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Physico-chemical properties of termite mound soil

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ABSTRACT

The objective of this study was to determine the termite mound soil properties from Hasnapur village during November2012 to March 2013. The surrounding soil and mound soil consisted of 61.1% and 38.9% sand and 29.5% and 70.59% clay, respectively. There were significant differentiation between mound and adjacent soil. The test parameters such as organic carbon, phosphorus, K, Mg, Fe, Zn and Cu were inclining while N, Ca, S and Mn were decline in mound soil. This study highlights that termite mound soil properties are generally more than the surrounding. The study showed highly positive correlation between mound and surround soil (r= 0.99) and significant't' test.

Key words: Physico-chemical properties, Termite, Mound soil.

INTRODUCTION

Soil is a natural body composed of minerals, mixed with some organic matter. It is the loose covering of fine particles which covers the surface of the earth. Soil is useful to living organisms as habit, habitat, support, food, shelter, etc. Agriculture depends on soil and land but it is not sufficient. Hence there is need to increase land or usefulness of soil.

An earthworm is the dominant member of the soil macrofaunafor the soil formation processes. The termites and ants also play the major role in the nutrient recycling, movement and transportation of soil material. Termites are ecosystem engineers built mounds, enhancing the content of organic carbon, clay and nutrients [1,2,3]. The mound soil redistributed by erosion, affecting soil micro structure and fertility [4,5]. Termites as major bioturbators, created biogenic structures that strongly influenced the physical and chemical properties of soils [6,7].

Termites (Isoptera) are social insects having 3000 known species, in which 75% are soilfeeding and 28 species are pests. The termite feed on non-cellular organic material mixed with clay minerals. The gut of termite is modified and adapted for rising of pH, oxygen and hydrogen which are important for soil chemical and physical modifications [8,9,10].In the study area mounds are more in number. Hence the present study was assigned to know then termite soil properties which will be useful.

MATERIALS AND METHODS

Study Area: The study area was Hasnapurvillage, Ahmednagar district, Maharashtra, India. It is located $19^{0}33'21''$ N latitude and $74^{0}26'37''$ E longitude. It experiences an average rain fall 58 cm and mostly dry area. There are several termites' mounds in the area.

Collection of Soil Samples: The mound soil samples were collected from twenty different sites of village during premansoon (Nov-2012 to March 2013). Sample was taken from different field survey number, then digged at about 30 cm deep 'V' shaped pitand collected from margin of V shaped pit. Also mound periphery (five feet) soil samples were collectedfor control. Each of samples was labeled, numbered with date of collection according to standard methods [11].

Soil Analysis: The samples were air dried, passed through a 2mm sieveand the content of gravel (>2 mm) by weight was determined. Particle size distribution was determined by sieving sand fraction, the silt and clay fraction. Soil pH was determined potentiometrically. Exchangeable cations were extracted with 1 M NH4 OAc at pH 7. Calcium (Ca) and magnesium (Mg) were determined by atomic absorption spectrophotometer, while potassium (K) was determined by flame photometry. Total carbon content was determined by dry combustion using an Eltra CS500-apparatus. Total nitrogen (N) was determined by the Kjeldahl method. Total phosphorus (P) was determined spectrophotometrically. The other soil properties were subjected for the estimation of Cupper (Cu), Manganese (Mn), Zinc (Zn) and Iron (Fe) through atomic absorption spectrum [11].

RESULTS AND DISCUSSION

General comparison of termite mound soil was with periphery soil the clay content of the termite mound was significantly high than the surrounding soils.

As indicated in table 1, data showed that the pH was 7.17 in termite mound soil and 7.67 surroundings respectively. It was slightly modified. Termite modified pH, up to 12.5 [2].The changes in pH depend upon species to species and soil type.

Present data raveled that the EC was 0.29dS/m in adjacent soil and 0.31dS/m in mount soil. By agricultural point of view soils with an EC greater than 4 dS/m are considered saline. The mound soil was not saline.

The table 1 depicted that carbon contents in termite mound was 0.57 % and adjacent soil as and 0.51% respectively. It was increased about 11.76% over the control. Soil carbon is the largest terrestrial pool of carbon [12].It plays a key role in the carbon cycle and it is important in global climatic models. Soil carbon improves the physical properties of soil. It increases the cation exchange capacity and water holding capacity of sandy soil [13].

In the present study nitrogen was observes as 23.01 mgg^{-1} in surrounding soil and 22.09 mgg^{-1} in mound soil. Mound soil showed decline in N content. Nitrogen is as necessary macronutrient for the plant growth and key regulator of ecosystem processes [14]. The increased N causes acidification and eutrafication [15]. So it is essential to know about N present in soil and future planning for cropping pattern.

The Phosphorus was found to be 17.03 mg/g in surrounding soil and 20.13 mg/g in mound soil. It is inclining. Phosphorus is often recommended as a row-applied starter fertilizer increases growth even if P does not increase grain yield.

In the present study potassium was noticed as 36.96 mgg^{-1} in the surrounding and 39.11 mgg^{-1} in termite mound soil. It is 5.5% higher than adjacent soil. Potassium is essential element. The main role of K is to provide the ionic environment for metabolic processes which regulates various processes including growth regulation.

The calcium was 51.51 mgg^{-1} in controland 48.87 mgg^{-1} in mound soil. Here is reduction over control. The micronutrient magnesium was recorded was 14.22 mgg^{-1} in surrounding soil and 16.55 mgg^{-1} in termite mound soil. There is about 14.14% reduction.

The data pertains in table 1 showed sulfur contents was 14.08mgg^{-1}in the control and 13.01mgg^{-1}in mound soil. Here is about reduction. The availability of sulfur to plants is dependent on the release from soil organic matter. Several workers have shown that net mineralization of soil sulfur is affected by organic matter additions, plant growth [16], in addition to temperature,moisture and nutrient supply [17].

Ferrous in the termioria soil was 6.17 mgg^{-1} and in the surrounding was 5.42mgg^{-1}. It is inclined than control.

Zinc in mound soil was 0.97 mgg^{-1}while 0.81 mgg^{-1} in the periphery.Here is increase in Zn over control. Zinc is essential for plant such as production of auxins, activates enzymes in protein synthesis, regulation and consumption of sugars, starch formation and root development. It is necessary for the formation of chlorophyll and carbohydrates. Copper in the mound soil was 12.30 mgg^{-1} and in the surrounding soil was 0.66 mgg^{-1}. There is about 27.83% decline over control. The copper is essential for plant such as a catalyst in photosynthesis, respiration, several enzyme systems for carbohydrate and protein metabolism. It is important for the formation of lignin in plant cell walls. Copper also affects the flavor, the storage ability and the sugar content of fruits.

Manganese in mound soil was 4.02 mgg^{-1} and in the surrounding 4.14 mgg^{-1}. It is less than control. Manganese is essential for many enzymatic reactions involved in metabolize of organic acids. Manganese along with Fe plays role in the formation chlorophyll.

The soil chemical properties showed significant differences between mounds and periphery soil. It showed highly positive correlation between mound and adjacent soil (r= 0.99) The Student t-test [0.95] was also significant at 1% level.

Studies on the variation in termite soil and control soil are as a result of organic matter and deposition of feces and saliva which enrich the soil with organic carbon, CaCO3, P,Mg and K [18]. During this process they can breakdown the litter into minute particles, enhancing the fungal and bacterial action, favoring the decomposition of organic matter[19]. The organic material passes through the digestive tract is subjected to various chemical and biological processes such as organic matter, as well as its humification degree and complication with metal ions [19]. Thus, the higher values of above parameters in the termite soil with comparison to adjacent soil are attributed to termite behavior of ingesting soil organic matter and returning it as fecal, in which organic matter is physically and chemically protected, forming stable aggregates. The acceleration of organic matter decomposition due to termite action can further increase the aggregate stability and soil porosity, which can enhance water retention [6,20]. In the oligotrophic environment, the phosphorous is mainly organic, the higher P associated with higher organic matter content in the mounds, compared with adjacent soil.

With reference to the present study following observations are made which would be explaining the mechanism and predict sound soil. Termite mounds showed higher pH,higher concentration of CandP in the mounds relative to adjacent soil is associated with organic matter incorporation bytermites, as fecal pellets mixed with saliva. It is indicated that a considerable effect of termites is associated with their role in nutrient cycling and renewal of mineral soil brought to the surface from digging. Regarding microstructure, usually compared to the micromorphological study reinforces that termite's activity has an essential role on it. Thus, they should be considered as a factor on soil. Further investigations are needed until we can establish a conclusive assertion, but data presented here corroborate termites' role in ecosystem and soils.

Table 1.Showing properties of termite mound soil.

Sr.N0.	Parameter	Normal value	Control soil	Mound soil
1	pH	6.0-8.0	7.17	7.67 (6.97)
2	Electric Conductivity (sd/cm)	< 1.0	0.29	0.31 (6.89)
3	Organic Carbon (%)	0.41-0.60	0.51	0.57 (11.76)
4	Calcium Carbonates (mgg^{-1})	6.0-10	12.32	14.28 (15.91)
5	Nitrogen (mgg^{-1})	281-420	23.01	22.09 (-3.09)
6	Phosphorus (mgg^{-1})	31-50	17.03	20.13(18.20)
7	Potassium (mgg^{-1})	280-350	38.70	48.18 (3.82)
8	Calcium (mgg^{-1})	500-1000	51.51	48.87 (-5.13)
9	Magnesium (mgg^{-1})	250-500	44.30	46.65 (5.30)
10	Sulfur (mgg^{-1})	10-50	14.08	13.01 (-7.60)
11	Ferrous (mgg^{-1})	4.50-10	5.42	6.17 (13.84)
12	Zinc (mgg^{-1})	0.61-1.0	0.81	0.97 (19.75)
13	Copper (mgg^{-1})	0.20-0.50	0.88	0.98 (11.36)
14	Manganese (mgg^{-1})	2.0-5.0	4.14	4.02 (-2.90)

Figures in parentheses are incliningor decline in percentages over the control.

The related literature indicates that mound soils generally have high clay content, enhancing water storage capacity. When soils with low water retention capacity are common and mound soil is spread on these soils it results in a higher soil moisture content and improved crop growth. Literature also shows that mound soils have high levels of calcium, phosphorus and organic matter, which also useful to better crop development. Plants also take up nutrients very easily from termite mound soil. Termite soil is proving aalternative to local farmers who cannot afford to buy expensive inorganic fertilizers. The mound density is very low but soil may be collected, crushed and mixed with top soil for small farming.

Some question need to be addressed to explain the mechanism how soil is formed. Does termite gut community effect on soil?How does gut chemicals and food materials interacts with each other's?What is the link or reaction between termite gut and normal soil?How will climatic changes affect termite mound soil?Is there are species specific reaction between termitesand soil?

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