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Original Research Article

Analysis and Effect of Soil Physicochemical Properties in Selected Areas in South Western Region of Rajasthan

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Physicochemical properties, Microorganisms, Soil enzyme activity

A B S T R A C T

The objective of the study was to enumerate microorganisms in selected site and their extracellular enzyme activity in the soil. Soil microorganisms utilized different type of waste such as industrial, domestic and agriculture to increasing soil enzyme activity (such as protease, amylase and catalase) were studied. Microorganisms correlated positively with pH, organic carbon matter, phosphorus, total nitrogen and micronutrients present in soil and negatively with. Soil physicochemical properties such as silt, clay, electrical conductivity water holding capacity, organic matter and total nitrogen contents and microbial population were also affected by soil microorganisms. Soil physicochemical properties and enzymatic activity together obtain the main indicators of soil quality. The main objective of study was to validate the presence of extracellular enzymes and comparing the soil enzymatic activity in industrial and agriculture area.

Introduction

Soil is an important system of terrestrial ecosystem. There is a direct impact of pollutants on minerals, organic matter and microbial community of soil (Lowry *et al*., 1951). The discharge of industrial effluents especially without treatment may have profound influence on physio-chemical and biological industries (David shyam Babu, 2010). Thus determination of enzyme activity and microbial biomass, chemical soil parameters seems to be the best approach for evaluating the state of microbial activity. A major industry that produces huge volume of waste water contains several toxic and non-biodegradable organic materials, may affect soil enzyme activities, which in turn soil fertility. In reality, the soil enzymes occupy a vital role in catalyzing reactions associated with organic matter decomposition and nutrient cycling (Poonkothai and Parvatham, 2005). The research has demonstrated that biodegradable is a specific type of organic matter, if added to the soil, improves its physicochemical properties (Lopedota *et al*., 2013). Moreover, it contains high amounts of mineral nitrogen (60–70% total nitrogen) compared with organic fertilizers (e.g., compost and cattle manure, contain around 6–30% of total nitrogen) (Svensson *et al*., 2004). The biodegradable material contains huge amounts of organic matter (total organic carbon at 35.6–63.3% DW and 28.1% DW, respectively) (Stefaniuk *et al*., 2015; Różyło *et al*., 2017). In addition to improving the physicochemical properties of the soil, organic matter also stimulates the microbial growth and increases the enzymatic activity. The fertility of the soil in the natural agroecosystem depends on the microbial processes such as mineralization of organic nitrogen (N), carbon (C), sulfur (S), and phosphorus (P); transformation of organic matter in the soil; and N_2 fixation by the soil microbial biomass (Joniec, 2018). The important parameters that reflect soil quality: quantity and quality of OM, soil structure, pH, and physicochemical properties. Microorganisms play a key role in the transformation of soil components of nutritional importance or the plants. Soil enzyme sustainability activities and soil physico-chemical properties are more important among these factors and more easily determined (Chandra *et al*., 2016; Robertson *et al*., 2016). Soil enzymes are involved in nutrient cycling in soil ecosystems. The types and quantity of enzymes depend on the soil quality and environmental conditions; hence, enzyme activities may be used as good indicators for soil fertility in different ecosystems. In addition, the formation and decomposition of SOC are regulated by almost all enzymes, so they are comparatively vital in soil carbon cycling (Theuerl *et al.,* 2010). Soil physicochemical properties are basic indicators for estimating the level of soil nutrient contents and characteristics. It was observed that available nutrient balance in soil was influenced by soil pH, moreover phytotoxicity of aluminate was reported in alkaline soil (with pH greater than 9) (Kinyangi, 2007). Soil electrical conductivity can serve as a measurement of soluble nutrients and it is useful in monitoring the mineralization of organic matter in soil (Ingole, 2015; Sde *et al*., 2000). Additionally, soil enzyme activities are commonly influenced by soil pH, and the relation between soil pH and enzyme activities also has control on SOC (Bueis *et al*., 2018). In general, soil physico-chemical properties and soil enzymes do great effort on SOC dynamics together. Previous studies about SOC and its influencing factors mostly focused on forests, wetlands, grasslands and so on (Nitsch *et al*., 2018; Lu and Xu, 2014).

Materials and Methods

Collection of soil samples

Soil samples were collected from Kota city different area such as Industrial area, Agriculture field, Human urban area of Kota, Rajasthan. Soil sample without effluent discharges served as control which was collected from adjacent site (1 km away) of industry. Soil samples with effluents were used for determination of physicochemical and biological activities. Soil samples were collected aseptically in sterile poly-bags from targeted sites and transferred to laboratory on same day. These soil samples were air dried and mixed thoroughly and kept overnight the solution was filtered for determination of soil texture.

Physico-chemical property of soil

The physical, chemical and biological properties of test soil were determined by the standard procedures. The soil particles like sand, silt and clay contents were analysed with the use of different sieves by the method given by Alexander, 1961. Whereas water holding capacity, organic carbon, total nitrogen, and soluble phosphorous of soil samples were determined by the methods of Jackson, 1973. Walkley-black (Narasimaha *et al*., 2011), and Microkjeldal (Gooty Jaffer Mohiddin *et al*., 2011) and Kurrevich and Shcherbakova (Kaushik *et al*., 2005), respectively. Electric conductivity and pH were determined by conductivity meter and pH meters, respectively.

Results and Discussion

Soil samples were analysed for their physico-chemical properties and their results were represented in table 1. However, soil texture in terms of percentage of sand, silt, clay in test soils, respectively. Higher water holding capacity was observed in test soil. Increased water holding capacity and electrical conductivity in contaminated soil of agriculture field may be due to the accumulation of organic waste. EC is an important indicator of soil health, it effects crop yields, crop suitability, plant nutrient availability and activity of soil microorganisms which influence key soil processes including the emission of green house gases, clay soil dominated by such as amino acid residues, acids and alkalis in the industrial soils. The results were in conformity with the past studies (Reddi and Narasimha, 2012; Nagaraju *et al.*, 2007; Poonkothai and Parvatham, 2005; Nizamuddin *et al*., 2008). The increased electrical conductivity in soil contaminated by the effluents industries. The parameters like organic matter percentage, total chloride, calcium, nitrogen, magnesium were higher in test soil. Higher organic matter of the polluted soil may be due to the discharge of waste water, this increased organic matter enhanced soil enzyme activity. This is due to organic waste that may contribute to maintain or increase the organic matter and nutrient content in the soil (Bollag *et al*., 2002). Narasimha *et al*., 2011 and Kaushik *et al*., 2005 made similar reports on the discharge of effluents from cotton ginning and distillery industries, respectively. Thus, soil is a potent system of terrestrial ecosystem, and direct discharge of industrial effluents especially that without treatment may have profound influence on physicochemical and biological properties of soil related to soil fertility (Nagaraju *et al.*, 2009). Similarly, discharge of effluents from various industries like sugar industry (Lowry *et al*., 1951), dairy factory (Nelson, 1944) and petrochemical industry (Andrade, 2012) influenced the physicochemical properties of soil.

The result obtained in this study demonstrated higher SOC contents in the soil. The plant roots directly affects SOC contents, due to a larger number of decayed roots providing a rich source of carbon for soil (Jobbagy and Jackson, 2000) on the other side, returning litter is also an important carbon source of surface SOC and therefore topsoil contained more SOC (Aon and Colaneri, 2001). SOC content were also affected by different sampling sites, mainly because different sampling sites varied in physic-chemical characteristics and enzyme activity. Additionally, in an environment where pH is too high (or too low), the enzymes that play in important role in transformation of nutrients and the formation of humus would be inactivated. Which also leads to the loss of soil fertility and SOC content in the study area, for example the excess of exchangeable sodium would replace other cations and micronutrients absorbed on soil, such as Ca^{2+} ,Mg^{2+},Cu, Zn and Mn (Pistocchi *et al*., 2017; Różyło *et al.*, 2017), leading to the deterioration of soil fertility and quality. Most soil enzymes appeared higher activities probably because soil enzyme activities increase with the rise of soil temperature (Wallenstein *et al.*, 2010). To find the main impact factors for soil quality in study area, soil physico-chemical properties enzyme activities and SOC were analyzed through PCA.

Table.1 Physico-chemical characteristics of soil samples

Name of Kota area	pH (1:2)	EC (ds/m)	%OC	(Cl^- me/l)	Na^+ (ppm)	Ca^{++} (me/l)	Mg^{++} (me/l)	%Silt clay	%sandy
Thermal Bundi Road	8.02	1.21	.44	.35	19.25	6.4	3.8	20	25
Balita Agriculture Field	7.01	2.67	.94	.66	23.27	11.6	6.6	50	55
JDB, Collage	7.02	1.42	.55	.74	21.70	8.4	8.6	40	48
Chambal Garden	7.02	2.12	.86	.82	23.30	22.5	10.8	60	65
Brick Factory	8.00	1.10	.23	.28	19.65	6.5	4.5	30	30
University of Kota	7.50	2.32	.54	.72	21.90	10.71	6.7	45	47
CPU, Kota	7.59	2.30	.65	.39	20.00	8.8	7.2	34	30
DCM, ROAD	8.02	1.51	.25	.68	13.00	6.8	4.5	30	28

In conclusion, the tested materials increased the number of soil microorganisms and increased the activity of the major soil enzymes. The application of biogas digestate and mineral mining waste showed a positive effect on the number of soil microorganisms and soil enzymes. The activity of microorganisms is higher in soil with the balanced ionic environment. This gives the possibility for sustainable development of microorganism assemblage and the complex action of soil enzymes. Heavy metals constitute a separate issue, for which no negative effect was found with respect to the number of microorganisms and enzymatic activity in the soil reclaimed with waste. This means that disturbance in the ionic balance and heavy metal content after application of waste remains within the tolerance range of the tested microorganisms. The possible benefits of increasing the content of macro- and micronutrients in the soil outweigh the harmful effect may include immobilization of toxins and their reduced bioavailability after increasing the organic carbon. The tested wastes can be used in agricultural practice to improve the microbiological activity of the soil with a large reserve of safety for the soil environment.

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