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PHYSICO-CHEMICAL ANALYSIS WITH REFERENCE TO SEASONAL CHANGES IN SOILS OF VICTORIA PARK RESERVE FOREST, BHAVNAGAR (GUJARAT)

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ABSTRACT:

The present study highlights the analysis of physicochemical properties of soil sediments of Victoria Park reserve forest near Bhavnagar city. The soil in this forest is of three types. The first one is “Morrum”, it is half decomposed soil just beneath the upper surface. The second type of soil is the coarse soil mixed with clay and the third type is the yellowish brown soil. In the present work entire area of reserve forest were divided into eight sampling sites. The soil parameters like pH, EC, Carbonate, Bicarbonate, Total Hardness, Nitrogen, Potassium and Phosphorous content, heavy metals like Fe, Zn, Cu and Mn were analyzed for pre and post monsoon period.

KEY WORD: Soil analysis, Victoria Park-Reserve Forest, Morrum, Coarse soil, Yellowish brown soil.

INTRODUCTION:

Soil is an important component of terrestrial ecosystems because the growth of plants and biogeochemical cycling of nutrients depend upon it. Of the total area of the world's land-mass (13.07×10^9 ha), only 11.3% is cultivated for crops; permanent grazing occupies 24.6%, forest and woodland 34.6% and 'other land' including urban/industry and roads, accounts for 31% (WRI - World Resources Institute, 1994). Pollution, along with the other types of degradation, such as erosion and continuing spread of urbanization, poses a threat to the sustainability of soil resources. Soil pollution can also be a hazard to human health when potentially toxic substances move through the food chain or reach groundwater used for drinking water supplies (Alloway, 1995 and Solanki, 2001).

Soil types are a major factor in determining what types of plants will grow in a certain area. Plants use inorganic elements from the soil, such as nitrogen, potassium and phosphorus, but the community of fungi, bacteria, and other microscopic creatures living within the soil are also vital. Soil is a dynamic medium made up of minerals, organic matter, water, air and living creatures including bacteria. It

continue change under the effect of physical factors like the parent material, time, the climate, the organisms present in it etc. Present investigation was carried out in the reserved forest (Victoria Park) which is situated 3 km south of Bhavnagar City, Gujarat State, India. Bhavnagar lies on the Western coast of India at 72° 11' E longitude and 21° 45' N latitude. It is a semi-arid region with very hot summer and cold winter. The average rainfall is about 740 mm. The hot, dry climate supports scrubby, thorny and xerophytic vegetation. The area has dry summer from March to mid-June, the wet monsoon season from mid-June to October. The months from November to February are mild, the average temperature being around 20°C, with low humidity. Due to proximity to the sea, the climate remains a bit humid throughout the year. This is a unique forest in India which exists near a city, under virtual threat of extinction.

MATERIALS AND METHODS:

For the present study, soil samples were collected in 2010 - 2011 from different forest sites in the Victoria Park reserve forest near Bhavnagar city. Study was primarily being focused on the testing of soil quality of Victoria Park. The entire study area was divided into total eight location and sample were collected from each location viz, sample-A to sample-H. Season wise sampling was done i.e. pre- monsoon and post monsoon. The soil sediment is sampled using Eckmen's dredge. Samples were analyzed for physico-chemical parameters such as pH, EC, Carbonate, Bicarbonate, Total Hardness, Nitrogen, potassium and phosphorous content, heavy metals like Fe, Zn, Cu and Mn by employing standard methods (Trivedy and Goel, 1984).

RESUTLS AND DISCUSSIONS:

As defined by Joffe (1949), Soil is a natural body consisting of layers (horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, chemical and mineralogical characteristics. Soil means a substrate for plant growth which performs many functions essential to life. In general, most plants grow by absorbing nutrients from the soil. Their ability to do this depends on the nature of the soil. The soil in this forest is of three types. The first one is "Morrum", it is half decomposed soil just beneath the upper surface. The second type of soil is the coarse soil mixed with clay and the third type is the yellowish brown soil.

Soil samples were analyzed for physico-chemical parameters such as pH, EC, Bicarbonate, Ca hardness, Mg hardness, Nitrogen, potassium and phosphorous content, heavy metals like Fe, Zn, Cu and Mn. (Table-1).

Soils with a pH greater than 7.0 are considered alkaline. Alkaline soils often occur in arid regions that receive less than 25 inches of rain per year. pH of soil ranged from 7.1 to 8.2 during pre monsoon season while in post monsoon it was recorded between 7.9 to 8.3 for different sample, (Table-1). In all samples it

was found greater in post monsoon than in pre monsoon which may be due to addition of rain water in soil. pH value less than 5 causes metallic toxicity on plants but in unpolluted soil condition is generally alkaline (7 to 9) due to accumulation of CaCO_3 and other salts in the predominantly evaporating moisture regimes (Alloway, 1995 & 1998 and Solanki, 2001). Soil alkalinity is caused by limestone that naturally exists in these arid soils. The effect of limestone and the interaction of irrigation-water minerals on soil pH and soil fertility will be discussed below.

Chemically, limestone is calcium carbonate (CaCO_3), and as this compound dissolves, the soil pH decreases or becomes more acidic. A product of this reaction is free calcium and carbon dioxide, which is given off as a gas. This can be demonstrated by adding vinegar (acid) to many alkaline soils. You will note a violent effervescence of carbon-dioxide gas as the limestone is dissolved by the acid. As free or soluble levels of soil calcium increase, soil pH will be lowered (7.3 to 7.8). The soil pH will not drop below 7.3 until all of the limestone in the soil has been dissolved. When bicarbonate or carbonate is added to the soil (i.e., water), limestone is formed. In this process, free calcium levels in the soil are decreased and the pH increases. Managing alkaline soil pH is best done by maintaining high levels of free calcium in the soil. This is why gypsum is added to soils with high soil pH (>8.0). Gypsum is an excellent and inexpensive source of soluble calcium. The soluble calcium removes the carbonate from the soil by forming limestone. This, in turn, lowers the soil pH. Elemental sulfur can also be used in the same way to lower soil pH. Elemental sulfur reacts with soil limestone

Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics. Electrical Conductivity shows no much variation in both the season and for all samples. Soil with EC greater than 4m.mho.cm^{-1} indicate the salinity in the soil (Sharma and Kaur, 1994). In present study EC ranges from $0.112\text{ m.mho.cm}^{-1}$ to $0.990\text{ m.mho.cm}^{-1}$, (Table-1) which shows that soil is not saline in nature. The electrical conductivity of soils varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Consequently, EC correlates strongly to soil particle size and texture.

Chloride is the most recent addition to the list of essential elements. Although chloride (Cl) is classified as a micronutrient, plants may take up as much chloride as they do secondary elements such as sulfur. Most soil chloride is highly soluble and is found predominantly dissolved in the soil water. Chloride is found in the soil as the chloride ion. Being an anion, it is fully mobile except where held by soil anion exchange sites. In areas where rainfall is relatively high and internal soil drainage is good, it may be leached from the soil profile. Atmospheric chloride deposition tends to be rather high along coastal regions and decreases as progress inland.

Chloride, nitrate, sulfate, borate, and molybdate are all anions in their available forms, and in that form they are antagonistic to each other. Therefore, an excess of one can decrease the availability of another. Little information is available on other specific interactions that may occur. Chloride content shows slightly decreased value in post monsoon due to dilution of calcium in soil by rain water in all the sapling sites. The Cl content of the soil is not an intrinsic property of the soil but is a result of soil management, because of its mobility in the soil and the fact that it moves with the water in the soil. The Cl anion is not adsorbed on soil particles at neutral and alkaline pH values, and therefore is easily leached. So in present study the values of Cl are not much in all the study areas.

Soil organic carbon (SOC) plays an important role as a source of plant nutrients and in maintaining the soil integrity. Any land use management that increases SOC by removing CO₂ from the atmosphere by storing it in the soil, is termed as carbon sequestration. Bicarbonate values indicate little variation at both spatial and seasonal level in all sapling sites. Calcium and magnesium hardness shows increased values in post monsoon analysis. Decreased value of pre monsoon analysis may be due to uptake of both the ions by soil organisms and plant while increased value in post monsoon analysis may be due to entry of new rain water in soil during monsoon. Increase and decrease in Ca content may be their uptake by living organisms and their release on decomposition (Misra and Puri, 1954).

Nitrogen exists in the soil system in many forms and changes (transforms) very easily from one form to another. The route that N follows in and out of the soil system is collectively called the "nitrogen cycle" and is biologically influenced. Nitrogen content shows increased value in post monsoon analysis than in pre monsoon data. It was ranged from 0.021 to 0.096 %, (Table-1). This may be due to increase in soil water content due to rainfall and also the favorable temperature and humidity together which favours the luxuriant growth of nitrogen fixing bacteria, blue green soil algae which are ultimately responsible for nitrogen content in soil. In contrast to the biological transformations, loss of nitrate by leaching is a physical event. Leaching is the loss of soluble NO₃⁻ as it moves with soil water, generally excess water, below the root zone. Nitrate that moves below the root zone has potential to enter either groundwater or surface water through tile drainage systems. Coarse-textured soils have a lower water-holding capacity and, therefore, a higher potential to lose nitrate from leaching when compared with fine-textured soils. Some sandy soils, for instance, may retain only 1/2 inch of water per foot of soil while some silt loam or clay loam soils may retain up to 2 inches of water per foot. Nitrate can be leached from any soil if rainfall or irrigation moves water through the root zone. That's why in our result nitrogen content varies in different sites of Victoria Park.

Potassium is an essential nutrient for plant growth. Potassium is involved in many plant metabolism reactions, ranging from lignin and cellulose used for formation of cellular structural components, to

regulation of photosynthesis and production of plant sugars that are used for various plant metabolic needs. It controls water loss from plants and is involved in overall plant health. Soils that have adequate potassium allow plants to develop rapidly and outgrow plant disease, insect damage and protect against winter freeze damage. Maximum values of potassium (510 kg/hector, Table-1) was found in post monsoon which may be due to leaching while after the monsoon season it may decreasing gradually and found lower in pre monsoon due to uptake by plant and living organisms within the soil. Potassium is an element that contains a positive electrical charge known as a cation. The soil clay particles contain a negative charge. So opposites attract. This feature prevents or limits the loss of potassium by leaching. The behavior of K in soil, release, absorption, fixation and leaching, is strongly dependent on the clay content and types of clay minerals present (Mengel and Kirkby, 1987). Soils with high clay content have both a greater amount of mineral potassium and more negative charges and therefore have more potassium. A sandy soil conversely has less mineral content and fewer negative charges and usually contains lower levels of plant available potassium. As result sandy soils will most likely have a greater need for potassium supplementation than clay soils. The soils Cation Exchange Capacity or CEC is a useful indicator of soil texture and is often used to determine which best management practices to use to maximize the value of amendments applied.

In natural systems like soil and water, P will exist as phosphate, a chemical form in which each P atom is surrounded by 4 oxygen (O) atoms. Orthophosphate, the simplest phosphate, has the chemical formula PO_4^{3-} . In water, orthophosphate mostly exists as H_2PO_4^- in acidic conditions or as HPO_4^{2-} in alkaline conditions. Phosphorus (P) is an essential element classified as a macronutrient because of the relatively large amounts of P required by plants. Phosphorus is one of the three nutrients generally added to soils in fertilizers. One of the main roles of P in living organisms is in the transfer of energy. Organic compounds that contain P are used to transfer energy from one reaction to drive another reaction within cells. Adequate P availability for plants stimulates early plant growth and hastens maturity. Phosphorus recorded maximum in post monsoon analysis. It was ranged between 39 to 49 kg / hector in post monsoon and 27 to 41 kg / hector in pre monsoon, (Table-1). The increase in phosphorus might be due to the absorption of phosphate ions in to suspended particles and sediments. The decrease might be due to assimilation of phosphorus from the water by phytoplankton would find to release more phosphorus from the sediments. According to McAuliffe *et al.* (1948), phosphate ions are very strongly absorbed by solid phase of soil; the result is very low concentration of phosphate in soil solution.

The factors contributing to the deleterious effect of heavy metals as environmental pollutants, it may be point out that they cannot be destroyed through biological degradation as in the case with most organic pollutions and secondly metals tend to accumulate in the environment especially with bottom sediments

of rivers and lakes by association with organic and inorganic matter through processes of adsorption, complex formation and chemical combination (Solanki, 2001). Heavy metal analysis result shows somewhat similar data in both the seasons (Table-1). There was no marked variation in the content of Fe, Mn, Zn and Cu and all the heavy metals were not recorded in excess amount. Research has demonstrated that plants are effective in cleaning up contaminated soil (Wenzel et al., 1999), it may be the reason behind this normal constitutes of heavy metals in this soil. Any type of pollution also not recognized in Victoria Park. In present result the order of heavy metal concentration was found $Fe > Mn > Zn > Cu$.

CONCLUSION:

Present study concludes that the all soil parameter were in normal criteria of healthy soil. This is also responsible for excellent reach diversity of flora in Victoria Park also studied by authors.

There were large variations of soil chemical and physical properties across the Victoria Park. The properties varied, along a gradient of soil development. Nutrient pools are good. Soil physical properties were strongly correlated with soil fertility, with favorable physical properties occurring in highly weathered and nutrient depleted soils. . Soil phosphorus concentrations very little varied with the all study area. Phosphorus availability in the younger soils was governed by the weathering of the primary and secondary minerals (particularly apatite) which in turn was controlled by soil pH.

There is a need of conserving this healthy ecosystem gifted by nature as the Bhavnagar city area is attached with this park and this may cause harm to this ecosystem in future if proper care is not taken.

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Table-1. Various soil parameters of Victoria Park, Bhavnagar

		Samples							
		A	B	C	D	E	F	G	H
pH	Pre monsoon	7.6	8.0	7.3	7.1	7.3	7.7	8.2	7.9
	Post monsoon	7.9	8.3	7.9	8.1	8.0	8.1	7.9	8.3
EC (m.mho/cm)	Pre monsoon	0.253	0.394	0.512	0.977	0.112	0.153	0.154	0.224
	Post monsoon	0.276	0.434	0.654	0.990	0.256	0.232	0.176	0.323
Chloride (%)	Pre monsoon	0.067	0.070	0.064	0.085	0.079	0.089	0.078	0.089
	Post monsoon	0.065	0.061	0.059	0.078	0.074	0.086	0.069	0.086
Bicarbonate (%)	Pre monsoon	0.23	0.30	0.39	0.25	0.27	0.28	0.40	0.26
	Post monsoon	0.27	0.24	0.27	0.26	0.29	0.33	0.26	0.23
Total Hardness (ppm)	Pre monsoon	90	110	120	100	142	123	120	90
	Post monsoon	80	120	90	110	130	120	125	100
Ca Hardness (ppm)	Pre monsoon	8.02	24.05	24.05	12.03	12.04	16.00	24.75	18.02
	Post monsoon	16.03	32.02	26.05	16.02	16.03	16.03	24.05	28.06
Mg Hardness (ppm)	Pre monsoon	5.87	7.31	6.87	5.75	5.50	6.00	7.50	5.00
	Post monsoon	6.75	8.75	7.59	6.70	7.31	7.31	7.87	5.87
Nitrogen (%)	Pre monsoon	0.068	0.097	0.041	0.028	0.069	0.012	0.014	0.017
	Post monsoon	0.087	0.096	0.054	0.034	0.065	0.022	0.034	0.021
Phosphorus (Kg/hector)	Pre monsoon	32	30	36	32	27	34	35	41
	Post monsoon	40	41	40	39	38	45	48	49
Potassium (Kg/hector)	Pre monsoon	450	438	450	455	392	383	445	449
	Post monsoon	490	468	510	480	470	430	530	510
Fe (ppm)	Pre monsoon	3.64	8.68	13.1	3.13	3.84	3.22	6.66	5.08
	Post monsoon	3.59	7.98	12.67	2.77	4.11	3.65	5.71	6.13
Cu (ppm)	Pre monsoon	1.10	1.04	0.46	0.54	0.68	0.60	0.80	0.69
	Post monsoon	0.97	1.08	0.82	0.62	0.96	0.23	1.11	0.43
Zn (ppm)	Pre monsoon	1.30	1.68	2.42	0.92	0.78	0.82	1.16	1.46
	Post monsoon	2.11	1.34	3.20	0.87	0.71	0.86	1.21	1.28
Mn (ppm)	Pre monsoon	3.46	2.45	3.46	3.56	3.67	3.28	5.84	4.84
	Post monsoon	2.49	2.34	3.11	3.47	2.98	3.77	4.33	5.11