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Vegetable farmland soil assessment around industries of Singrauli, Madhya Pradesh

Sandeep Mishra*[1], P.K. Singh[1], Rajesh Pandey[2], Sandeep K. Soni[2], Babbulal Patel[1] and Rajesh K. Patel[1]

Department of Chemistry, SGS Govt. PG College, Sidhi, MP, India
Department of Biochemistry, APS University, Rewa, MP, India

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ABSTRACT
Physico-chemical variations in terms of three basic parameters of soil were analysed. All soil samples adjoining with power plant effluent along with variation. The pH of the soil samples ranged from 7.12-8.54, EC from 0.65-1.10mmhos/cm, and SOM from 2.04-2.49% of soil samples were accounted. The pH value was maximum in winter for site II. The EC of soil was found maximum in winter for site II. The ascending order of EC in different season at different site was found to be rainy > summer > winter for site I (National Thermal Power Corporation) and III (Essar Power MP Ltd) and summer > rainy > winter for site II (Reliance Sasan Ultra mega Power Ltd.). The SOM was observed maximum in summer for site I National Thermal Power Corporation. The ascending order of SOM in different season at different site was found to be rainy > winter > summer for the site III (Essar Power MP Ltd), Site II (Reliance Sasan Ultra mega Power Ltd.) and Site I (National Thermal Power Corporation).

Key words: Physico-chemical analysis, Soil, Industrial area, Singrauli

I. INTRODUCTION

Soil is one of the imperative and expensive resources or primary reservoir of heavy metals in the overall metal cycle in nature. All living things are directly and indirectly dependent on soil for day to day needs and 95% of the human food is derived from the earth [1]. A complex organization of soil is being fabricated through constitution as inorganic matter, organic matter, soil organism soil moisture, soil solution, and soil air. Roughly, the soil contains 50-60% mineral matter, 25-35% water, 15-25% air and little percentage of organic matter [1]. Soil is a natural body consisting of coatings of mineral ingredients of uneven thickness, which fluctuate from the parent materials in their morphological, physical, chemical and mineralogical attributes [2]. Recently, contamination of large areas of farmland by means of heavy metals has become a chief concern. It originates mainly from municipal waste, car exhausts, residues from industry, and the use of agro practiced chemicals.

Soil is composed of constituent parts of broken rock that have been modified via chemical and mechanical progressions like weathering and erosion. In the recent years of expansion mostly industries are in concert very important part, even every nation looking towards globalization through industrialization [3]. Due to industrialization, most of the biodiversity, soil, surrounded by the industry get contaminated and even some times it possibly will be obliterated [4]. The most possible sources of soil, water and plant pollutions are sewage sludge, remains of industrial factories in addition to intensive fertilization. In suburban areas, the use of industrial waste water is common practice in many parts of the world, including India [5]. The make use of sewage effluents for irrigating agricultural land is a worldwide practice. Due to discharge of waste matters, industrial area soils get contaminated. Due to discharge of effluents directly or after treating to the surface nearby its industrial area soil get contaminated highly. Soil pollution is caused by the presence of xenobiotics and other alteration in the natural soil background [6]. The physicochemical characteristics and their value of heavy metals in soils around the metals scrap dumps significantly originated [7].

The study area Singrauli district is developing industrialized region, often called a city of power. Recently, it is getting the ranking under the developing city of Madhya Pradesh by the NITI Aayog, India. Singrauli and their population also affected by various health based problems due to situated or located industrial hub or zone. Singrauli landscape hosts having the many thermal power stations and commercial operations based on the coal of the region. The Singrauli region in India is

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one of the most polluted industrial sites of Asia. Thermal power Plants represent the main source of pollution in Singrauli region, emitting six million tons of fly ash per annum.

Geographical locations of the study area

Singrauli district located in the north eastern part of Madhya Pradesh with Geographical area of 567200 ha and has latitudes of 230 49' and 24 42' North and longitude of 810 18' to 820 48' East with an altitude of 609 meter above sea level, covers an area of 5,672 Km^2.

In Singrauli, the climate is warm and temperate, average annual temperature is 24.7°C. The normal rainfall of the district is 1132.7mm. In concern of the eco-supporting data, the maximum variation recorded due to industrial establishment and their released pollutant. In specific terms of rainfall, greatest rainfall takes place during south west monsoon period. Rainfall 89% of the annual rainfall takes place during monsoon period i.e. June to September. July is the wettest month of the year. Only 11% of the annual rainfall takes place between October to May period (CGWB, 2013). Satellite map of sampling site incorporated all three sampling points as Site I, II and III (Fig 1).

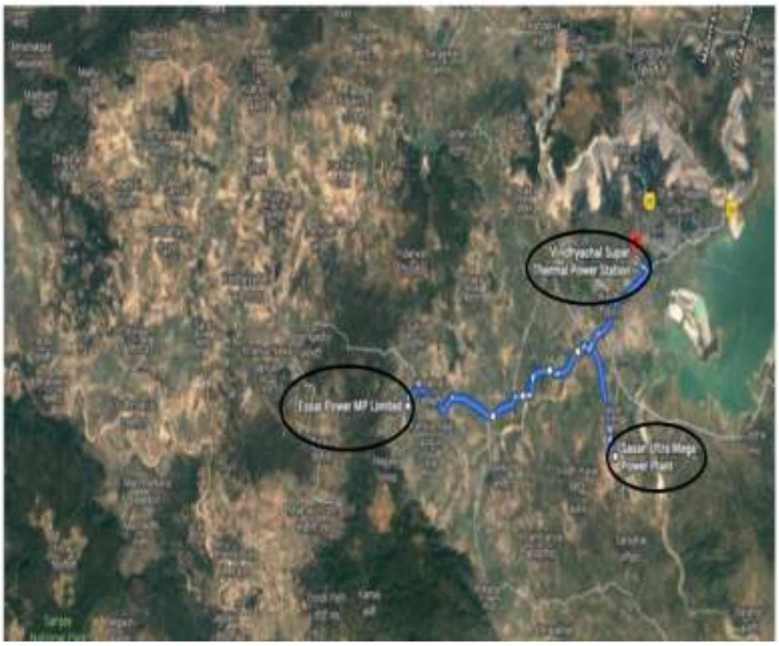

Fig. 1 The satellite map of sampling site.

Study site

The environment of Singrauli district is polluted due to the huge exploitation of coal. Thus the present study was conducted around three thermal power plants of Singrauli District namely- National Thermal Power Corporation (Site I), Reliance Sasan Ultra Mega Power plant (site II), Essar Power M.P. Ltd. (Site III).

Selection of sampling station and sampling procedure

For the purpose of this study samples were collected from three industrial sites. Soil samples were collected randomly from the standard depth of farm land (0-15cm), grasses, mosses, litter and other residues were removed from soil surface. Soil was collected in plastic bag, which were sealed and labelled properly. Before analysis, the samples were spread out thinly on a piece of paper for drying in air shade. The big lumps were broken down and plant roots and other undesirables matter were removed. After the soil become completely dry it was sieved through a 2mm sieve [8]. The samples were preserved in clean sealed polythene bags for investigating parameters.

Soil associated physico chemical measurement

The farm land soil samples located around the selected industries were collected from three different sites of Singrauli industrial region during diverse seasonal periods of the year 2018-2019. The collected samples was analyzed to determine their physico-chemical characteristics in terms of pH, electrical conductivity (EC) and Soil organic matter percent (SOM) by standard methods [9,10] . The pH meter was calibrated by using 4.01, 6.86, 9.18 buffer solution. Standard protocols were apply for the testing of soils [11,12].

II. RESULTS AND DISCUSSION

The physico-chemical properties of farm land soil of agricultural region in industrial area of Singrauli were analysed for the three sites with sample and sub sampling criteria. The obtained values were compared according to seasonal variation and examined the order of minimum to maximum variation in terms of pH, electrical conductivity (EC) and, Soil organic matter percent (SOM).

Physico-chemical characteristics of soil samples

Soil pH

The impact of seasonal variation on pH value of soil collected from different farmland around different industrial sites of Singrauli district. The pH of the soil around site I i.e. National Thermal Power Corporation (NTPC) farmland was found to be in the range of 7.40-7.80 with maximum and minimum pH in winter season (Table 1). similarly the pH of soil around site II i.e. Reliance Sasan Ultra Mega Power Ltd. farmland was found to be in the range of 8.37-8.60 with maximum in winter and minimum in rainy season. Around site III i.e. Essar Power MP Ltd farmland pH of soil was found in the range 7.12-7.72 with minimum in rainy season and maximum in winter season. The finding suggested that average pH of soil around the site II farmland was found to be maximum (8.47 ± 0.07) followed by site I (7.57 ± 0.12) and Site III (7.40 ± 0.23) throughout the year.

Average soil pH were compared on seasonal basis and it was observed that the pH exceeds permissible limit (pH 7.5) in all season with maximum in winter season (7.80 ± 0.52) followed by summer (7.77 ± 0.51) and rainy (7.74 ± 0.51) seasons (Fig 2). When mean results of different sites were compared on seasonal basis it was observed that soil pH was maximum at site II (Reliance Sasan Ultra mega Power Ltd) followed by site I and site III (Essar Power MP Ltd). Maximum mean pH was observed in winter season at site II (8.51 ± 0.1) while minimum at site III (7.36 ± 0.24) during rainy season (Fig 1).

Table 1. Seasonal variation in pH value of the soil samples collected from vegetable farmland around different industries of Singrauli district.

Sample Site	Rainy	Winter	Summer	Average
Site I National Thermal Power Corporation				
Site I a	7.62	7.54	7.57	7.58
Site I b	7.48	7.40	7.45	7.44
Site I c	7.53	7.80	7.70	7.68
Mean	7.54	7.58	7.57	7.57
SD	0.07	0.20	0.13	0.12
Site II Reliance Sasan Ultra mega Power Ltd				
Site II a	8.37	8.54	8.46	8.46
Site II b	8.52	8.60	8.50	8.54
Site II c	8.41	8.40	8.42	8.41
Mean	8.43	8.51	8.46	8.47
SD	0.08	0.10	0.04	0.07
Site III Essar Power MP Ltd				
Site III a	7.45	7.48	7.40	7.44

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Site III b	7.12	7.16	7.16	7.15
Site III c	7.23	7.38	7.29	7.30
Site III d	7.65	7.72	7.70	7.69
Mean	7.36	7.44	7.39	7.40
SD	0.24	0.23	0.23	0.23
WHO Permissible Limit		7.5		

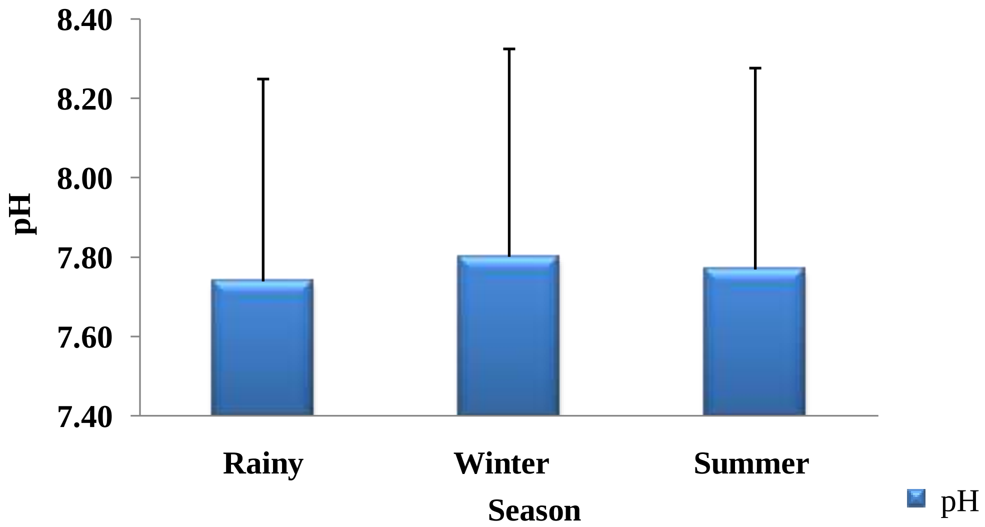

Fig 1. Variation in soil pH at different season throughout the study period

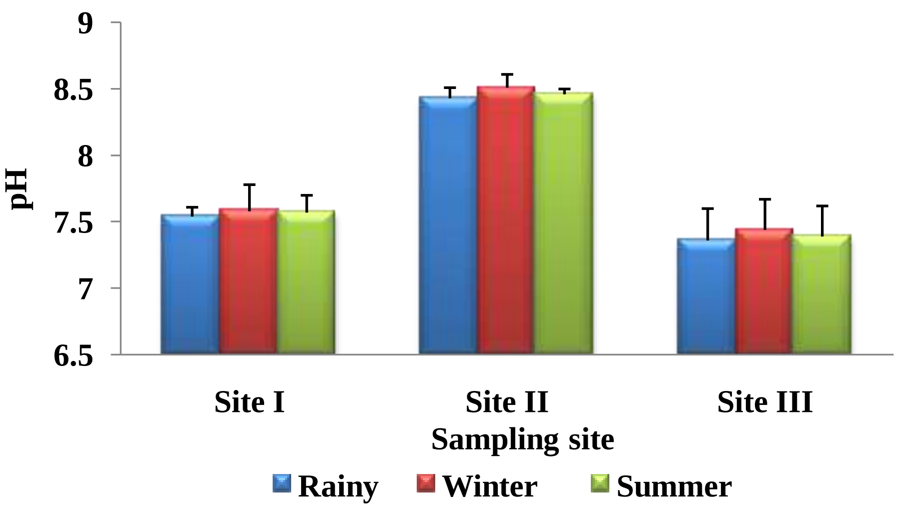

Fig 2. Variation in soil pH at different season and site

The study of physiochemical parameters like pH result showed, the soil was alkaline in almost all the samples, the average pH content of soils was recorded as ranges from 7.30-8.54 for all three sites. The up and down of the pH range depends upon the available minerals/salts in the soil. Soils of the diverse farms are established to be mostly alkaline. The ascending order of pH in

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different season at different site was found to be rainy > summer > winter. Maximum pH ranges were recorded in favor of the site II (Reliance Sasan Ultra mega Power Ltd.) as compared to Site I (National Thermal Power Corporation) and Site III (Essar Power MP Ltd.). In case of high alkalinity the solubility of minerals decreases, which creates nutrient deficiencies in the soil. [11, 12].

Soil Electrical Conductivity (EC)

The Electrical conductivity (dSm^{-1}) of soil samples collected in different season around different industrial sites of Singrauli district was presented in Table 2. The EC of the soil around site I and site III farmland was found to be in the range of 0.52-1.14 dSm^{-1} and 0.51-0.82 dSm^{-1} respectively with maximum EC in winter season and minimum in rainy season while EC at site II farmland was found to be in the range of 0.57-0.87 dSm^{-1} maximum in winter and minimum in summer. The average EC of the soil around the site I (National Thermal Power Corporation) farmland was found to be maximum (0.79 ± 0.01 dSm^{-1}) followed by site II Reliance Sasan Ultra mega Power Ltd (0.69 ± 0.02 dSm^{-1}) and III Essar Power MP Ltd (0.69 ± 0.01 dSm^{-1}) throughout the year.

The average EC value of the soil throughout the year among different season and at different site (seasonal basis) was presented in Fig 3 and Fig 4. Average EC of the all soil sample was found within permissible limit 8.5dSm^{-1}. During sampling year in winter season the average EC of soil was found maximum (0.91 ± 0.15) followed by summer (0.69 ± 0.07) and rainy (0.57 ± 0.06) seasons (Fig 3and 4).

When mean results of different sites were compared on seasonal basis it was observed that soil EC was maximum at site II (except winter season) followed by site III and site I. EC was observed maximum in winter season at all three sites ie. Site I (1.12 ± 0.02), site II (0.84 ± 0.03) and site III (0.8 ± 0.02) while minimum at site I (0.53 ± 0.01) during rainy season (Fig 4.1.2 b). The ascending order of EC in different season at different site was found to be rainy > summer > winter for site I (National Thermal Power Corporation) and III (Essar Power MP Ltd) and summer > rainy > winter for site II.

Soil organic matter plays an important role as a source of plant nutrients and in maintaining the soil integrity. The SOM value was found to be medium in the entire soil sample sites. SOM value generally decreases with increasing depths a number of factors influence the rate of decline SOM levels fine textured, clay soils hold much more than sandy soils for two reasons, firstly clay particles from bonds that hold organic matters. Secondly, decomposition occurs more quickly in well aerated sandy soils.

Long-term exposure of industrial pollution for all three sites on the vegetable growing farmland soil can increases EC, SOM values in soils [13-15]. The present investigations were in conformity with the outcomes of the reported survey [16]. EC is the capacity of water to carry ions, so it depends on the occurrence of ions and their concentration. Concentration of ions also shows variation in industrial area which might be the reason of variability of EC in soil samples. Physio-chemical properties of soil with in special concern to organic carbon stock under diverse land employ systems also documented with finding agreement [17].

A wide variation in the physico-chemical properties of soil of agricultural region was established in the present study. Different samples of soils from the industrial area showed divergence in the physico-chemical features commencing one another with respect to chemical attributes, as anticipated owing to a comparatively wide spectrum of power or electricity manufacturing foundations and due to existence of chemical in the industrial effluent.

Table 2. Seasonal variation in electrical conductivity (dSm^{-1}) of the soil samples collected from vegetable farmland around different industries of Singrauli district.

Sampling Site	Rainy	Winter	Summer	Average
Site I National Thermal Power Corporation				
Site I a	0.52	1.11	0.75	0.79
Site I b	0.54	1.14	0.72	0.80
Site I c	0.52	1.11	0.71	0.78

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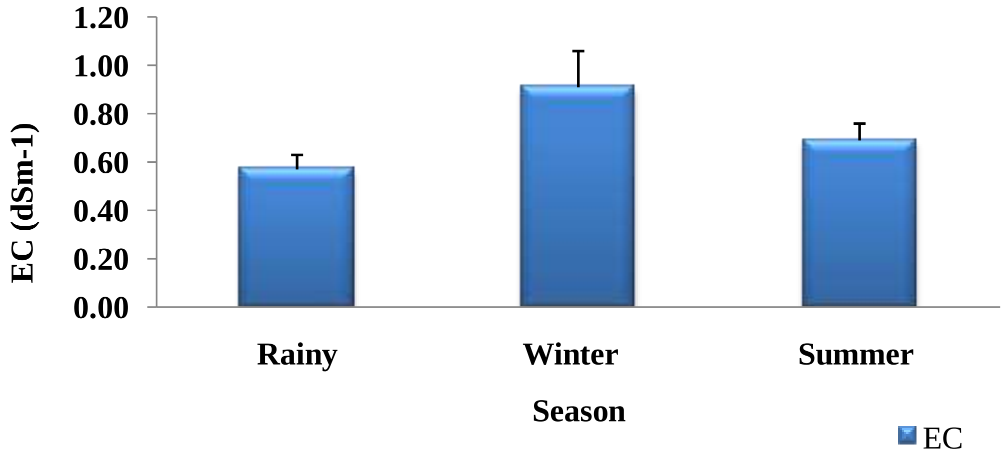
Mean	0.53	1.12	0.73	0.79
SD	0.01	0.02	0.02	0.01
Site II Reliance Sasan Ultra mega Power Ltd				
Site II a	0.67	0.84	0.62	0.71
Site II b	0.62	0.81	0.57	0.67
Site II c	0.65	0.87	0.59	0.70
Mean	0.65	0.84	0.59	0.69
SD	0.03	0.03	0.03	0.02
Site III Essar Power MP Ltd				
Site III a	0.56	0.82	0.71	0.70
Site III b	0.58	0.79	0.75	0.71
Site III c	0.51	0.80	0.74	0.68
Site III d	0.53	0.78	0.74	0.68
Mean	0.55	0.80	0.74	0.69
SD	0.03	0.02	0.02	0.01
WHO Permissible Limit		8.5		

Fig 3. Variation in soil Electrical Conductivity (dSm^{-1}) in different season.



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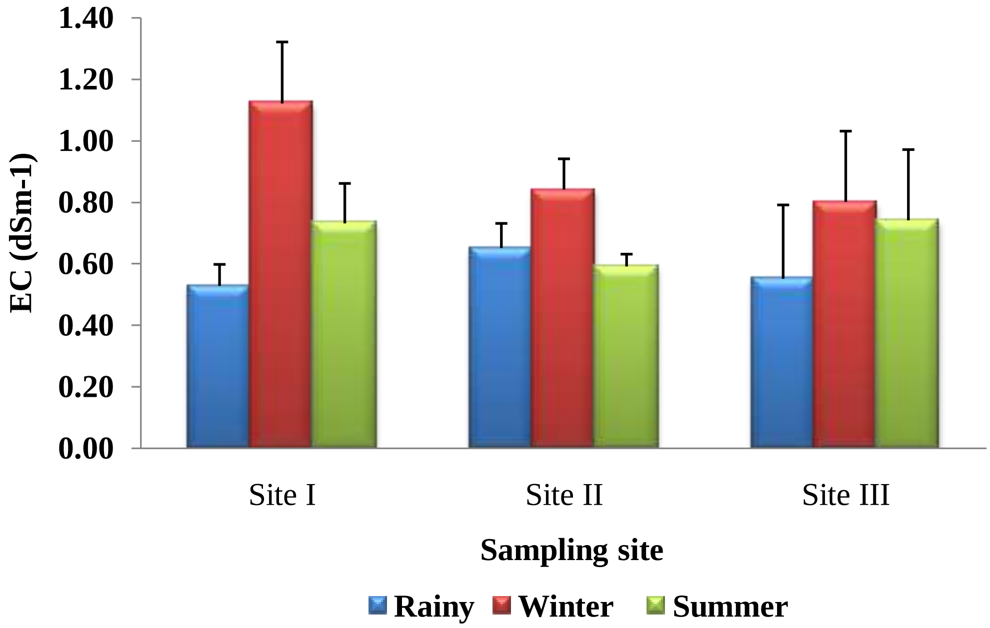

Fig 4. Variation in soil Electrical Conductivity (dSm^{-1}) in different season and site.

Soil Organic Matter (SOM)

The organic matter (%) of soil samples collected in different season around different industrial sites of Singrauli district was presented in Table.3. The SOM of the soil around site I and site III farmland was found to be in the range of 2.20-2.68 % and 1.95-2.19 % respectively, with maximum SOM in summer season and minimum in rainy season while around site II farmland SOM was found to be in the range of 2.02-2.33 % with maximum SOM in summer season and minimum in winter season. The average SOM around site I farmland was found to be maximum (2.47 ± 0.02 %) followed by site II (2.18 ± 0.04 %) and site III (2.06 ± 0.01 %) throughout the year.

The average SOM of the soil throughout the year among different season and at different site (seasonal basis) was presented in Fig 5 and Fig 6. During sampling year in winter season the average SOM of soil was found maximum (2.34 ± 0.23) in summer followed by winter (2.23 ± 0.21) and rainy (2.08 ± 0.12) seasons (Fig 6). When mean results of different sites were compared on seasonal basis it was observed that soil SOM was maximum at site I followed by site II and site III. SOM was observed maximum in summer season at all three sites ie. site I (2.66 ± 0.02), site II (2.3 ± 0.04) and site III (2.14 ± 0.03) while minimum at site III (1.97 ± 0.03) during rainy season. The ascending order of SOM in different season at different site was found to be rainy > winter > summer. Soil organic matter (SOM) is essential intended for the retention of metals in the soil by this means decreasing the mobility, bioavailability and enhances the utility of soil for agricultural aspects whereas the some deficiency of nutrients has become measure constraint to productivity and stability of soil [18-20]. Recorded variation might be due to indiscriminate dumping of refuse and decompositions of dead plants like performed higher dominant anthropogenic activities in this study areas.

Table 3. Seasonal variation in soil organic matter (SOM) (%) of the samples collected from vegetable farmland around different industries of Singrauli district.

Sampling Site	Rainy	Winter	Summer	Average
Site I National Thermal Power Corporation				
Site I a	2.28	2.52	2.68	2.49
Site I b	2.26	2.52	2.64	2.47
Site I c	2.20	2.50	2.65	2.45
Mean	2.25	2.51	2.66	2.47
SD	0.04	0.01	0.02	0.02
Site II Reliance Sasan Ultra mega Power Ltd				
Site II a	2.05	2.27	2.30	2.21
Site II b	2.03	2.29	2.26	2.19
Site II c	2.04	2.02	2.33	2.13
Mean	2.04	2.19	2.30	2.18
SD	0.01	0.15	0.04	0.04
Site III Essar Power MP Ltd				
Site III a	1.95	2.08	2.16	2.06
Site III b	1.95	2.05	2.19	2.06
Site III c	1.99	2.05	2.12	2.05
Site III d	2.00	2.04	2.09	2.04
Mean	1.97	2.06	2.14	2.06
SD	0.03	0.02	0.04	0.01
WHO Permissible Limit		Not defined		

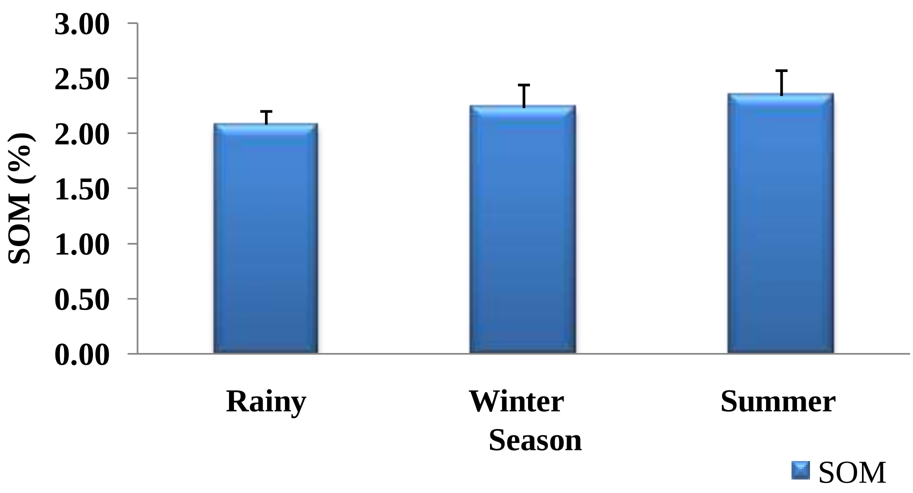

Fig 5. Variation in soil organic matter (%) in different season.

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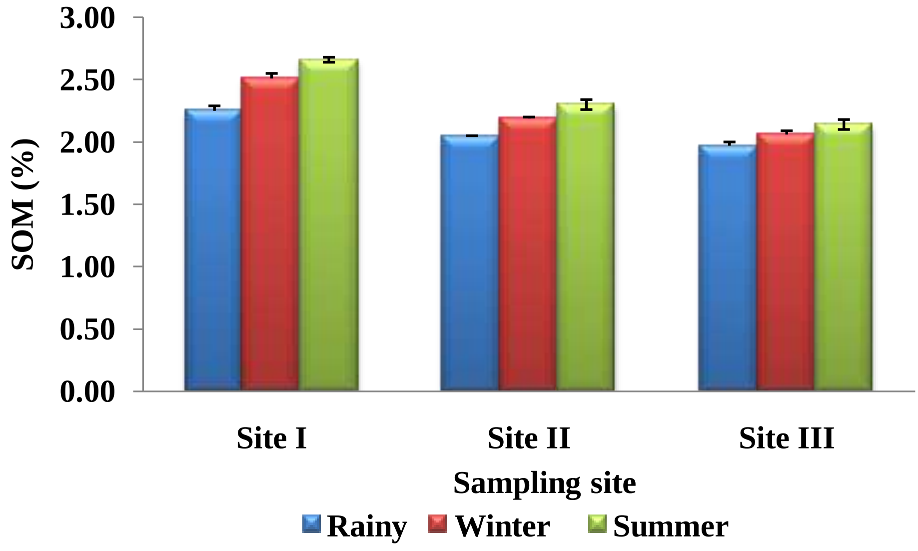

Fig 6. Variation in soil organic matter (%) in different season and site.

III. CONCLUSION

Physico-chemical analysis is a useful tool for the immediate assessment of materials like soil. A wide variation in the physico-chemical properties of soils in degraded site was found in the present study. In the present investigation soil samples of the all three farm land site show pH value ranges from alkaline on the other hand control site pH is very strongly acidic. On the basis of organic matter of soil, it shows variable altercations concentration it is clearly indicated that the soil of industrially degraded area has lost their fertility. The electrical conductivity of soils was maximum in favor of National Thermal Power Corporation. Over all finding indicates as the rapid growths of population in addition to technological and established industries have brought massive difficulties as well as degradation of soil quality standard in favor of human wellbeings.

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