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Soil profiling and Physical parameters of leguminous crops grown soils around established industries in Singrauli (M.P.)

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ABSTRACT

Soil is the most diverse, nutrient rich loose surface material which covers most of our land. Soil contains both the organic and inorganic matter. Industrial activities affect and demolishing the influence on the soil health conditions. The assessment of the level of contamination is a noteworthy step towards counteracting ecological contamination. Anthropogenic activities are responsible for the contamination of the environment. Determination of physical parameters and nutrient profiling were perfumed in samples of irrigated waste water used in leguminous crops grown around the three established industries (station 1 Mahan Super Thermal Power Project), station 2 (Chitrangi Power Project), and station 3 (Sasan Ultra Mega Project) in Singrauli (M.P.). Investigation allowed for two sequential years 2020-2021 and 2021-2022.

There are five leguminous crops Soybean (Glycine max) with Raj Soya-24 variety, Beans (Phaseolus vulgaris) as Pusa beans 2, Pea (P. sativum) with Paras (IGKV), Gram (Cicer arietinum) JG 315, and lentice (Phaseolus vulgaris) Pusa lentils 5 were studied for two respective years 2020-21 and 2021-22. All the crops were according to their concern seasons and irrigated with waste irrigated water. Soil pH, EC, SOM, and OC% along with soil profiling (Clay, moisture etc) were studied in the soil samples.

Sampling station was station 1 Mahan Super Thermal Power Project of Singrauli soil was shown variable soil physical parameters were determined through standard methods and suggestion of APHA. The correlation variation exists along with other supplemented parameters that indirectly affect the soil physical parametric and profile measurements. The increase in growth characteristics with soil is evident from data on soil sample analysis, which showed high content of nutrients in the soil samples that established a direct indirect impact on physical parameters of soil in both respective investigating years.

Key words: leguminous crops, industries, Singrauli region, acid digestion, physical parameters, soil profiling.

I. INTRODUCTION

The use of wastewater in metropolitan agriculture has become a general trend for over a century. Thus, heavy metals end up accumulating in plants and soils. Many perilous substances become part of soils and plants by means of dumping of hospital and industrial waste [1,2]. The affected and altered irrigated water directly affected the cereals crops and soil productivity. Effects of heavy metal pollution are reflected in ecosystems in different forms, like lowered productivity, decreased biodiversity, and simplification in structure [3-6]. Soil ecosystems are greatly disturbed by addition of noxious chemicals. Soil health is the state of the soil being in sound physical, chemical, and biological condition, having the capability to sustain the growth and development of land plants‖ [7] . Soil acts as a filter and buffer for contaminants, but its potential to cope is finite. If the capacity of the soil to mitigate the effects of pollutants is exceeded, the contaminants pollute other compartments of the environment. Soil pollution causes a chain reaction that starts with reduced soil biodiversity, alters organic matter incorporation rates, and then weakens soil structure and ability to resist erosion. Main sources of soil pollution are by industrial activities that release large amounts of chemicals into the environment during manufacturing, transportation and use [8-10]. Degradation of the soil is the most problematic problem of the Indian soil. The process of soil degradation is the result of natural forces and human activities. India is now reaping what it had sown decades ago [11, 12]. The food productivity and environmental quality is dependent on the physico-chemical properties of

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soil, so it is very important to know the basic knowledge about the physico-chemical properties of soil [13-15].

Heavy metal percolation in soil causes contamination of underground water sources as well [16-18]. Region of Singrauli known for evolving industrial pollution, main discharge consist heavy metals. Disposal of et al sewage water and industrial wastes is a great problem. Often it is drained to the agricultural lands where it is used for growing crops including vegetables. Heavy metals are ubiquitous in the environment, as a result of both natural and anthropogenic activities, and humans are exposed to them through various pathways [19]. Wastewater irrigation is known to contribute significantly to the heavy metal contents of soil [20]. Heavy metals in wastewater come from industries and municipal sewage, and they are one of the main causes of water and soil pollution. Long-term use of wastewater on agricultural lands contributes significantly to the build-up of the elevated levels of these metals in soils and plants [21-23] which is of serious concern. The current study focuses on the industrial setting and the surrounding agricultural area. Heavy metals are released by industries after being disposed of. It is crucial to periodically evaluate the quality of food items in this region by metal analysis along with the physical profiling of water, due to the significance of these metals for humans and the associated threat they cause, as well as a growth in environmental contamination.

II MATERIAL AND METHODS

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. Thermal power plants represent the main source of pollution in Singrauli region, emitting six million tons of fly ash per annum and other usual and unusual waste. Geographically Singrauli located in the north eastern part of Madhya Pradesh. Study area or region cover to the Singrauli especially around situated sites selected with specifies three stations.

In present study four stations were selected as code of station 1 (Mahan Super Thermal Power Project), station 2 (Chitrangi Power Project), and station 3 (Sasan Ultra Mega Project). Station 1 (Mahan Super Thermal Power Project) with three sampling sites (Raila, Klairahi, and Rajmilan) where leguminous crops were frequently and commercially grown from last several years, station 2 taken as Chitrangi Power Project also with three sampling sites (Ajani, Badgad, and Duara), Station 3 as Sasan Ultra Mega Project with three sampling sites (Makrohar, Saraijhar, and Pipara). All three selected sampling sites completely fulfilled the aspects of our research plan in terms of leguminous crops, level of water used in irrigation, bioaccumulation of heavy metals etc. Sites of each station were allotted identical codes during the investigation and carefully collected sample examinations/analysis with 1SI-1SIII, 2SI-2SIII, and 3SI-3SIII respectively.

Soil samples collection and physical parametric measurement

Grab and integrated method gives used to collect the samples from the sites. Autoclaved and labelled glass bottles and plastic bottles made of fluorinated polymers were used for collection of samples. The soil samples were collected store carefully for further investigation. Collected soil samples were followed for analysis. Physical parameters of soil, were determined through standard method of APHA, 1998, CPCB and WHO. The pH was determined by1:2 soil water suspension method using digital pH meter [24] EC was determined by1:2 soil-water suspension method using digital EC meter [25]. Organic carbon was determined by the wet oxidation [26. Physicochemical properties along with soil profiling were determined using standard protocols [27]. All the analysis conducted in laboratory of department of Chemistry, S.G.S. Govt Autonomus P.G. College, Sidhi, M.P.

III RESULTS AND DISCUSSION

The associated physical nature of soil offers the best ability to bond with other elements, which expedites the problem of metal toxicity at varying levels. The high OM% of the Singrauli water and soil sample supports the likelihood of similar composition. When compared to its geographic position and the presence of mining resources, another study indicated that various metrics pertaining to soil and water data were present in more significant numbers due to other sampling field site variances [28].

The heavy metals of the soil samples varied due to geographical alteration and discharge of effluents from industries to surrounding existing agronomic fields selected in our investigation during 2020-2022. Crop quality, quantity, and soil composition are greatly affected by the quality of water used for irrigation. Soil contains salts, minerals, and various pollutants but their level differs depending on the source from which the water is obtained. The irrigated water changes the soil composition and the pollutants are also absorbed by the plants cultivated in such field soils [29-31].

The presence of essential compounds in waste irrigated water makes it beneficial for leguminous crop production but the presence of toxic pollutants in it drastically affects the physiochemical structure of the soil. Toxic pollutants especially get easily transferred and bio-accumulated in edible crops such as crops grown in such soil which poses serious health risks among the consumers of such leguminous crops [32]. During the year 2020-21 analysis of soil samples was determined in all three station 1 Mahan Super Thermal Power Project), station 2 (Chitrangi Power Project), and station 3 (Sasan Ultra Mega Project) the correlation was calculated and the matrix was determined.

1. **Soil profiling of leguminous crops collected samples for investigating year 2020-21 and 2021-22.**

pH value

The pH value of the soil sample collected between 2020 and 21 was found to be at its highest in Badgad, station II, with a value of 7.54 ± 0.70 and an RSD% of 0.70; on the other hand, it was at its lowest in Saraijhar, site III, with a value of 7.15 ± 0.023 and an RSD% of 0.32. Rajmilan, Raila, and Klairahi sites had pH values of (7.52) > (7.47) > (7.45) in that order for station I. For sites Ajani, Badgad, and Duara, respectively, this order was (7.54) > (7.42) > (7.41) for station II. Similarly, it was discovered that the order for station-III was (7.45) > (7.27) > (7.15) for the sites Saraijahr, Pipara, and Makrohar concurrently (fig. 1). Thereby indicating the soils are moderately alkaline. pH value increases with the increasing depth because the upper horizons receive maximum polluted water and by dissolved carbonic acids and presence of high amount of exchangeable sodium ions. Similar finding were reported [30].

Additional research conducted in 2021–2022 revealed that the pH values of soil samples were highest in Rajmilan and Badgad, stations I and II, with pH values of 7.51; however, the lowest values were discovered in Saraijhar, station III, with pH values of 7.15 and an RSD% of 0.32. The pH values for sites Rajmilan, Raila, and Klairahi were (7.51) > (7.48) > (7.47) in that order for station I. For sites Badgad, Duara, and Ajani, respectively, this sequence was (7.51) > (7.43) > (7.420) for Station-II. Similarly, it was discovered that the order for station-III was (7.45) > (7.27) > (7.15) for the sites Saraijahr, Pipara, and Makrohar simultaneously. The results indicated that the soil's pH is alkaline; in 2021, it ranged between 7.15-7.54 (fig. 2). Due to presence of organic matter and porous particles in soil similar finding were reported [33].

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Fig. 1 Comparative pH status in soil samples of leguminous growing crops around industries of Singrauli 2021

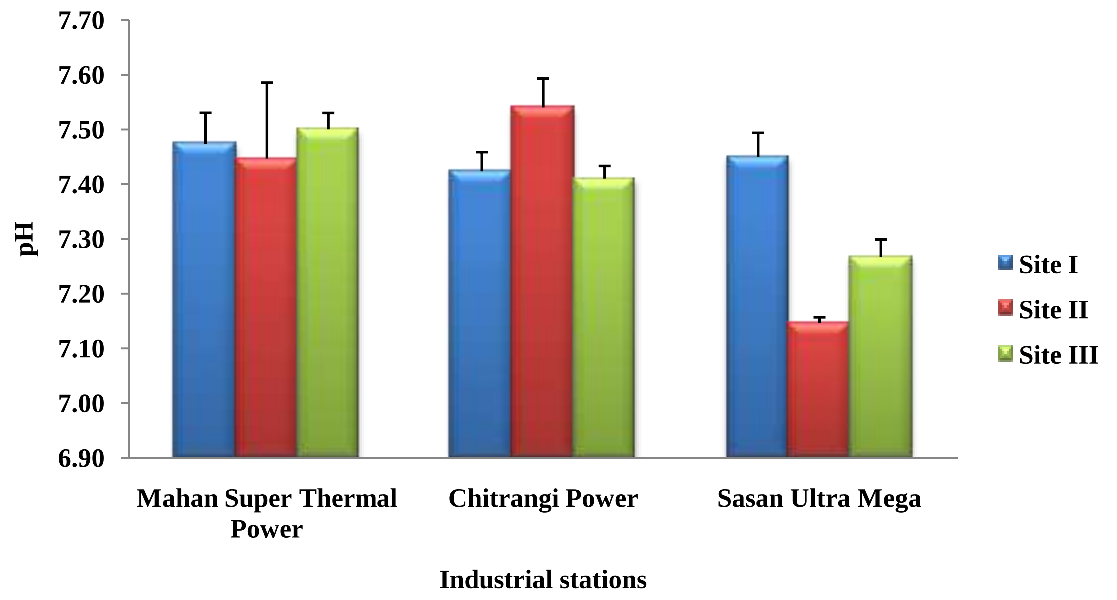
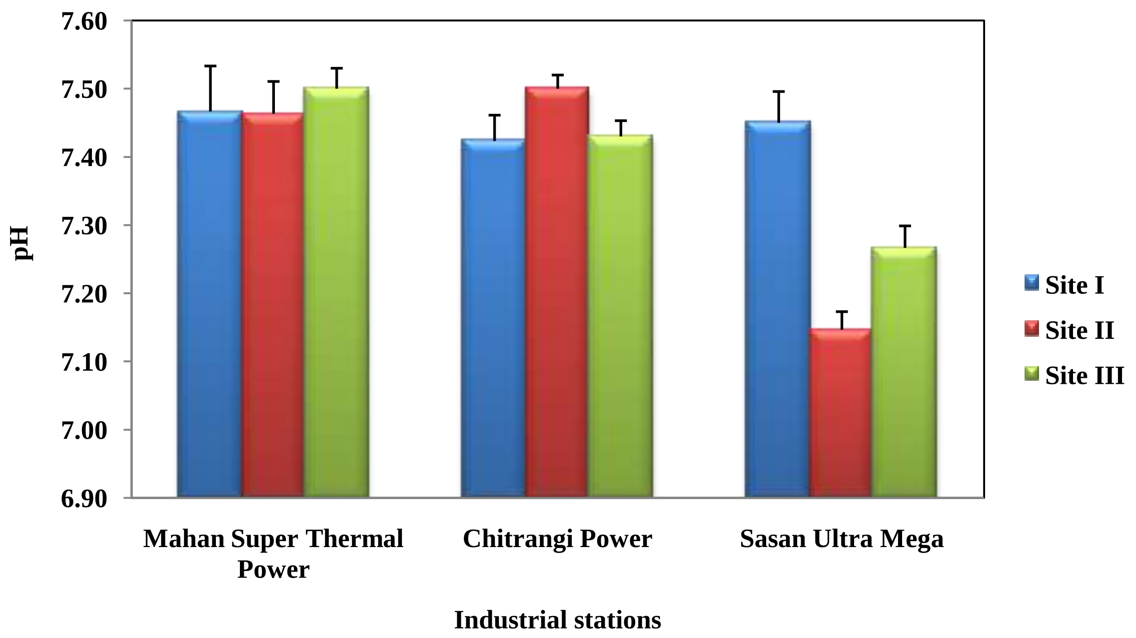


Fig. 2 Comparative pH status in soil samples of leguminous growing crops around industries of Singrauli 2022



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Soil Electrical Conductivity (EC)

During the first investigation year of 2020-21, the electrical conductivity (dSm^{-1}) of soil samples collected from around different industrial sites of Singrauli was expressed. In station I the order of EC found as (1.12 > 0.72 > 0.53) for the sites Klairahi, Rajmilan, and Raila respectively. Similarly for the station II the order was (0.85 > 0.65 > 0.62) for sites Badgad, Ajani and Duara respectively. In station III the maximum EC was recorded in Makrohar sites and minimum was in Saraijhar sampling site with values 0.84 and 0.69 dSm^{-1} respectively. Thus, 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. During the year 2021-22 the study found the order of EC for station I as Klairahi > Rajmilan > Raila with values (0.79 > 0.73 > 0.55). In the station II most EC was evidenced in Duara site with assessment. Similarly for the Station-III the order was (0.84) > (0.74) > (0.68) for the sites Makrohar, Pipara, and Saraijhar sites respectively (Fig. 3 and 4).

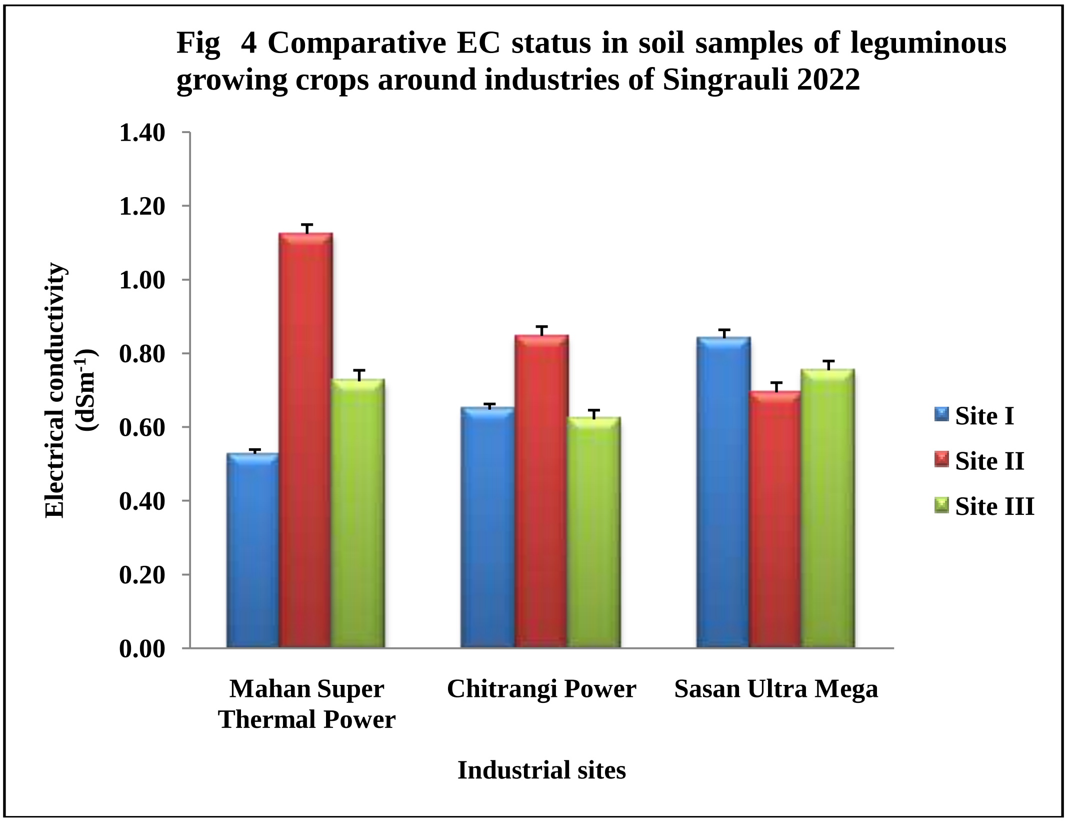

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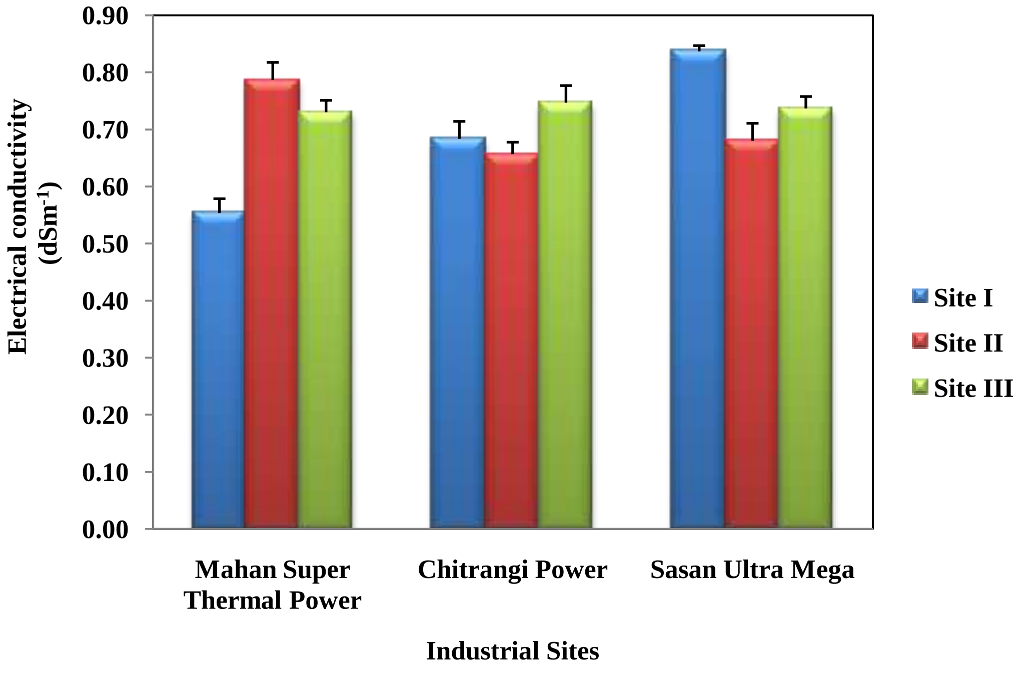
Fig 3 Comparative EC status in soil samples of leguminous growing crops around industries of Singrauli 2021-22



3 Soil Organic Matter (SOM)

When the organic matter (%) of soil samples taken in 2020–21 from three distinct industrial Singrauli locations was examined, there were notable differences between the three stations. The highest percentage of soil matter was found in Klairahi, Badgad, and Saraijhar at stations I, II, and III, with values of 2.62%, 2.25%, and 2.14%, respectively. The range of OM% in station I, if observed separately, was 2.55-2.62%. On station II, however, this range was noted to be between 2.07 and 0.25%. In a similar vein, station III's results varied between 2.04 and 2.14% (fig. 5). Soil organic matter supplies essential nutrients and has unexcelled capacity to hold water and absorb cations [34]. It also functions as a source of food for soil microbes and thereby helps enhance and control their activity [35]. The content of organic matter in a soil can be maintained the structure of soil. It affects the available water capacity and infiltration rate.

The sequence of OM% for Raila, Klairahi, and Rajmilan sites was discovered to be 2.64% > 2.62% > 2.55% in the next study year (2021–2022). For the sites Badgad, Duara, and Ajani in station II, the ascending order of OM% was 2.28% > 2.22% > 2.16%. Likewise, station III OM% ranged from 2.14 to 2.23%. The organic carbon decreases with increasing depth due to the fact that surface soil contains composed and partial decomposed organic matter while subsoil contains decomposed organic matter which has undergone chemical and biological changes. Similar finding were reported [36].

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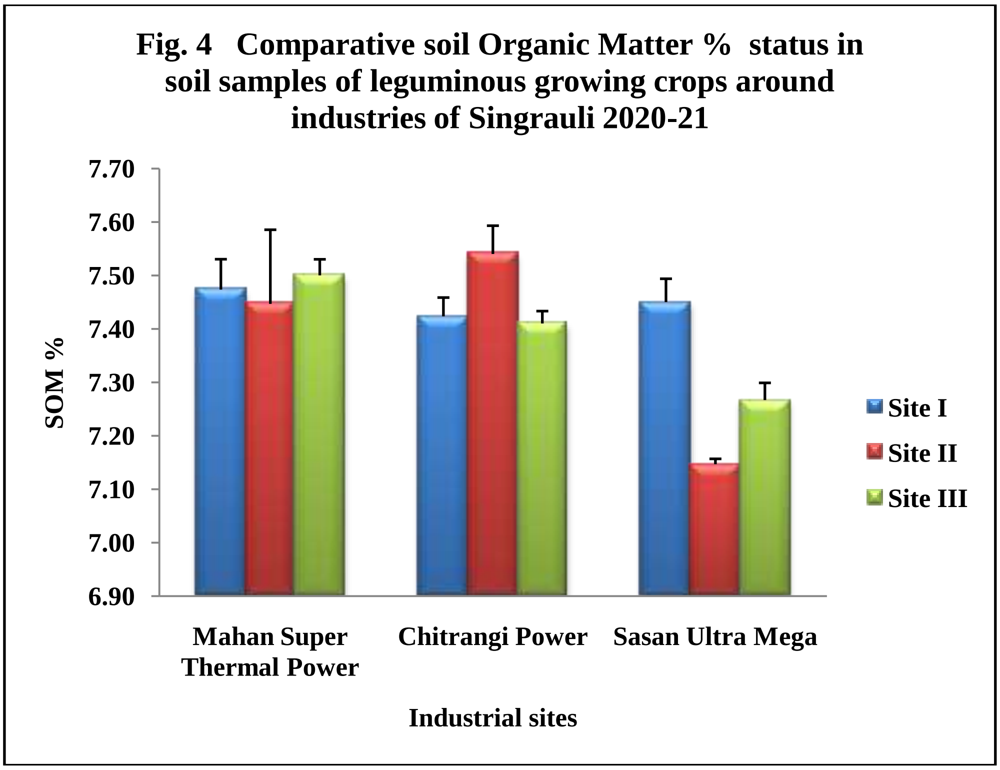

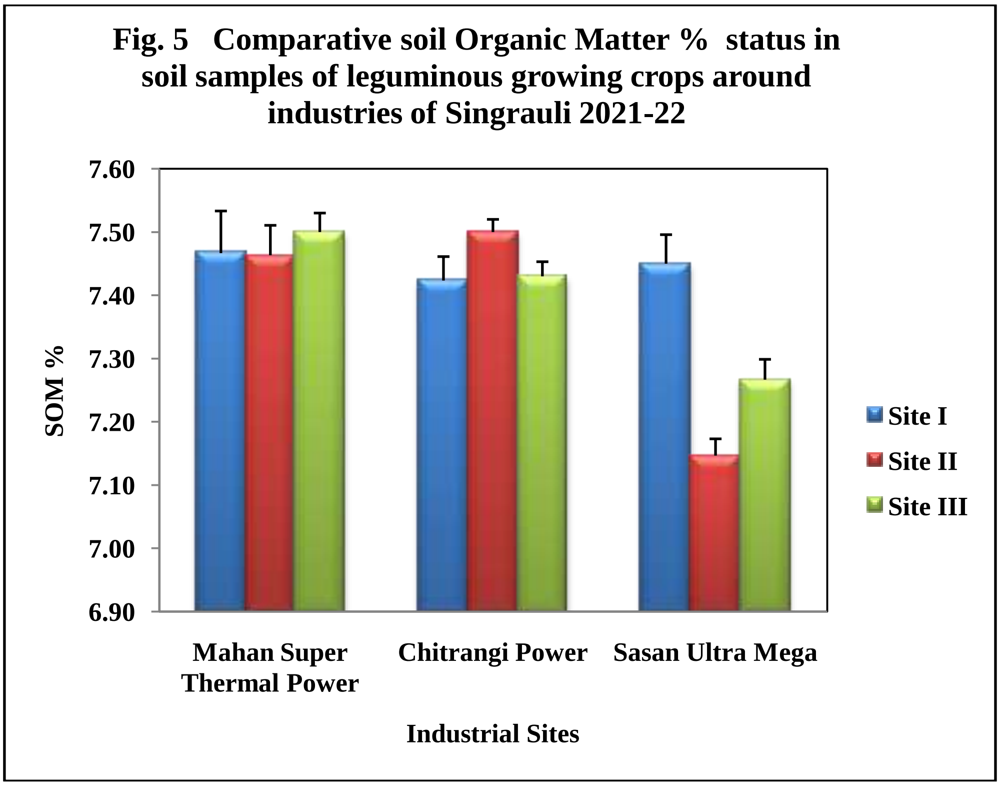

2. Evaluation of Soil properties and soil profiling status during 2021 and 2022

The percentages of moisture, slit, sand, and clay in the soil were measured and recorded at a standard depth below the surface. The soil's texture varied in appearance. Climate adjustments may have altered the percentage parameters. Station I > Station II > Station III had the highest mean+SD values (32.74 ± 0.118) > (24.64 ± 0302) > (19.50 ± 0.782) for the slit% in 2020-21. However, when considering moisture percentage, the ranking shifted to mean+SD values of 0.46 ± 0.015) > 0.39 ± 0.01) > 0.36 ± 0.020) for stations I, III, and II, respectively. The sand percentage order was completely different, with recorded values of (27.64 ± 1.360) > (25.85 ± 1.109) > (22.37 ± 1.10) for stations III, II, and I. Similar to other metrics, station II recorded the maximum values for clay% and OM% when they were seen (fig. 6).

Station I > Station II > Station III had the highest slit% order during 2021–2022, with mean+SD values of (36.07 ± 1.079) > (25.67 ± 1.174) > (21.69 ± 0.677). In the case of moisture percentage, on the other hand, the mean+SD values were (0.49 ± 0.026) > (0.43 ± 0.015) > (0.39 ± 0.015) for stations I, III, and II, respectively. Station III > Station II > Station I showed the decreasing tendency for sand percentage, with recorded values (36.95 ± 0.612) > (25.02 ± 1.127) > (22.36 ± 0.367). Station-III > Station-II > Station-I had the highest clay percentage order, with values of (45.98 ± 2.14) > (44.04 ± 2.09) > (43.96 ± 1.85). Similarly, station I > station II > station III had values of 2.55 ± 0.102) > 2.53 ± 0.069) > 2.24 ± 0.020 for the OM% order. The results of the soil slit%, moisture%, clay%, and organic matter percentages showed that station % expressed more than station II (fig. 7).

Fig. 6 Soil properties % in soil collected from liguminous crops farmland around industries of Singrauli 2020-21

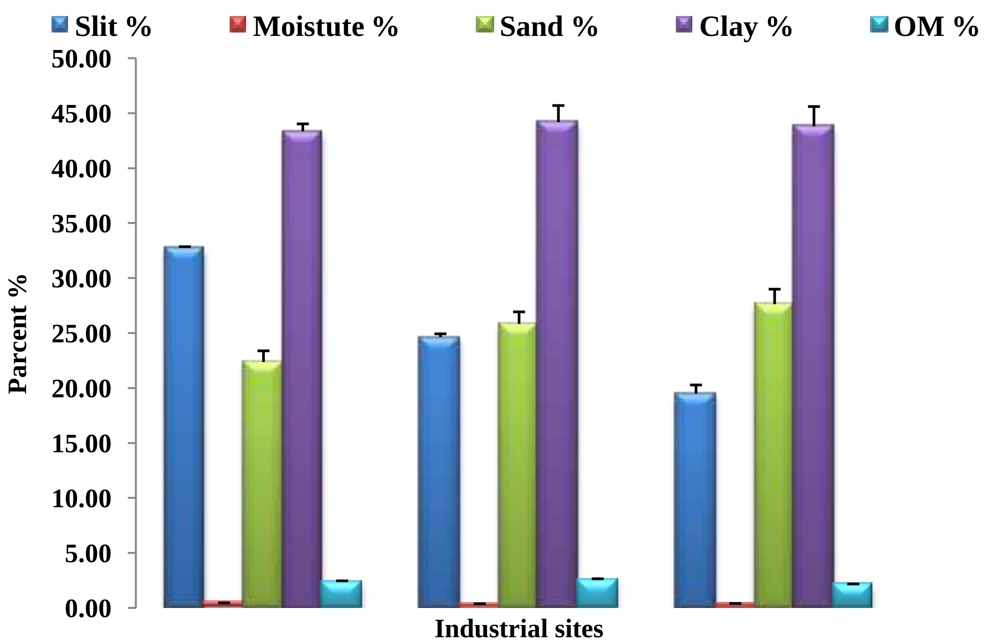

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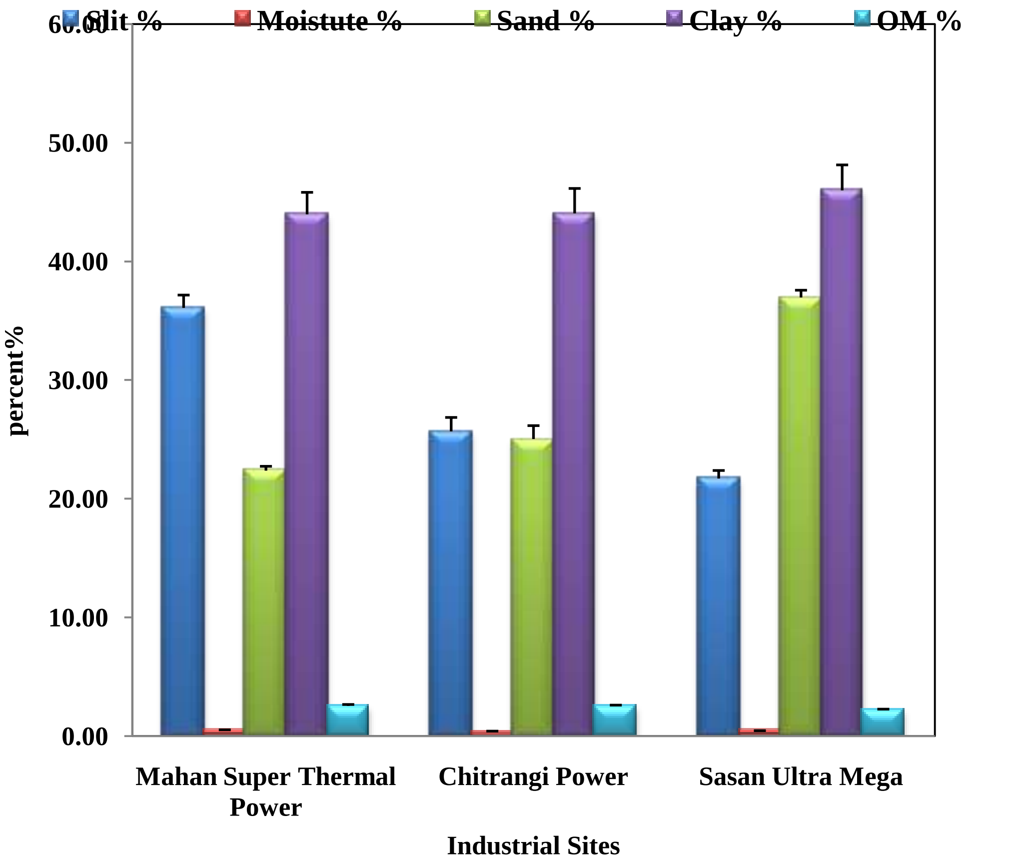
Fig. 7 Soil properties % in soil collected from liguminous crops farmland around industries of Singrauli district in 2021-22



3. Correlation study on soil properties of leguminous crop during 2020-21 and 2021-22

The first inquiry year (2020–21) saw the lowest positive correlation (0.362115) between clay percentage and sand percentage and the largest positive correlation (0.9786887) between OM percentage and sand percentage in the correlative study among several soil characteristics for texture analysis. Furthermore, there was a correlation between value 1 and every parameter. The percentage of sand and moisture (-0.99937) and the percentage of clay and moisture (-0.39501) showed the highest and lowest negative correlations. Figure shows that during 2020–21, there was only a positive correlation discovered in moisture% between moisture and silt%, clay%, and sand%. In contrast, a negative link was established between sand and slit%, clay%, and moisture% OM%. The deficiency of nutrients has become major constraint to productivity, stability and sustainability of soils [37, 38]. A soil aggregate status usually deteriorates rapidly if soil is repeatedly cropped with annuals that supply little organic matter to the soil; require extensive cultivation [38-40]. It must not be forgotten that they were among the first outputs from poor and degraded soils. The adaptability of crops from the Fabaceae group and their ability to tolerate high salinity, temperatures and even droughts, yielded different varieties in different environments, and enabled the restoration of arid ecosystems [41].

The maximum positive correlation between OM% and sand% was determined to be 0.978687 during 2021–22; whereas, the smallest positive correlation was found to be 0.362115 between clay% and sand%. The greatest negative associated value for the percentages of sand and moisture was found to be -0.99937, as shown in tables 1 and 2.

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Table 1 Correlation study on soil properties of leguminous crop during 2020-21

	Slit %	Moisture %	Sand %	Clay %	OM %
Slit %	1				
Moisture %	0.878306	1			
Sand %	-0.89474	-0.99937	1		
Clay %	0.092274	-0.39501	0.362115	1	
OM %	-0.78397	-0.98537	0.978687	0.545816	1

Table 2 Correlation matrix of soil properties in leguminous crop farmland around industries of Singrauli during 2022

	Slit %	Moisture %	Sand %	Clay %	OM %
Slit %	1				
Moisture %	0.878306	1			
Sand %	-0.89474	-0.99937	1		
Clay %	0.092274	-0.39501	0.362115	1	
OM %	-0.78397	-0.98537	0.978687	0.545816	1

IV. CONCLUSION

The associated physical nature of soil offers the best ability to bond with other elements, which expedites the problem of spoil toxicity at varying levels in present investigation. The soil sample varied due to geographical alteration and discharge of established industrial effluents from industries to surrounding existing agronomic fields selected in our investigation during 2020-2022. Soil quality in terms of pH, EC, SOM, OC%, quantity, and soil composition (Moisture, clay, slit and sand were greatly affected through the quality of irrigated waste water employed for irrigation practices. The untreated waste irrigated water caused toxicity in humans due to contaminated structure. Overall finding highlighted about pollution load which indicated that the waste water affect to the leguminous field soils. Sampling station was station 1 Mahan Super Thermal Power Project of Singrauli soil was shown variable soil physical parameters were determined through standard methods and suggestion of APHA. The correlation variation exists along with other supplemented parameters that indirectly affect the soil physical parametric and profile measurements. The increase in growth characteristics with soil is evident from data on soil sample analysis, which showed high content of nutrients in the soil samples that established a direct indirect impact on physical parameters of soil in both respective investigating years

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