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Research Article

Physicochemical Properties of Termite Mounds and Surrounding Soils in Kothaguda Forest Region, Mahabubabad District, Telangana

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ABSTRACT

Physicochemical analysis of termite mounds and surrounding soils in Kothaguda forest region were investigated during June, 2018 to May, 2019. The test parameters such as soil p^H, organic carbon, available nitrogen, available phosphorus and available potassium were determined in mounds soil and surrounding soils. These parameters were increased in mounds soil than surrounding earth soil in rainy season followed by winter and summer seasons. Elemental analysis shows significant variability of the elemental ranging about soil p^H (7.32-8.18), EC (0.09-0.36ds/m), OC (0.78-1.90%), AN (75kg / ha to 414 kg/ha), AP (66 to 328 kg/ha), APo (288 to 367 kg / ha) in mound soil followed by p^H(6.34-7.2),EC(0.06-0.27ds/m), OC(0.64-1.79%),AN(125-351kg/ha),AP(66-328kg/ha), and Apo(201-365kg/ha) in surrounding soils during rainy season. During winter season, the elements ranged about p^H (6.05-7.87), EC (0.11- 0.79dS/m), OC (0.53-1.08%), AN (125kg / ha to 238kg/ha), AP (10.26 to 41 kg/ha), APo (149 to 249kg / ha) in mound soil followed by p^H(5.5-8.13), EC(0.05-0.72 dS/m), OC(0.31 – 1.04%), AN(88-226kg/ha),AP(10.26 - 39kg/ha), and Apo(149 – 286 kg/ha) in surrounding soils respectively. In summer season, the elemental analysis were recorded about p^H (5.72-7.69), EC (0.12-0.78dS/m), OC (0.44-1.01%), AN (89kg / ha to 218 kg/ha), AP (9.20 to 25 kg/ha), APo (116 to 200kg / ha) in mound soil followed by p^H(5.07-7.82), EC(0.05-0.71dS/m), OC(0.30 – 1.02%), AN(50 - 216kg/ha), AP(9.20 - 37kg/ha), and Apo(101 – 279 kg/ha) in surrounding soils respectively. The results show that all the test parameters were higher in mounds soil than the surrounding soils. However, the available potassium was higher in the surrounding soils. From the current study, it can be concluded that the physicochemical properties of mounds soil were very high and influenced the plant growth in the mounds area when compared to non-mound areas.

1. Introduction

Termites are social insects that live in colonies belong to the order Isoptera. They are often called as white ants which are morphologically and phytogenetically different from the ants, bees and wasps [1]. Termite's colony contains king and queen (reproductive individuals and many non-reproductive individuals. The non-reproductive individuals are divided into workers and soldiers where workers are responsible for foraging and repairing of the mounds whereas the soldiers are responsible in the defence. Some termite species line within the wood, while others live inside the soil matrix in nests. Some of the termites build complex nests with gallery system inside the soil and build mounds emerging from the soil surface. Generally termites are affected by the environment where they live. The activities of termites influence to a great extent in the local soil biota [2]. Termites transform the clay and use it as a cementing agent during mound construction and synthesize argano-metal complexes [3]. Arshad et al.,(1981) studied the chemical properties of the mound soil built by macrotermites in East Africa and he stated that mounds are built of subsoil which is not affected in its chemical properties by the termites [4]. In certain areas of levelling of termite mounds, there is a formation of slicks spots-alkali affected patches. These spots are as a result of termitaria levelling that occurs only in the areas with saline ground water [5]. Microhabitats created by termites are favourable for the development of symbiotic microorganisms, providing them with optimum security from predators and other interferences , loss of extreme fluctuations of wetting and drying cycles, as well as abundant and accessible nutrients[6]. In Africa, farmers collect termite mounds soil and apply to their crop fields because it is rich in available nitrogen, total

phosphorus and organic carbon than surrounding soil [7]. Kaschuck et al. (2006) stated that the collected soil samples from top, middle, bottom of termite mounds showed a greater content of potassium, phosphorus, calcium, magnesium, organic carbon and low pH in the inner part of termite mounds in relation to surrounding soils [8]. The main objective of this study deals in investigating the physicochemical properties of mound soil and the surrounding soils in the forest ecosystem.

2. Material and Methods

2.1 Study Area

The study area was Kothaguda Forest Region of Mahabubabad district, Telangana State located between 17°35 55. 101"N latitude and 80°0 19.733"E longitude. It experiences minimum annual rainfall (04mm) recorded in March, and recorded maximum rainfall (374.8mm) in August. Kothaguda forest is dry deciduous forest with rich diversity..

2.2 Soil Samples Collection

Soil samples were taken from Kothaguda forest region, Kothaguda, Mahabubabad district. The termite mounds were selected in ten different sites, one sample from each site. A total of 10 samples were collected from the termite mounds and 10 samples from the surrounding soils of the mounds which lied 50 meters away from the mound. Total 60 samples were collected in this study period, labelled properly and were brought to the laboratory for determining the soil properties. Soil p^H was measured using the soil p^H meter and electric conductivity by Electric conductivity meter and cell. Organic Carbon was estimated by using Walkley and Black wet oxidation method, Available Nitrogen was by the micro Kjeldahal method, Available Phosphorous in soil by Olsen method and Available Potassium by using flame photometry.

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3. Results

Termite mounds soil elemental analysis was found to be significantly higher than the surrounding soils. Tables–1-6 showed that termite mound soil p^H was 7.7 in monsoon, 7.27 in winter and 6.80 in summer followed by surrounding soil p^H was 6.78 in monsoon, 6.38 in winter and 6.03 in summer. The changes in p^H values depend upon the species to species and soil type. Termite mounds soil EC showed 0.24(dS/m) in monsoon, 0.34(dS/m) in winter and 0.33(dS/m) in summer followed by surrounding soils it was 0.16(dS/m) in monsoon, 0.23(dS/m) in winter and 0.22(dS/m) in summer. The both samples were not saline in nature. In this study Organic carbon of mound soil was observed to be 1.17% in monsoon season, 0.75% in winter and 0.67% in summer followed by 1.12%, 0.71% and 0.65% for surrounding soil respectively. OC plays a key role in the carbon cycle and it improves the physical properties in the soil [9]. Available Nitrogen at mound soil was found to be 267.2(kg/ha) in monsoon, 180.7(kg/ha) in winter and 146.6 (kg/ha) in summer seasons. It was recorded as 259.0(kg/ha) in monsoon, 159.6(kg/ha) in winter and 136.2(kg/ha) in summer for the surrounding soil. Abiyot L et. al, (2016) stated that mound soil nitrogen was higher than the adjacent soil in Ethiopia [10]. High concentration of nitrogen causes acidification and eutrophication [11].

Table-1. Physicochemical properties of mounds soil in different sites during monsoon season 2018-19

Physicochemical properties of Mound soils in Monsoon season 2018-19								
S.N	**Name of the place**	**Type**	**PH**	**Ec (dS/m)**	**Organic carbon (%)**	**Available Nitrogen (kg/ha)**	**Available phosphorous (P_2O_5) (kg/ha)**	**Available potassium (K_2O) (kg/ha)**
1	Gunjedu	Mound soil	7.9	0.27	1.12	326	197	351
2	Pakhal	Mound soil	8.1	0.36	1.03	201	328	315
3	Thimmapuram	Mound soil	8.08	0.31	1.8	326	295	365
4	Musmi	Mound soil	8.05	0.31	1.18	314	197	297
5	Punugondla	Mound soil	7.83	0.25	0.81	289	325	321
6	Chinthagudem	Mound soil	7.32	0.32	1.9	301	263	346
7	Pandem	Mound soil	6.94	0.1	0.93	414	66	285
8	Madagudem	Mound soil	6.93	0.09	1.12	75	263	359
9	Thirumalagandi	Mound soil	7.72	0.19	1.05	188	295	367
10	Karlai	Mound soil	8.16	0.24	0.78	238	131	362

Table-2. Physicochemical properties of Mound Surrounding soils in different sites during monsoon season, 2018-19

Physicochemical properties of Surrounding soils in Monsoon season 2018-19								
S.N	**Name of the place**	**Type**	**PH**	**Ec (dS/m)**	**Organic carbon (%)**	**Available Nitrogen (kg/ha)**	**Available phosphorous (P_2O_5) (kg/ha)**	**Available potassium (K_2O) (kg/ha)**
1	Gunjedu	Earth soil	7.16	0.27	1.35	125	66	326
2	Pakhal	Earth soil	7.2	0.24	0.64	251	295	326
3	Thimmapuram	Earth soil	6.4	0.13	1.2	339	263	286
4	Musmi	Earth soil	6.82	0.25	1.79	351	263	301
5	Punugondla	Earth soil	6.41	0.11	1	326	131	335
6	Chinthagudem	Earth soil	6.57	0.15	1	251	66	201
7	Pandem	Earth soil	6.72	0.12	1.2	238	99	365
8	Madagudem	Earth soil	7.05	0.14	1.18	163	327	268
9	Thirumalagandi	Earth soil	7.13	0.18	1.24	263	197	362
10	Karlai	Earth soil	6.34	0.06	0.69	289	328	345

Table -3. Physicochemical properties of mounds soil in different sites during winter season 2018-19

Physicochemical properties of Surrounding soils in Monsoon season 2018-19								
S.N	**Name of the place**	**Type**	**PH**	**Ec (dS/m)**	**Organic carbon (%)**	**Available Nitrogen (kg/ha)**	**Available phosphorous (P_2O_5) (kg/ha)**	**Available potassium (K_2O) (kg/ha)**
1	Gunjedu	Mound soil	7.81	0.38	0.82	151	13	249
2	Pakhal	Mound soil	7.87	0.22	0.54	125	31	241
3	Thimmapuram	Mound soil	7.76	0.3	0.87	201	22	214
4	Musmi	Mound soil	7.83	0.27	0.69	176	12	196
5	Punugondla	Mound soil	7.34	0.21	0.8	201	21	216
6	Chinthagudem	Mound soil	6.68	0.22	1.08	138	11	195
7	Pandem	Mound soil	6.36	0.11	0.68	238	21	149
8	Madagudem	Mound soil	6.05	0.71	0.53	213	41	168
9	Thirumalagandi	Mound soil	7.32	0.19	0.63	163	10.26	186
10	Karlai	Mound soil	7.71	0.79	0.83	201	0.52	198

Table-4. Physicochemical properties of mound surrounding soils in different sites during winter season, 2018-19

Physicochemical properties of surrounding soils in winter season 2018 -19								
S.N	**Name of the place**	**Type**	**PH**	**Ec (dS/m)**	**Organic carbon (%)**	**Available Nitrogen (kg/ha)**	**Available phosphorous (P_2O_5) (kg/ha)**	**Available potassium (K_2O) (kg/ha)**
1	Gunjedu	Earth soil	6.42	0.13	0.75	163	2	149
2	Pakhal	Earth soil	6.42	0.13	0.96	151	11	196
3	Thimmapuram	Earth soil	6.46	0.12	0.72	88	22	204
4	Musmi	Earth soil	7.74	0.2	0.95	163	11	201
5	Punugondla	Earth soil	6.04	0.12	0.41	163	22	241
6	Chinthagudem	Earth soil	5.7	0.11	1.04	226	11	241
7	Pandem	Earth soil	5.85	0.05	0.72	188	39	286
8	Madagudem	Earth soil	5.6	0.53	0.84	216	10.26	213
9	Thirumalagandi	Earth soil	8.13	0.26	0.31	88	10.26	268
10	Karlai	Earth soil	5.5	0.72	0.45	150	20.52	185

Table -5. Physicochemical properties of mounds soil in different sites during summer season, 2018-19

Physicochemical properties of mounds soil in summer season, 2018-19								
S.N	**Name of the place**	**Type**	**PH**	**Ec (dS/m)**	**Organic carbon (%)**	**Available Nitrogen (kg/ha)**	**Available phosphorous (P_2O_5) (kg/ha)**	**Available potassium (K_2O) (kg/ha)**
1	Gunjedu	Mound soil	7.69	0.38	0.62	101	10	49
2	Pakhal	Mound soil	7.1	0.2	0.44	110	25	200
3	Thimmapuram	Mound soil	6.67	0.29	0.77	106	18	180
4	Musmi	Mound soil	7.07	0.2	0.6	126	11	172
5	Punugondla	Mound soil	7.12	0.2	0.72	181	20	116
6	Chinthagudem	Mound soil	6.09	0.21	1.01	89	10	145
7	Pandem	Mound soil	6.2	0.12	0.58	218	20	131
8	Madagudem	Mound soil	5.72	0.7	0.5	213	22	152
9	Thirumalagandi	Mound soil	7.12	0.15	0.6	142	9.2	160
10	Karlai	Mound soil	7.17	0.78	0.83	180	15.25	180

Table-6. Physicochemical properties of mound surrounding soils in different sites during summer season, 2018-19

Physicochemical properties of surrounding soils in summer season, 2018-19								
S.N	**Name of the place**	**Type**	**PH**	**Ec (dS/m)**	**Organic carbon (%)**	**Available Nitrogen (kg/ha)**	**Available phosphorous (P_2O_5) (kg/ha)**	**Available potassium (K_2O) (kg/ha)**
1	Gunjedu	Earth soil	5.9	0.1	0.55	165	11	101
2	Pakhal	Earth soil	6.12	0.12	0.9	142	10	122
3	Thimmapuram	Earth soil	6.28	0.11	0.7	50	18	165
4	Musmi	Earth soil	7.82	0.19	0.85	128	10	101
5	Punugondla	Earth soil	5.83	0.11	0.37	110	19	220
6	Chinthagudem	Earth soil	5.07	0.11	1.02	190	11	241
7	Pandem	Earth soil	5.85	0.05	0.64	179	37	279
8	Madagudem	Earth soil	5.1	0.49	0.79	216	9.2	210
9	Thirumalagandi	Earth soil	7.13	0.26	0.3	62	9.2	250
10	Karlai	Earth soil	5.2	0.71	0.41	120	15.25	160

In this study, nitrogen levels in mounds soil and surrounding soils were suitable for plant growth. Mounds soil Phosphorus observed to be 236.0(kg/ha) in monsoon, 20.27(kg/ha) in winter and 16.05(kg/ha) in summer whereas it was 203.5(kg/ha) in monsoon, 16.9(kg/ha) in winter and 14.1(kg/ha) in summer for the surrounding soils. This result was consistent with the study conducted by Ackerman et al (2007) [12]. Although, the feeding habit of termite and materials used for construction of mound can have significant impact on phosphorus sorption affecting availability of phosphorus for plant growth in forest [13]. The Potassium levels were found to be 336.8(kg/ha) in monsoon, 201.2(kg/ha) in winter and 158.5(kg/ha) in summer in mounds soil whereas it was 311.5(kg/ha) in monsoon, 218.7(kg/ha) in winter and 184.9 in summer for the Surrounding soils. Potassium provides the ionic environment for metabolic processes which regulates various processes in growth of trees [14]. The chemical characteristics of the mound materials of Macrotermes bellicosus showed that the composition is close to that of surrounding soils [15]. Lal et. al.,[16] and Afolabi et. al., [17] determined that mounds soil can have either higher or lower values of organic carbon, available nitrogen, available phosphorus and potassium in relation to surrounding soil [16]. According to this study, it can be concluded that termite mounds soil and surrounding soils play a significant role in plants growth in forest ecosystem. The mound building termites increase the soil fertility by litter decomposition and foraging activity on forest floor.

Conflicting Interests

The authors have declared that no conflicting interests exist.

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