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MYRISTICA SWAMP FOREST-GEOCHEMICAL APPROACH, KULATHUPUZHA FOREST RANGE, KERALA

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Abstract
The micronutrients needed smaller quantities for the improvement of soil. Many factors influencing the variations in micronutrients. In the present study, among the soil micronutrients like Mn, S, Fe, Zn, Cu, and B available Fe content were higher in three sites. If the soil with high Fe contents the amount of Mn will decreases

Key words: Freshwater, wetland , museum

Introduction

Myristica swamps are one of the unique freshwater wetland ecosystems in Western Ghats. Myristica swamps were first reported by Krishnamurthy in 1960 from the Travancore area of southern Western Ghats. These swamps were found in the valleys of Shendurney, Kulathupuzha and Anchal forest ranges in the southern Western Ghats. In 1968 Champion and Seth classified the vegetation as tropical freshwater swamps (4C/FSI). In 1988 Pascal described the vegetation and Rodger and Panwar (1992) pointed the vegetation as most critically needing conservation. These swamps, as their name indicates are characterised by the dominance of the member of family Myristicaceae. Myristica swamps in the Western Ghats are a critically endangered ecosystem are now largely confined to 53 patches in the Kulathupuzha and Anchal forest ranges and the Shendurney wild life sanctuary in Kerala (between 77.27^o and 77.58^o and 8.74^o and 9.03^o below 200m MSL). The swamps have accumulative area of just 149.75 hecter, which is 0.0039 % of Kerala's land area.

Myristica swamps are virtually live museum of ancient life great interest to biologists. The swamps have high watershed value. The characteristic feature of the myristica swamp is the abundance of trees belonging to the family myristicaceae. Particularly two species viz. *Myristica magnifica* and *Gymnacrantherafaquhariana*.Other myristica species found (although less frequently) are *Myristica malabarica* and *Knemaaltenuata*. Members of other families such as Celestraceae, Dipterocarpaceae, Anacardiaceae, Xanthophyllaceae, Myrtaceae etc. are a significant part of the swamp community in some of these swamps. Ground vegetation consists mainly of Pandanus, Calamus, Ochalandra and members of Araceae, Acanthaceae, and Zingiberaceae family. Endemic and endangered species such as *Myristica fatua var. magnifica*, *Syngiuntravancorium*, *Listiatravancorica* are also found. Plants growing in swamps have special kind of adaptations, such as: roots, rhizomes, physiological adaptations, seed germination etc. Spatial variation of the microbial population in Myristica swamp soils probably attributed to the variation of vegetation structure.

The mangroves have various types of aerial roots, thick and leathery evergreen leaves, seed germination intoseedlings before the fruit drops from the parent plants, high osmotic pressure of the cell sap to combat the salinity in the medium and so on. Aerial adventitious roots like stilt roots that spring out from the main trunk of the plant and it provide additional support to the swamp trees in the soft soil. These roots might become woody and flattened with age, becoming flying buttresses, as in Myristica species and *Virolasurinomensis*. The stilt roots were bending downward and enter the soil also. Some Malayan species of Myristica produce stilt roots in swampy conditions and not when they grow elsewhere. *Myristica malabarica* of the Western Ghats often produces stilt roots flying buttresses, even though it is seldom associated with swamps, indicating its -

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possible origin in the swamps. Apart from the Myristica, the several flood – tolerant species of the Western Ghats, such as *Elaeocarpus, Holigarna, Madhucanerifolia, Pandanus*, etc. also produce stilt roots.

Swamp species are also physiologically adapted to their habitat. They are known to cope with oxygen deficiency of soil through anaerobic respiration. Their lenticel-studded aerial roots toxic products of anaerobic pathways of metabolism, such as ethyl alcohol, acetaldehyde, ethylene, etc. diffuse out. Since the roots of such plants are associated with highly reduced soils that contain numerous substances toxic to them, the roots degrade the harmful products through oxidation. Hence root aeration is very essential for wet land plants. Apart from venting out toxic products, they also serve as primary entry points for oxygen to the root zone. Moderate levels of oxidation take place in soil by the knee roots.

Materials and methods

The soil sample was collected from four different sites (MS1- MS 4) of Myristica Swamp patches of Kulathupuzha forest range, Arippa, Thiruvananthapuram, Kerala. The MS1 belongs to Sasthamnada (karimkurinjipacha), MS2 Sasthamnada temple, MS3 Ammayambalam, and MS4 Ammayambalam region. The samples were taken from the depth of 0-10 cm using augur. All the collected soils stored in clean polythene bags.

Results and discussion

Texture (%)

Soil texture is an important physical property. It refers to the relative proportion of different soil groups such as sand silt and clay. From the textural analysis of the soil revealed that site MS1 contained clay loam, MS2 with sandy loam, MS3 and MS4 indicated as same as sandy clay loam respectively (Table 1.1).

pH

The present study revealed that the pH value of MS1 4.9, MS2, MS3 and MS4 indicated as same value 4.8. These soils are very acidic in nature. The average mean differences between the sites were 4.83 ±0.01.

Electrical conductivity (µs/cm)

Soil generally contains small amounts of various soluble salts. EC value of MS1 141.5, MS2 63.14, MS3 80.61, and MS4 62.11. The average mean difference between the sites was 86.79 ± 9.74.

TDS (ppm)

Total dissolved solids are the amount of dissolved inorganic chemicals. It also refers to the amount of minerals, metals, organic material and salts that are dissolved. MS1 113.4, MS2 50.38, MS3 62.98 and MS4 50.29 respectively. The average mean difference between the sites revealed that 69.25±7.83.

TSS (mhos/cm)

Total suspended solids is the dry weight of suspended particles, most suspended solids are made up of inorganic materials.The observed average mean difference between the sites was 0.11±0.00. There is no significant difference was noticed on the sites. The data showed in MS1 0.12, MS3 0.14, MS2 and MS4 indicated as same (0.09mhos/cm).

Salinity (ppt)

Salinity is the soluble salt content of the soil. Salts occur naturally within soils, soil minerals weather and release salts and are flushed or leached out of the soil by drainage water in areas with sufficient precipitation. From the study, salinity of different sites showed significant differences. Salinity of MS1 54.12, MS2 35.81, MS3 178 and MS4 was 34.19 respectively. The average mean difference between the sites was 75.53±17.99.

Organic carbon (%)

Soil organic carbon (C_{org}) refers to the carbon component of organic compounds. Soil organic carbon accounts for less than 5% on average of the mass of upper soil layer. The average mean difference of the site was 2.93±0.07. Present study showed that small differences between the data. In the case of $C_{org}$for MS1 3.36, MS2 2.7, MS3 2.85 and MS4 1.95 % respectively. Nitrogen (%)

Nitrogen occupies a unique position among the major nutrients. Available nitrogen plays an important role in soil fertility. The study showed that there is a small difference between the values. N values of site MS1 2.50 MS2 1.43, MS3 0.93 and site MS4 was 0.36 respectively. The average mean difference between the sites was 1.30 ±0.23.

Phosphorus (kg/ha.)

Phosphorus (P) is an essential macro element. It found in the soil in organic compounds and in minerals. Phosphorus content of MS1 69.03, MS2 34.97, MS3 43.94 and MS4 was 67.33. The average mean difference between the sample sites was 53.91 ±4.46.

Potassium(kg/ha.)

The study revealed that there is no significant difference between the obtained data. Potassium content of MS1, MS2, MS3, and MS4 were indicated as the same value as 100.8. The average mean difference between the sites was 100.8±0.02

Micronutrients

Micronutrients are required in trace amounts for the normal growth and development of living organisms, whereas plants require specific minerals. The micronutrients such as Mn, S, Fe, Zn, Cu, and B showed significant difference. The average mean difference of the available Mn content in the soil sample was 5.49 ±1.03; the available S content in soil sample was 44.60 ± 8.39, Fe was 103.88 ± 15.78, Zn content was 3.73 ± 0.36, mean difference in Cu was showed 2.26 ± 0.15, the available B in the soil sample was revealed 0.96 ±0.03 (Table 1.3).

Discussion

The soil samples from different sites showed moderately same pH and are acidic in nature. Similar studies were observed in the studies of Salim *et al*., (2015) and Uchida and Hue (2000) explained that the swamps soil became acidic in nature. The natural weathering process makes soil acidic and generally devoid of nutrients. They revealed natural forest has low pH because organic matter in the form of plant litter and highly acidic in the undisturbed forests as compare to disturbed forest. High amount of humus in forest soils is also responsible for low pH.

EC can serve as soluble nutrients. Here the result showed that moderately medium EC values. The increased EC was observed in the MS1 and least in MS4. According to Thomas *et al.,* (2007) explained that the Myristica swamp soil showed moderately low electrical conductivity. Similar studies were observed in Khan *et al*., (2016), reported that the values of soil EC ranged largely between the lowest of 23.8 and the highest of 71.8µs/cm. Here the result only MS1 showed 141.5µs/cm conductivity.

The present study showed comparatively high salinity. Cordell *et al*., (1989) observed that high pH often an indication of excessive salt levels, it causes an 'osmotic effect' High osmotic pressure of the cell sap to combat the salinity in the medium (Chandran and Mesta; 2006).

According to Sulthana *et al*., (2019) increased soil salinity changes forest successional pattern and also decreases the productivity of the soil. Total dissolved solids concentration is the sum of the cations and anions. From the result TDS showed maximum values at each site. In the case of total suspended solid there is no significance among the values. High concentrations of suspended solids can cause many problems. Soil organic carbon influences many soil characteristics.

It describes the organic constituents in soil in various stages of decomposition such as tissues from dead plants and animals. The soil samples from different sites showed maximum percentage of C org. Similar case was observed in the studies of Kumar et al., (2014) revealed that wetland soil showed maximum percentage of C org under natural forest. The increasing percentage will improve soil fertility by improving the soil structure..The soil texture has a strong influence on soil C org (Gili *et al*., 2010). Bhat and Kaveriappa (2009) reported that C_{org} content was lower in the soil than those of other forest ecosystems in the Western Ghats, which was supported by earlier reports (Jose *et al*., 2014 and Varghese and Menon 1999). According to Madhu *et al*., (2016) observed that the organic carbon content of surface soil was greater than sub- surface soil.

According to Salim *et al*., (2015) revealed that the amount of potassium values generally increases because of shifts in soil equilibrium; it may depend upon the type of clay minerals present. From their result they observed that the potential seasonal variations, amount of soil humus, presence of type of vegetation etc. were influencing soil micro and macro nutrients. According to Bhat and Kaveriappa (2009). The swamps are also characterized by lower amounts of major nutrients than in other type of ecosystems due to continuous waterlogging effect. The total N and P contents lower in the soil than other forest ecosystem in the Western Ghats.

Macronutrients play an important role in fertility -

management of the soil. The macronutrients analysed were N, P and K. Results showed that the available nitrogen was lower than that of available phosphorus and potassium. But the available potassium content was slightly higher. Nitrogen is the most limiting nutrient. Similar studies were observed in Miah *et al*., (2005) and Khan *et al* (2016 under certain conditions gaseous nitrogen losses through denitrification and volatilization. Waterlogging condition in swamp results in high leaching losses of nitrogen, and also reported that N and P contents of the swamp were lower than other forest ecosystem.

The micronutrients needed smaller quantities for the improvement of soil. Many factors influencing the variations in micronutrients. In the present study, among the soil micronutrients like Mn, S, Fe, Zn, Cu, and B available Fe content were higher in three sites. If the soil with high Fe contents the amount of Mn will decreases. According to Miah *et al.,* (2005) availability of B decreases with increasing soil pH. From their report they found that nutrient deficiencies are relative and a deficiency of one element implies adequate or excessive quantities of another and also the effect of soil pH on nutrient availability is clearly observed.

Texture refers to the different size distribution such as sand, silt and clay. In the present study the textural analysis indicates that the soil texture in the study area was generally contained clay loam, sandy loam and sandy clay loam types respectively. Soil texture plays a key role in carbon storage and strongly influences nutrient retention and availability (Khan *et al*., 2010). The heterogeneity of soil occurred at small scale even in same swamp sites. The clay content was higher in MS1 and other three sites were showed spatiotemporal variations. Similar studies were observed in Jose *et al*., (2013) revealed that Myristica soil was well drained, loamy soils with thick vegetation, with moderate erosion.

Figure 1. Knee root

Figure 2. Stilt root

Material and Parameters were followed for the study

Sl.No	Parameters	Methodology Adopted
1	Soil texture (%)	International pipette Method
2	pH	Electrometric Method (pH Meter)
3	Electrical conductivity (µs/cm)	Electrometric Method (Conductivity Meter)
4	TDS AND TSS (ppm)	Filtration Method (TDS Meter)
5	Salinity (ppt)	Argentometric Titration (Salinity meter)
6	Organic Carbon (%)	Walkley and Black Method
7	Nitrogen (%)	Kjheldal Distillation Method
8	Phosphorus (kg/ha)	Spectrophotometric Method (Spectrophotometer)
9	Potassium (kg/ha)	Flame Photometric Method (Flame Photometer)
10	Micronutrient analysis (ppm).	Digestion method (AAS)

Table.1.1 Analysis of Texture and their mean difference between the sites

Sample site	Sand (%) Mean ± SD	Silt (%) Mean ± SD	Clay (%) Mean ± SD
MS1	30.6 ± 0.04	34.4 ± 0.12	35 ± 0.81
MS2	70.9 ± 0.04	14.1 ± 0.04	15 ± 0.47
MS3	75.8 ± 0.08	0.2 ± 0.04	24 ± 0.81
MS4	76.5 ± 0.04	0.5 ± 0.08	23 ± 0.47

Table.1.2. Analysis of physicochemical variables and their average mean

Parameters	**MS1**	**MS2**	**MS3**	**MS4**	**Mean ± SE**
pH	4.9	4.8	4.8	4.8	4.83±0.01
EC (µs/cm)	141.5	63.14	80.61	62.11	86.79±9.74
TDS (ppm)	113.4	50.38	62.98	50.29	69.25±7.83
TSS(mhos/cm)	0.12	0.09	0.14	0.09	0.11±0.00
Salinity(ppt)	54.12	35.81	178	34.19	75.53±17.99
C org (%)	3.36	2.7	2.85	1.95	2.93±0.07
N (%)	2.50	1.43	0.93	0.36	1.30±0.23
P (kg/ha.)	69.03	34.97	43.94	67.73	53.91±4.46
K (kg/ha.)	100.8	100.8	100.8	100.8	100.80±0.02

Table.1.3. Analysis of micronutrients and their mean difference between the sites

Sample site	**Micronutrients (ppm)**					
	Mn	S	Fe	Zn	Cu	B
MS1	10.52	17.81	169.05	5.02	2.95	1.08
MS2	6.09	36.56	63.81	2.67	2.13	0.87
MS3	4.32	32.81	140.34	2.38	2.47	0.85
MS4	1.05	91.25	42.34	4.83	1.51	1.05
Mean ± SE	5.49±1.03	44.60±8.39	103.88±15.78	3.73±0.36	2.26±0.15	0.96± 0.03

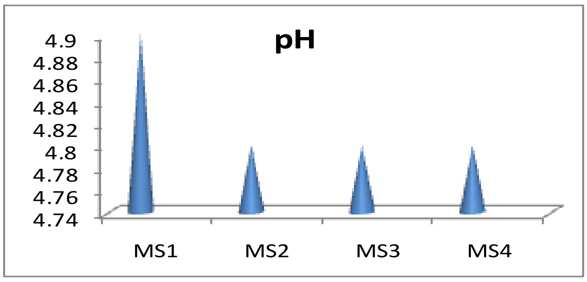

Fig.1.1. Variations of pH in soil samples

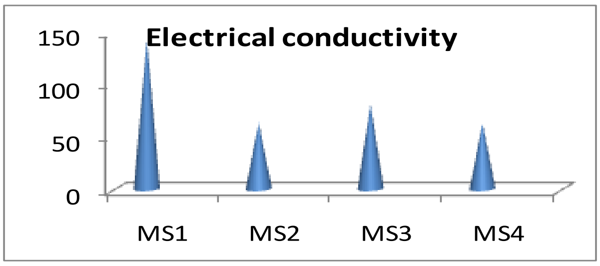

Fig.1.2. Variations of Electrical conductivity in soil samples

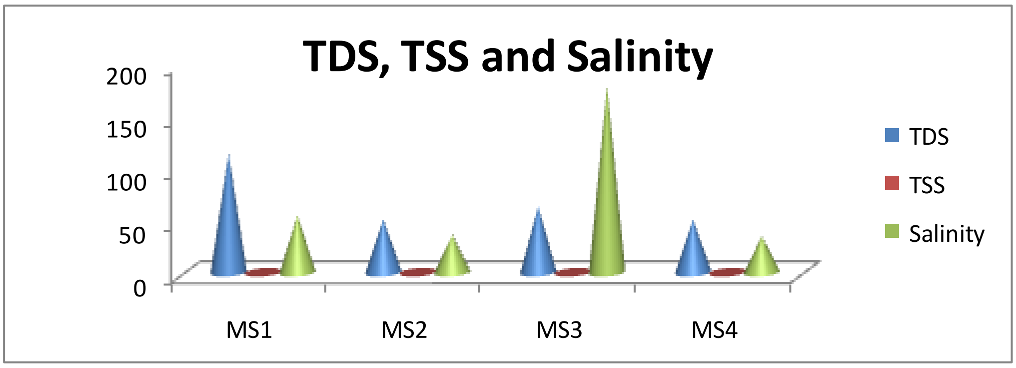

Fig.1.3. Variations of Total Dissolved Solids, Total Suspended Solids and salinity in soil samples

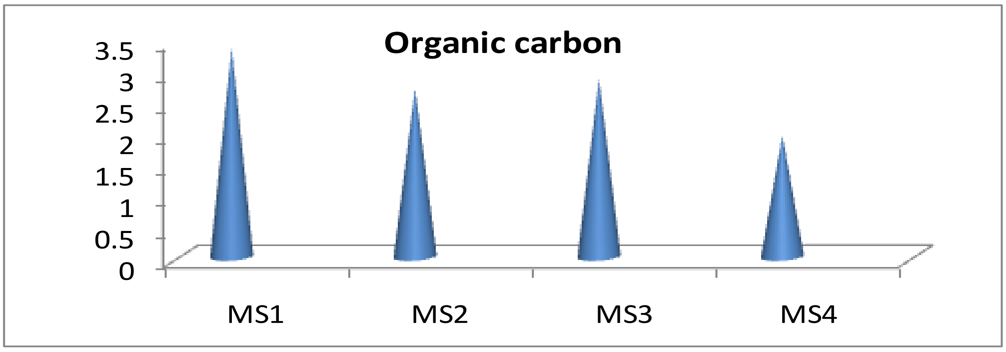

Fig.1.4. Variations of total Organic carbon in soil samples

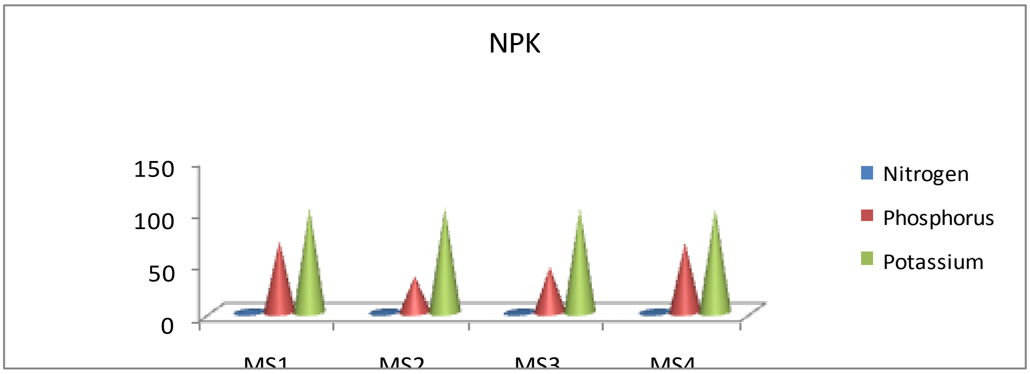

Fig.1.5. Variations of Macronutrients (N, P & K) in soil samples

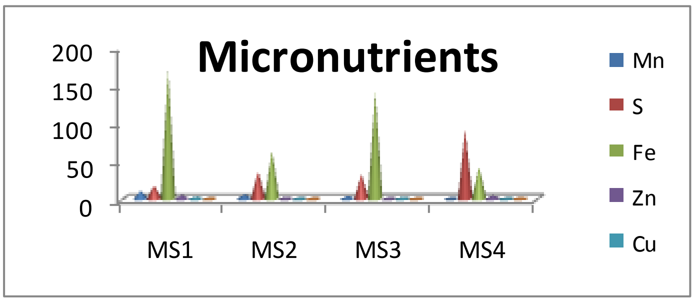

Fig.1.6. Variations of Micronutrients (Mn, S, Fe, Zn, Cu, & B) in soil samples

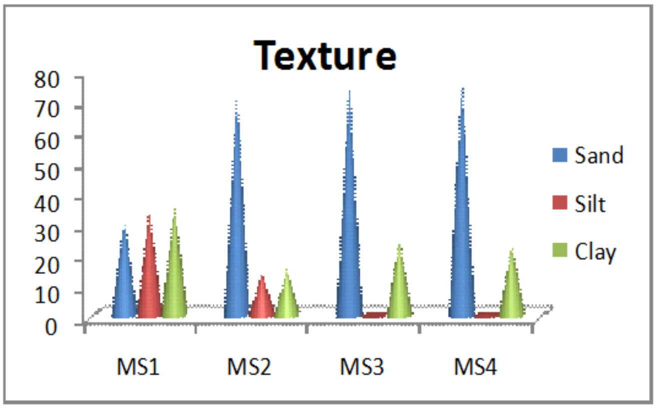

Fig.1.7. Textural variations among Myristica swamp soil samples

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