of the town. It provides drinking and other water needs for the local inhabitants and almost million tourists annually. It also meets the need of water for the endemic wildlife in that habitat. Soil can be considered as one of the most important ecological factors, the formation of which is a resultant of breaking of rocks by weathering and degradation by the action of wind, water, climate and temperature. Soil characteristics are proportional to the rocks from which the soil has been formed. The botanical diversity at any topography depends upon the nature of the soil. The presence of organic matter and availability of minerals in the soil play a vital role in making it a dynamic medium for fertility and growth of vegetation. Hence soil is an important substrate for the diversity of flora at any locale.

2. MATERIALS AND METHODS

2. 1. Study area

Nakki-Lake (Fig. 1) (Mount Abu) has great importance for the residents of the town. Through a seasonal survey, the specific status of soil parameters in Nakki-Lake have been studied through different weather cycles (2018) across three regions based on the geography and contact with human population over the top bank area. The area surrounding Nakki Lake can be categorised into three regions as Populated, Non-Populated and Mountain region.

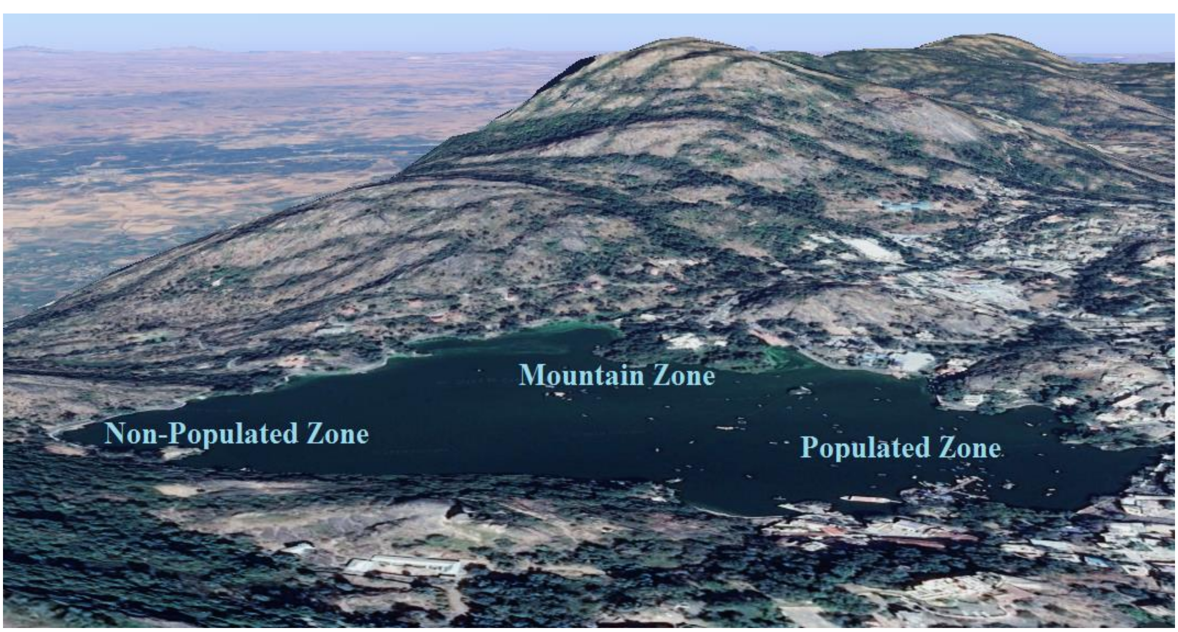


Fig. 1. GIS view of Nakki-Lake, Mount-Abu, Rajasthan, India

2. 2. Collection of Samples

The present study primarily focuses on the physico-chemical analysis of soil samples collected from three different sites covering the total area of Nakki-Lake in the period 2018. Soil samples were collected from three respective sites (Fig. 1) using surgical suites by making a 'V' shaped cut to a depth of 15-20 cm in the sampling spot, uniform thick chunks of soil up to 3cm were collected in a plastic bucket. These soil lumps were broken into small pieces through a wooden pestle and dried. The air dried soil samples were stored in glass bottles and labelled for various laboratory analyses (Fig. 2).

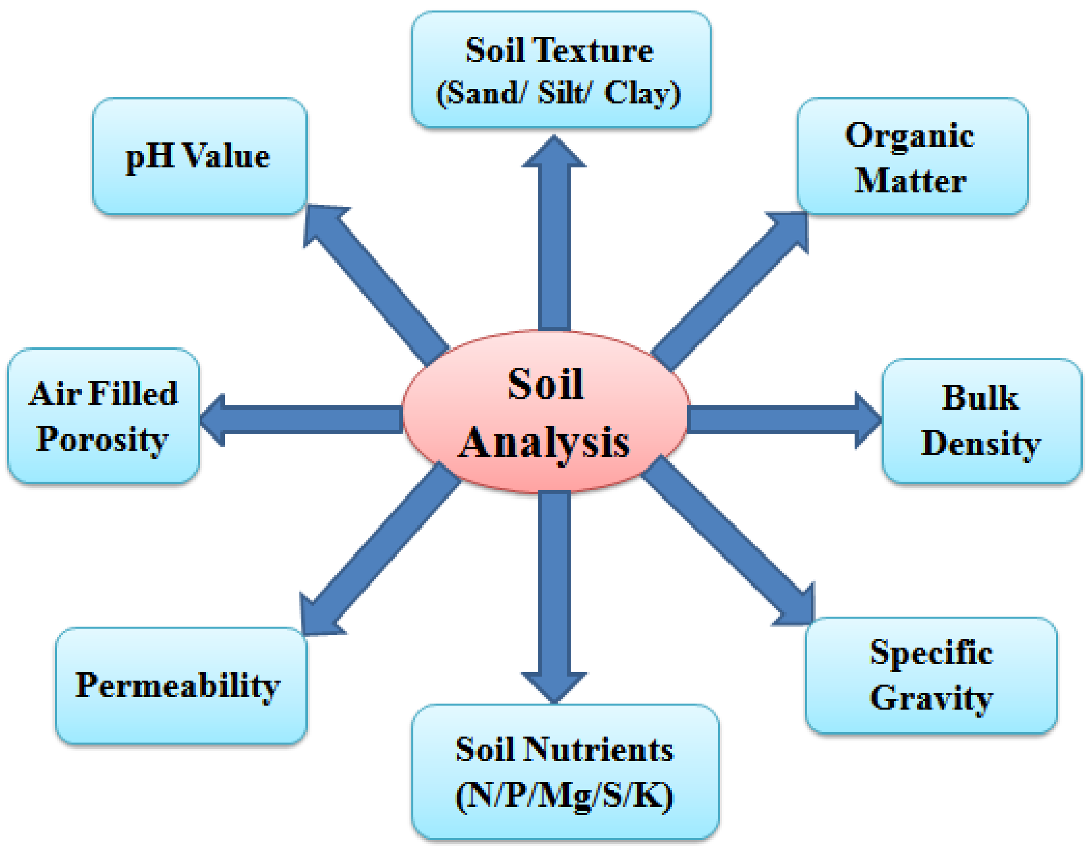


Fig. 2. Parameters: Soil Analysis

2. 3. Soil Texture

It refers to the estimated per cent of sand, silt, and clay present in the soil, which can be determined through the hydrometer method. The soil aggregates were separated through sodium hexametaphosphate. The aggregates were mixed with sodium hexametaphosphate solution overnight. The soil solutions were transferred to one litre graduated cylinders and filled with water. The soil solutions were mixed with a stirrer to disperse the soil particles. Based on size, the soil particles were separated. Soil measurements were taken with a soil hydrometer.

2. 4. Estimation of pH and EC

The pH indicates the presence of hydrogen ion in a solution. To estimate the pH of the soil sample, each sample was taken in a different glasses and the final solution was made by adding distilled water in the ratio of 2:1 each. The combined electrode was inserted into supernatant and the pH was recorded. Similarly the pH of different samples was measured and recorded. Electrical conductivity (EC) indicates the presence of ion contents of a solution which is directly proportional to the current carrying capacity of soil, thus giving a clear idea of the soluble salts present in the soil. The electrical conductivity of soil samples was determined by immersing a Digital Electrical Conductivity Meter in the supernatant solution.

2. 5. Estimation of Organic matter

A good physical condition of the plants is dependent on the supply of organic constituents (nutrients) in the soil. The availability of organic matter in the soil is due to the decomposition of plant and animal residues, living and dead microorganisms. It contributes to the soil structure, fertility and water holding capacity. Organic matter present in the soil was estimated by Walkey-Black method. The dry soil sample of 5g passed through a sieve (0.5 mm) was taken into a 500 ml conical flask. 10 ml of 1N potassium dichromate and 20 ml concentrated H_2SO_4 were added and shaken for a minute. The solution was set aside for around 30 minutes and 200 ml distilled water; 10 ml phosphoric acid and 1ml diphenylamine indicator were added. This solution was titrated against standard ferrous ammonium sulphate till the colour changed from purple-blue to green. The present organic matter in the soil sample was oxidised by 1N $K_2Cr_2O_7$ solution.

2. 6. Estimation of Available Nitrogen:

Nitrogen in soil is mainly present in organic form in small quantities with ammonium and nitrates. The available nitrogen was estimated by alkaline permanganate method. In a distillation apparatus 20 gm of the soil sample was added to 10ml of 0.35% potassium permanganate, 10ml of 2.5% sodium hydroxide, and 10 ml of distilled water. In a 250 ml beaker 0.02 N sulphuric acid was poured through a 25 ml pipette and with two to three drops of methyl red indicator was added. The solution formed was titrated against 0.02N potassium hydroxide till the pink colour changed into the light yellow. The percentage of nitrogen present in the given soil sample was calculated from the titre value of 0.02N sulphuric acid actually consumed by ammonia.

2. 7. Estimation of Available Phosphorous

The phosphorus available in soil was found to be in several forms and combinations as orthophosphate, but only a small fraction of it may be available to plants. Available phosphorus was estimated by Olsen's method (Olsen, *et al.*, 1954). 100 ml of 0.5 M sodium bicarbonate (pH 8.5) was added to 5g of soil in a 250 ml conical flask followed by one teaspoonful of carbon black and shaken for 30 minutes and filtered through filter paper (No. 40). 10 ml of the filtrate was pipetted out into a 50 ml volumetric flask with addition of a drop of p-nitrophenol indicator and the pH was adjusted to 3.0 with 4N HCl. Then 5 drops of 0.1 N stannous chloride was added and it was continuously shaken. The colour intensity was read photometrically after 5 min with a 660 light red filter in photoelectric calorimeter. The quantity of phosphorus was calculated as mg/L.

2. 8. Estimation of Available Potassium

Out of the total non-exchangeable form (fixed K) of potassium present in soil samples, there is small amount of potassium held in exchangeable form (available K). The available potassium in soil samples was estimated by Flame photometric method (Jackson, 1958). 25 ml of 1N ammonium acetate was added to a 150 ml conical flask with a 5g of air dried soil sample and shaken for five minutes mechanically and immediately filtered through a dry grade-1 filter paper. 25 ml of distilled water was added to 5ml of filtrate. The diluted extract was atomized to a flame photometer to note the quantity of potassium in soil samples (mg/L).

3. RESULT AND DISCUSSION

The result confirms that the soil sample from respective sites have minute variations in clay, silt as well as in sand content. The value of sand content is higher than clay and silt content. The soil is moderately alkaline with pH 7.11, Average Sand Content (75.12%), Silt Content (11.23%) Clay Content (6.25%), Organic Matter (3.36%), Permeability (27.67 mm/hr) Air Filled Porosity (14.33 %). The average percentage of nutrient parameters in the soil showed low mean values including Nitrogen (0.23 mg/L), Phosphorus (52.33 mg/L), Potassium (732.67 mg/L), Sulphur (244.33 mg/L), and Magnesium (153.67 mg/L).

The limnological study on Nakki-Lake (Mount-Abu) Rajasthan done by Gothwal and Gupta (2018) reported moderately alkaline water (pH 7.08), alkalinity of (102.16 mg/l) and other limnological parameters showed low mean values including TDS (161.83 mg/l), chloride (109.73 mg/l), and hardness (95.66 mg/l). The average dissolved oxygen levels were at 5.75 mg/l while average nitrate and sulphate levels were 31.19 mg/l and 123.73 mg/l respectively. Based on the results of quality parameters of water, Nakki-Lake is prone to be eutrophic.

The value of Air filled porosity present in soil of Nakki-Lake indicates the adequate pore size distribution and continuity, which plays an important role in root growth in the soil. The permeability of the soil indicates the transmission of water and air, also an important quality for fish culture; hence it promotes fish diversity in the Lake-Ecosystem. The specific gravity of soil is 2.65 kg/m^3, as the soil composition has abundant sand particles and it ranges from 2.61 to 2.65. The higher electrical-conductivity promotes growth of vegetation in the lake-ecosystem, as the higher osmotic pressure around the roots results in water absorption. The presence of excessive amount of exchangeable sodium in the soil shows the process of aggregation, which is an important cause for deflocculation where soil aggregates to disperse into its constituent individual soil particles which occur mostly in sodic soil.

Sen *et al.* (1997) reported variation in pH of some dominant soils of Manipur from 4.9 to 6.0; hence hill soils are acidic with surface pH, the clay content is 18.8% to 54.4%. Hossain *et al.* (2004) reported the highest record of bulk density (1.46 g/cm) as under no tillage at 20-30 cm soil depth. The maximum particle density (2.53 g/cm^3) was measured by 10 cm deep tillage at 10-20 cm soil depth. At different tillage operations soil porosity was influenced statistically. The soil porosity of 64.68 % was observed maximum by 20 cm deep tillage at 0-10 cm soil depth.

They also stated that the high air filled porosity indicates low moisture content in the soil. Srikant *et al.* (1993) observed soil with low pH, $CaCO_3$, clay content at higher elevations, CEC and exchangeable cations than the soils at lower elevations. Choudhary (1994) reported the presence of finely dispersed $CaCO_3$ influenced by increases with depth in soils as per topography in different landforms of western Rajasthan. Pramanik and Douli (2001) reported distribution of sulphur in some Alfisols of West Bengal, concentrated in the surface of soil profile. However, it decreased with increasing depth of soil. The correlation found between organic matter, pH and S shows the abundance of various Sulphur forms in the soil profiles as in the order: Total S > Organic S > $CaCl_2$ extractable S > NaH_2PO_4 extractable S > NH_4 OAC extractable S > H_3 PO_4 extractable S > HC1 extractable S.

Table 1. Nakki-Lake: Physico-Chemical Analysis of Soil.

S. No	Parameters	Populated	Non-Populated	Mountain
1	Sand Content (%)	75.44	73.6	76.32
2	Silt Content (%)	11.28	10.76	11.65
3	Clay Content (%)	5.94	6.3	7.3
4	pH Value	7.04	7.12	7.16
5	Fusion Point	1244	1239	1254
6	Permeability (mm/hr)	28	26	29
7	Exchangeable Sodium (µs/cm)	0.88	0.94	0.91
8	Sulphur Content (mg/l)	223	265	245
9	Effective Temperature of Destruction (°C)	988	976	950
10	Nitrogen Content (%)	0.22	0.26	0.22
11	Calcium Carbonate (%)	1.44	1.56	1.43
12	Organic Matter (%)	3.55	3.1	3.43
13	Air Filled Porosity (%)	15	13	15
14	Bulk Density (%)	1458	1436	1465
15	Chloride (Cl) (%)	4032	4125	4168
16	Specific Gravity (kg/m3)	2.62	2.59	2.65
17	Phosphorus Content (mg/l)	53	48	56
18	Potassium Content (mg/l)	749	720	729
19	Magnesium Content (mg/l)	158	153	150
20	Electrical Conductivity ($CaSo_4$ Extract) (mg/l)	2411	2450	2480

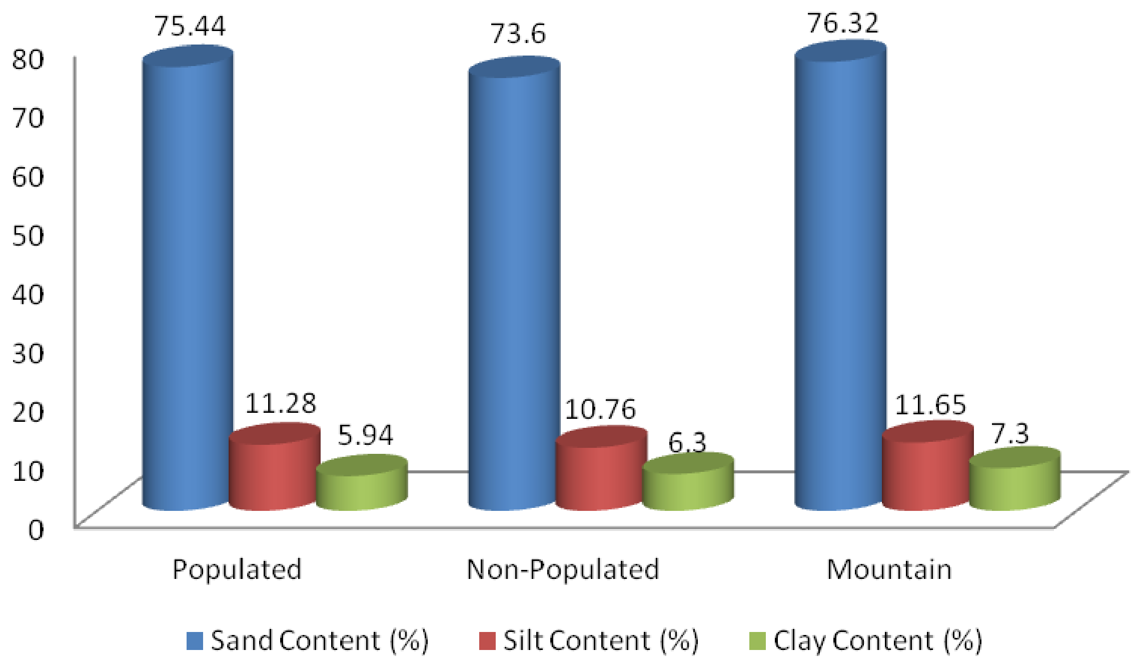


Fig. 3. Comparative Analysis: Soil Texture

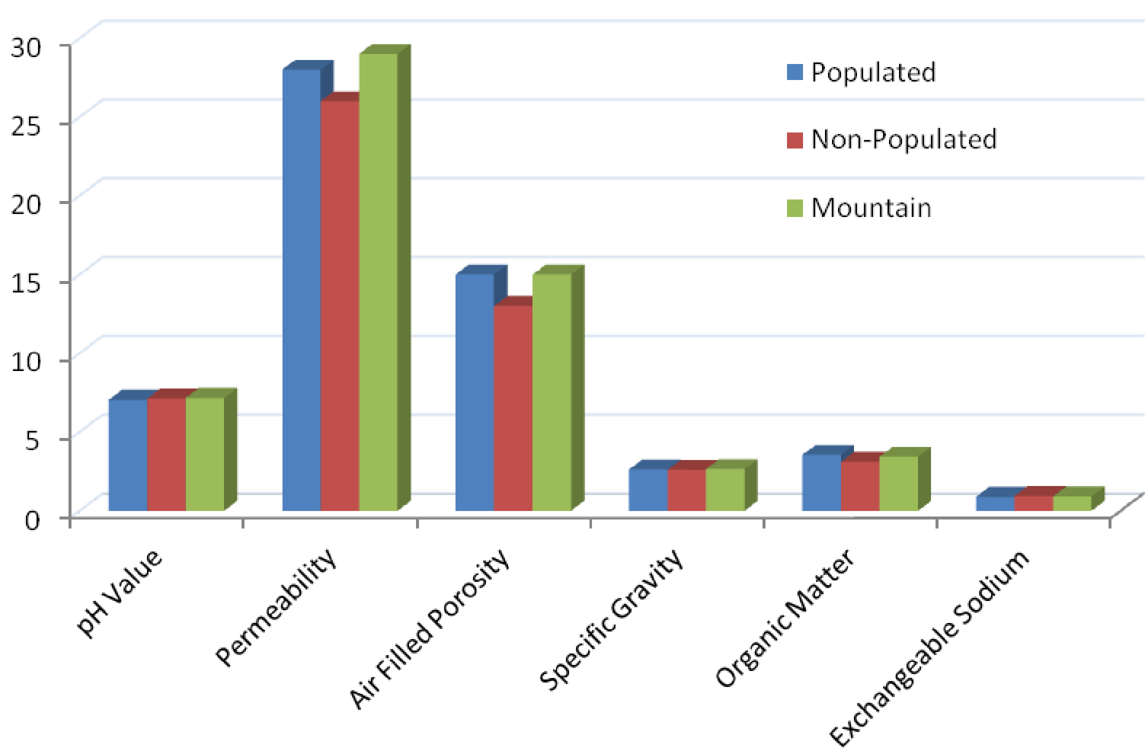
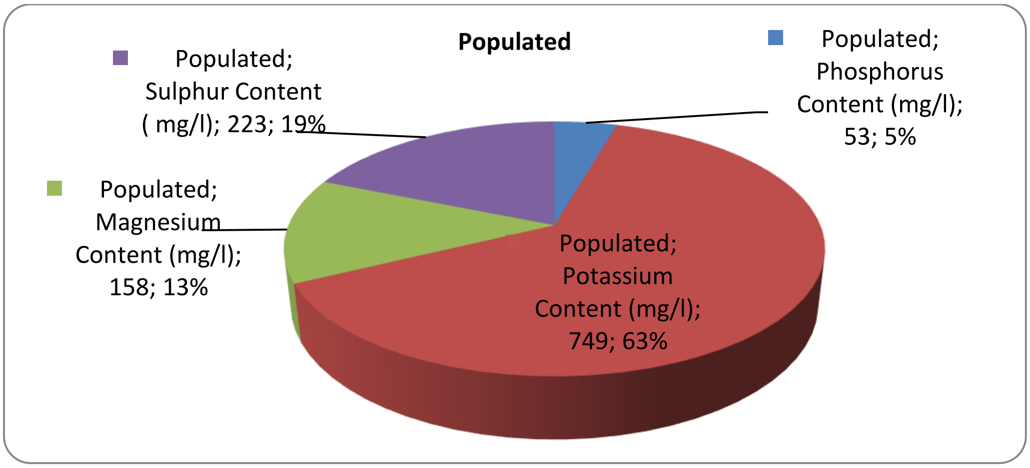
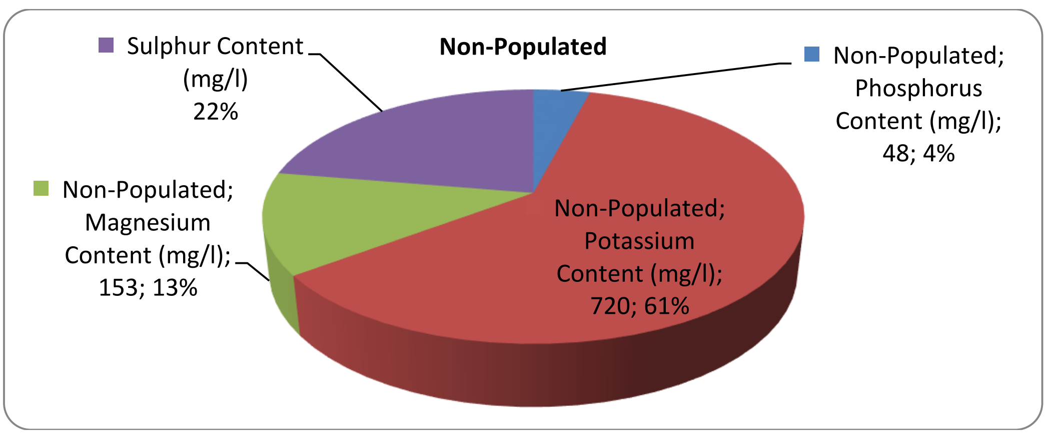


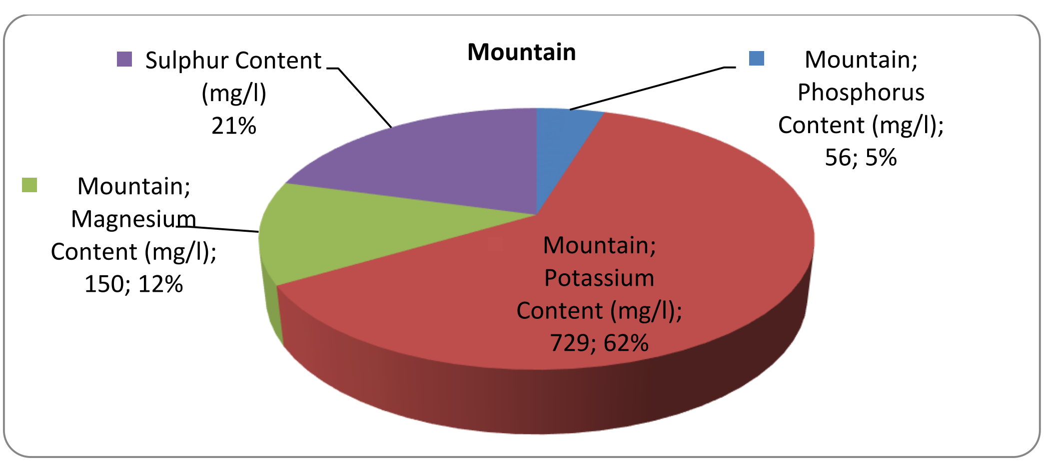
Fig. 4. Comparative Analysis: Soil Parameters



(A) Populated Region



(B) Non-Populated Region



(C) Mountain Region

Fig. 5(A,B,C). Pie-Chart Analysis: Soil Nutrients in different regions

4. CONCLUSION

The flora at any geographic location of an ecosystem depends upon the type of soil available there. Soil parameters play an important role in the biodiversity of vegetation. The present research is relevant to study physico-chemical status of soil needed for vegetative diversity and its growth in Nakki-Lake and its surrounding area. This study explains that the soil available in Nakki-Lake and its surrounding area is rich in the adequate amount of nutrients needed for vegetation.

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