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Impact of termite activity on physicochemical properties of mound soil

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ABSTRACT

A present study was assigned to evaluate an impact of termite activity on mounds soil properties at Chinchpur village. Result showed significant differences between mound and surrounding soil. Generally all the parameters are inclining in nature but nitrogen, calcium, sulfur and manganese were decline in mound soil. However, these relationships were also termite specific between mound soil and adjacent soil. This study highlights the activity of the termites is increasing the contents of some parameters in the mound soil and discussed.

Key words: Termite, mound soil, physical and chemical properties.

INTRODUCTION

Nowadays termites like earthworm are seen as important soil organisms that effects soil functioning and ecosystem activity. In tropics termites play an important role in nutrient cycling, transportation of soil materials, soil formation and biological activities. Termites are biological agents that produce significant physical and chemical modifications in soil [1]. Termites are useful organisms as earthworm and plays important ecological role in soil fertility. Several workers have known that termites are in tropical and subtropical region as an ecological counterpart of earthworm. Termites act as a decomposer that another common decomposer cannot act. They feed on plant materials and dry tissue. Termite doesn't produce cellulose and lignin. They breakdown plant debris, dead trees and wood, so digest them and apply their waste to mount building. Termite's activity increases the amount of organic matter and changes the composition of clay minerals in soil that used for building their nests [2]. Termite increases soil permeability with drilling and poke the soil profile foam construction production. The termite nests are underground, termite mound, tree termite nests and one piece nests. Underground nests are common on lower temperature area, mention temperature and moisture on optimal level [3]. Termite mounds often seen in India region. The high of mound is more than a few meters. The mounds are made with materials from underlying soils. It was reported that some farmers collect termite mound soil and apply to crop field it can be rich in nitrogen, total phosphorus, and organic carbon than adjacent soil [4].

MATERIALS AND METHODS

Study Area: The study has been carried out in the Chinchpur urban region, Ahmednagar district, Maharashtra, India. Study area (2.56 sqkm) is located 74^{0}35'-37'N latitude and 19^{0}24-28'E longitude. It experiences an average rain fall 58 cm and mostly dry area. The soil is black cotton soil along with the Pravara river basin. There are several termites' mounds in the area. Physico-chemical property of termite mound tends to know the quality of soil to react to the external environment.

Collection of Soil Samples:
The termite mound soil samples were collected from twenty-five different selected sites of villages from Chinchpur. The collections were made during dry monsoon. At each sites, soil sample was taken from different field survey number. The study sites were fixed, then digged at about 30 cm deep 'V' shaped pit and remove all soil after the samples were collected from margin of V shaped pit with help of large scalpel. Also five feet surrounding the mound soil samples were collected as control. The collected samples were made into four same sized parts and then removed two opposite parts. The process was repeated until the sample retained one half kg [5]. Each of samples then were labeled, numbered, with date of collection, survey number, name of village, type of field, etc.

Soil Analysis:
The collected soil samples were analyzed for various physico-chemical parameters. The experiments were carried out in triplicates. It includes pH, electric conductivity (EC), organic carbon (OC), available Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulfur (S), were determined according to APHA [5]. The soil samples are subjected for the estimation of Copper (Cu), Manganese (Mn), Zinc (Zn) and Iron (Fe) through atomic absorption spectrum (AAS).

Statistical Analysis:
The analysis of variance was performed using MS/Excel/2007. The mean values were compared by Student t-test ($p \leq 0.05$).The main effect and interaction was analyzed by a general at a significant level of $p \leq 0.05$. A correlation coefficient r (significant correlation at $p \leq 0.05$ marked with). The mean data is presented in table 1.

RESULTS AND DISCUSSION

The soil chemical properties showed significant differences between termite mounds and adjacent soil. It showed highly positive correlation between mound soil and adjacent soil (r= 0.99) The Student t-test was also significant at 0.05% level. Result showed that the amount of nutrients such as organic carbon, potassium, phosphorus, magnesium were elevated but ferrous, copper and zinc in trace amount while total nitrogen, calcium, sulfur and manganese in termite mound soil were reduced

The pH was observed 8.35 in termite mound soil and 8.05 surroundings. It is about 3.73% increase in pH. The pH was not highly modified. There is about 0.3 differences. Termite modified pH, up to 12.5 [6]. The changes in pH depends upon soil type, plant material and termite gut activities.

The EC was 0.24dS/m in adjacent soil and 0.25 dS/m in mount soil. There is about 4.17 % incline over control. As agricultural point of view soils with an EC greater than 4 dS/m are considered saline. The mound soil was not saline in nature. The salt-sensitive plants may be affected by conductivities less than 4 dS/m and salt tolerant species may not be impacted by concentrations of up to twice the maximum agricultural tolerance limit [7].

The organic carbon content in mound was 0.45 % and adjacent soil as 0.41%. It was increased about 9.76% over the control. Soil carbon is the largest terrestrial pool of carbon [8].It plays a key role in the carbon cycle and thus it is important in global climatic models. It improves the physical properties of soil and increases the cation exchange capacity, water holding capacity of soil and it contributes to the structural stability of clay soils [9].

Total nitrogen was observed as 20.7 mgg^{-1} in surrounding and 20.1 mgg^{-1} in the mound soil. Termite mound soil showed decline in nitrogen content. It is as essential macronutrient for the plant growth. Although it is a key regulation of ecosystem processes [10]. The increased nitrogen causes acidification and eutrophication [11].

The Phosphorus was found to be 18.41 mg/g in surrounding and 21.12 mg/g in termite mound soil. It is about 14.72% more than adjacent soil. It is often recommended as a row-applied starter fertilizer and starter applications may increase early growth but does not increase grain yield.

Potassium was noticed as 31.06 mgg^{-1} in the control and 34.19 mgg^{-1} in mound soil. It is 10.08% higher than adjacent soil. Potassium is essential element and its main role is to provide the ionic environment for metabolic processes which regulates various processes including growth regulation [12].

The calcium was 48.21mgg^{-1} in surrounding and 45.91 mgg^{-1} in mound soil. There is about 4.77% reduction over the control. The micronutrient magnesium was recorded was 13.21 mgg^{-1} in surrounding soil and 14.95 mgg^{-1} in termite mound soil. There is about 13.26% inclined.

The sulfur contents was 13.68 mgg^{-1}in the control soil and 12.40mgg^{-1}in mound soil. There is about 9.36 % reduction. The availability of sulfur to plants is dependent on the release of this element from soil organic matter [13]. It is also shown that net mineralization of soil Sulfur is affected by organic matter additions [14] and plant growth [15].

Ferrous in the mound soil was 5.04 mgg^{-1} and in the surrounding 4.85mgg^{-1}. It is about 3.92 % higher than control. Zinc in the mound soil was 0.4 mgg^{-1} and in the surrounding 0.39 mgg^{-1}. There is about 2.56 % incline over the control. Zinc is essential for many plant functions 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 1.97 mgg^{-1} and in the surrounding 2.01 mgg^{-1}. There is about 2.03 % elevation over control. It is essential for plant functions such as a catalyst in photosynthesis, respiration, several enzyme systems, and carbohydrate and protein metabolism. It is important to the formation of lignin in plant cell walls which contributes to the structural strength of the cells and the plant. Manganese in the mound soil was 5.22 mgg^{-1} and in the surrounding 4.08 mgg^{-1}. It is about 3.32% declined over the control. It was higher than prescribed standards. Manganese has activated many enzymatic reactions involved in metabolize of organic acids. Manganese along with Fe plays role in the formation chlorophyll.

Termite enrich the soil with organic carbon, phousphrous, potassium, and magnesium as a result of digesting plant materials and depositing feces and/or saliva in their working at the surface [16]. During this process they can breakdown the litter into minute particles, enhancing the action of fungi and soil bacteria, thus favoring the decomposition of organic matter, and helping for the formation of humic substances. The organic material which 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 [17]. The acceleration of organic matter decomposition due to termite action can further increase the aggregate stability and soil porosity, which can enhance water retention [18,19]. In the oligothrophic environment, the source of phosphorous is mainly organic, the higher P associated with higher organic matter content in the mounds, compared with control soil.

Manuwa [20] in the study of physical and chemical parameters of termite mound was obtainedsimilar conclusion about potassium, calcium and magnesium concentration but unlike this survey result is reported reducing the amount of nitrogen and phosphorus. In the present study nitrogen was also declined. In order to study the effect of termite mounds on plant establishment and development of plant species in forest have been shown that nitrogen and phosphorus were elevated in termite mound, also phosphorus and magnesium did not differ significantly between termite mound and control soil [21]. Semhi [22] also exported that the activity of termites after increased most macro elements but decreased the amount of potassium and also showed the contents of some trace elements except for manganese.

Soil analysis showed that an increase in clay percent in the soil with termite activity. One reason of this may be related to preferred selection of clay particles by termites. Similar results have been reported [23], but Akrena [24] were seen lower percentage of clay in the termites soil. Roose [25] also have shown that termites' activity increases the amount of orgasmic matter in the soil that they use the construction of their nests. The findings concluded that termites have impact in soil and its function. Their role has been observed in decomposition of plant material, nutrient cycles, soil formation, etc. The role of termites has been surveyed as pests and determines the effects of them ion physical and chemical properties of soil more studies are needed. The study of termite mound soil have shown that the mound soil can have higher or lower value of organic carbon, total nitrogen, exchangeable Ca, Mg, and K, water holding capacity and water infiltration rate.

Table 1.Showing physicochemical properties of termite mound soil

Sr.N0.	Parameter	Normal value	Control soil	Termite mound soil	% decline or incline over control
1	pH	6.0-8.0	8.05	8.34	3.73
2	Electric Conductivity (sd/cm)	< 1.0	0.24	0.2 9	20.83
3	Organic Carbon (%)	0.41-0.60	0.41	0.45	9.76
4	Nitrogen (mgg^{-1})	281-420	20.70	20.10	-2.09
5	Phosphorus (mgg^{-1})	31-50	18.41	21.12	14.72
6	Potassium (mgg^{-1})	280-350	31.06	34.19	10.08
7	Calcium (mgg^{-1})	500-1000	48.21	45.91	-4.77
8	Magnesium (mgg^{-1})	250-500	13.21	14.95	13.26
9	Sulfur (mgg^{-1})	10-50	13.68	12.40	-9.36
10	Ferrous (mgg^{-1})	4.50-10	4.40	5.04	14.54
11	Zinc (mgg^{-1})	0.61-1.0	0.39	0.42	7.70
12	Copper (mgg^{-1})	0.20-0.50	1.91	2.01	5.24
13	Manganese (mgg^{-1})	2.0-5.0	4.22	4.08	-3.32

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