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Comparative studies of organic enrichers in the improvement of physico-chemical and microbiological characteristics of saline/usar soils

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ABSTRACT

In the present study, for maintaining the saline alkali / usar soils, certain amendments such as farmyard manure (fym) and prepared compost were used. Both the enricher were added separately in the ratio of 5%, 10%, 15%, 20% and 25% (W/W) in air dried and sieved soil samples of saline alkali soils. Different physico-chemical characteristics showed a definite trend of change in values with the increasing concentration of farmyard manure and prepared compost. The values of organic carbon, organic matter, total nitrogen, exchangeable potassium, cation exchange capacity and water holding capacity increased both in farmyard manure and prepared compost. But from this experiment, it is clear that different doses of prepared compost showed better reclamation of saline-alkali soil than farm yard manure (fym). On comparing the efficacy of farm yard manure and prepared compost amended soil on microbial numbers, it can be concluded that prepared compost showed greater improvement in fungal, bacterial and actinomycetes population over the control. It is an indicative of improvement in soil reclamation and management of problem soil. Qualitatively soil microfungi expressed different dominant community members in different doses of amendments as revealed from the data of IVI (individual value index) of individual fungal species.

INTRODUCTION

The problem of salt affected soils is of global occurrence and is a matter of great concern to many countries of the world. Soil degradation can be attributed to the changes brought due to human intervention by way of introduction of irrigation, use of saline water or due to other development works leading ultimately to accumulation of salts in a region (Bhargava,1989). The contamination and degradation coupled with other activities have increased the salt affected area.

India alone estimates an increase in salt affected area ranging from 6.1 mha (Ray Chaudhary, 1965) and 7 mha (Abroll and Bumbia, 1971) to 23.8 mha (Massoud, 1974). The problem of soil

salinity is increasing year by year in different states in India, Uttar Pradesh has been using about 50,000 acres of land annually since 1939 (Bains, 1972).

Saline / alkaline and so called 'Usar' soil could be improved for agriculture purpose by certain amendments. Inorganic and organic supplements bring a profound change in its physico-chemical and microbiological properties leading to improvement in soil productivity (Dixit, 1960; Bandopadhyay *et al*., 1969; Vishwanathan, 1975; Gautam, 2002).

The present study is concerned with the reclamation and management of saline-alkali soils via amending it with organic compost and farm yard manure. Keeping in view that use of organic soil amendments could play an effective role in reclamation of salt affected soil, an effort was made to study the using impact of farm yard manure and prepared compost in relation with change in physico-chemical and microbiological characteristics of natural soil.

EXPERIMENTAL SECTION

The present work comprises of collection of soil samples from five chosen sites of Chomuha village situated in the Chhata Tehsil of Mathura District. The soil samples were collected up to 0-6 cm depth from the surface, with the help of sterilized iron borer, following the method given by Johnson and Curl (1972).

The soil samples were brought to laboratory for the isolation of microflora and analysis of physico-chemical properties of soils as per methods of Jackson (1973) and Piper (1966). To evaluate the role of organic enrichment on physico-chemical and microbiological attributes of saline alkali soils, both the farm yard manure and prepared compost materials were used.

Freshly collected, air dried and sieved soil samples weighed in equal amount, were taken in separate fresh polythene bags. To each bag both the enrichers were mixed separately in the ratio of 5%, 10%, 15%, 20% and 25% (W/W) respectively. Moisture status of the amendment soil samples was maintained at 60-70% water. The samples were stored at room temperature and detailed analysis were made after 10 days of amendment. Natural soil samples without any amendment to serve as control were also similarly maintained and studied.

RESULTS AND DISCUSSION

It is clearly evident from the values (Table-1) obtained particularly to pH (8.3±0.0446), electrical conductivity (7.34±0.1665), exchangeable sodium percentage and bicarbonate, sulpahte and chlorides (88.4±0.1560, 30.5±0.3529,12.04±0.3925 and 28.1±0.5257 respectively), that the soil is of saline- alkali nature and unfit for cultivation. It is also revealed that water holding capacity percentage, ranged in between 21.2 to 22.1 and that of moisture 1.40 to 2.51%, thus reflecting the poor status of physical condition of the soil. The present, soil type showed a poor percentage of organic carbon (0.22%) and similarly the organic matter and total nitrogen content were also poor.

Table-1 reveals physico-chemcial characteristics of saline alkali soil amended with 5%, 10%, 15%, 20% and 25% doses of farm yard manure and prepared compost after 10 days of amendments respectively. It indicates that organic carbon, organic matter, potassium etc. values increased in farm yard manure amendments with the increase of doses. While moisture, water holding capacity, pH, total nitrogen values initially increased upto 15% concentration of farm

yard manure and then showed a decline in 20% soil and again increased in 25% amended soil. In all amendments their amount were better than control (Table-1)

Different doses of prepared compost showed better reclamation of saline alkali soil than farm yard manure. Soil moisture, water holding capacity, showed an increment from 5% to 20% prepared compost amended soil and then decreased in 25% prepared compost amended soil. pH of soil was maximum (8.3) in 10% compost amended soil. It decreased with higher does of amendments from 8.0 to 7.9, almost similar results were observed in farm yard manure amended soil (Table-1). Organic carbon, organic matter total nitrogen and calcium carbonate showed, lowest values in 5% farm yard manure amended soil and highest value in 25% farm yard manure amended soil. This trend was almost similar in compost amended soil.

From table 2 & 3, It was found that control soil was dominated by *Aspergillus fumigatus*$_1$ (IVI=28.31), *A. fumigatus*$_2$ (IVI=22.89) and *A. nidulans*$_2$ (IVI=27.25) respectively. Dominance of *Aspergillus* was also reported by Saksena *et al.*, (1966).

In 5% farm yard manure amended soil the dominative microfungi were *A. niger*$_2$ (IVI=31.46), *A. niger*$_1$, *A..fumigatus* (IVI=26.06) in both and *A.nidulans*$_1$ (IVI=22.83). The 10% farm yard manure amended soil was dominated by *A. niger*$_1$ (IVI=32.66), mycelia sterilia$_3$ (IVI=18.93) and *A.niger*$_2$ (IVI=22.52) (Table-2).

There was dominance of *A. niger*$_1$ (IVI= 30.64), *A. niger*$_2$ (IVI= 29.14) and mycellia sterilia, (IVI= 24.06) in 15% farm yard manure amended soil. The 20% amended soil was dominated by undefined fungus species $_1$ (IVI= 30.94), *A niger*$_1$, (IVI=29.30), *A. flavus* (IVI= 22.83), *A. niger*$_2$ (IVI= 22.83). In 25% farm yard manure amended soil. *A. nidulans* (IVI=26.47), mycillia sterilia $_2$ (IVI= 24.78), *A. fumigatus*$_2$ (IVI= 19.46) were the dominant fungi. These findings are in accordance with views of earlier workers Alexender, 1971, who assigned the soil micro environment in itself to be a special microcosm possessing a characteristic microbial community made up of population coexisting and interacting with each other.

In the 5% compost amended soil *A. niger*$_2$, *A. niger*$_1$ and *A. terreus* (IVI= 27.28, 25.51 and 22.13 respectively) were dominant. The 10% compost amened soil was dominated by *A. niger*$_1$ (IVI= 27.04), *A. terreus* (IVI= 27.04), *A. fumigatus* (IVI= 23.77) and *A. niger*$_2$ (IVI= 22.37). In 15% compost amened soil there was dominace of *A. niger*$_2$ (IVI=30.06), mycellia sterilia$_2$ (IVI=26.86) and mycelia sterilia$_1$ (IVI= 22.27). The 20% compost amended soil had the domiance of *A. niger*$_2$ (IVI= 24.14) followed by *A. flavus* (IVI= 22.82) and *A. terreus* (IVI=1991) (Table-3). In the 25% compost amended soil *A. niger* (IVI=26.57), *A. flavus* (IVI=23.76) were dominant .

Table-4 shows population dynamics of fungi, bacteria and actinomycetes in saline-alkali soil amended with different doses of farm yard manure. The population of fungi in thousand per gram of soil was 2.7 in natural undisturbed soil. In the amended soil the population varied from 2.5 (in 10% farm yard manure amended soil) to a maximum of 3.1 (in 20% farmyard manure amended soil). A considerable decreased in fungal population at higher salt affected soil was noticed. The fungus sensitivity to salt was also reported by Mickovsky, 1961.

Table- 1 Physio-chemical analysis of saline-alkali soils amended with different doses of farm yard manure and prepared compost after 10 days of amendment.

S. No.	Characteristics	Ctrl Soil	Doses of *fym* amendment (w/w)						Doses of prepared compost (w/w)					
			5%	10%	15%	20%	25%	Avg.	5%	10%	15%	20%	25%	Avg.
1	Temperature (^{0}C)	28.4 ± 0.1682	22.2± 0.060	21.1± 0.535	23.7 ± 0.376	23.6± 0.415	23.8± 0.523	22.88± 0.252	20.2± 0.246	22.0± 0.340	24.0± 0.705	23.0± 0.213	23.0± 0.677	22.44± 0.202
2	Moisture (%)	2.47 ± 0.2021	2.14±0 0.268	4.24± 0.192	4.39± 0.176	4.36± 0.392	3.84± 0.307	3.79± 0.105	3.66± 0.366	4.52± 0.240	4.73± 0.366	4.78± 0.184	4.42± 0.207	4.42± 0.196
3	Water holding capacity (%)	21.6 ± 0.1824	21.8±0 0.460	22.9± 0.366	24.4± 0.258	22.8± 0.502	25.3± 0.483	23.44± 0.256	23.9± 0.464	23.8± 0.330	24.5± 0.607	22.8± 0.966	25.3± 0.372	24.06± 0.462
4	pH	8.3± 0.0446	8.2 ± 0.081	8.0 ± 0.073	8.2 ± 0.096	8.2 ± 0.092	8.1 ± 0.070	8.14± 0.056	8.0 ± 0.107	8.3 ± 0.083	8.2 ± 0.096	8.0 ± 0.191	7.9 ± 0.102	8.08± 0.082
5	Organic carbon (%)	0.22 ± 0.0092	0.9 ± 0.016	1.39± 0.168	2.02± 0.042	2.14± 0.067	2.17± 0.053	1.724± 0.052	1.32± 0.166	1.72± 0.189	2.39± 0.170	2.93± 0.143	3.14± 0.221	2.3± 0.162
6	Organic matter (%)	0.38± 0.0160	1.54± 0.027	2.39± 0.243	3.48± 0.0737	3.69± 0.116	3.73± 0.092	2.97± 0.324	2.36± 0.286	2.82± 0.327	4.12± 0.293	5.05± 0.247	5.36± 0.381	3.94± 0.254
7	Total nitrogen (%)	0.018± 0.0007	0.07± 0.001	0.11± 0.017	0.17± 0.003	0.18± 0.005	0.18± 0.004	0.142± 0.004	0.11± 0.014	0.14± 0.016	0.20± 0.014	0.25± 0.012	0.26± 0.019	0.192± 0.012
8	Calcium carbonate (%)	1.52± 0.0230	0.06± 0.008	1.84± 0.020	1.67± 0.155	1.56± 0.109	0.94± 0.048	1.214± 0.015	1.48± 0.254	1.80± 0.154	1.68± 0.213	1.71± 0.240	0.89± 0.249	1.51± 0.162
9	Ex. Potassium (ppm)	2.40± 0.169	10.9± 0.337	11.5± 0.371	14.9± 0.292	17.7± 0.595	21.0± 0.460	15.2± 0.250	9.9± 0.248	11.5± 0.228	15.0± 0.298	17.0± 0.547	21.0± 0.361	14.88± 0.246
10	CEC (me/100gm)	5.33± 0.2177	5.52± 0.193	5.32± 0.182	6.19± 0.252	6.30± 0.246	6.14± 0.267	5.89± 0.156	5.78± 0.217	5.64± 0.164	6.34± 0.190	6.44± 0.162	5.72± 02433	5.98± 0.198
11	ESP	88.4± 0.1560	83.7± 0.534	76.3± 0.194	65.0± 0.334	60.8± 0.598	56.4± 0.631	68.44± 0.242	87.8± 0.203	76.0± 0.644	64.8± 1.342	60.3± 1.100	62.0± 0.269	70.18± 0.212
12	Ece (dsm^{-1})	7.34± 0.1665	5.20± 0.309	5.23± 0.145	4.86± 0.236	5.73± 0.271	5.03± 0.253	5.21± 0.125	6.28± 0.025	5.49± 0.644	5.33± 0.002	5.25± 0.002	4.58± 0.199	5.38± 0.022
13	$Ca^{2+} + Mg^{2+}$ (meL^{-1})	22.6± 0.5375	18.3± 0.338	19.6± 0.377	20.3± 0.325	19.1± 0.352	19.4± 0.428	19.34± 0.214	21.4± 0.181	16.8± 1.027	15.2± 0.436	14.0± 0.177	17.4± 0.538	16.96± 0.682
14	Na^+ (meL^{-1})	45.6± 0.5408	30.4± 0.532	29.5± 0.237	23.0± 0.448	21.4± 0.544	28.0± 0.259	26.46± 0.236	40.5± 0.270	39.4± 0.462	35.0± 0.932	32.7± 0.333	28.9± 0.579	35.30± 0.328
15	$CO_3^{-2} + HCO_3^{2-}$ (meL^{-1})	30.5± 0.3529	20.3± 0.222	24.8± 0.262	21.9± 0.398	20.6± 0.450	17.7± 0.245	21.06± 0.204	22.1± 0.385	20.5± 0.630	18.5± 0.003	15.3± 0.428	16.2± 0.513	18.52± 0.356
16	Cl^- (meL^{-1})	28.1± 0.5257	22.8± 0.243	20.2± 0.340	18.6± 0.442	19.3± 0.360	21.6± 0.253	20.5± 0.352	25.1± 0.373	23.5± 0.999	20.3± 0.400	19.0± 0.428	18.7± 0.942	21.32± 0.258
17	SO_4^{2-} (meL^{-1})	12.04± 0.392	14.0± 0.366	11.9± 2.576	14.9± 0.490	14.3± 0.277	7.98± 0.139	12.61± 0.202	15.0± 0.216	12.3± 0.407	12.6± 0.470	11.8± 0.455	7.08± 0.540	11.75± 0.358

TABLE –2 IVI of Fungal species obtained in varying doses of treated with farm yard manure

S.No.	Name of species	Control soil	5%	10%	15%	20%	25%
1.	*Absidia butleri*	-	8.85	16.54	17.4	16.37	-
2.	*A. lichtheimii*	-	8.85	-	-	-	-
3.	*Mucor hiemalis*	15.31	15.28	16.54	13.05	16.37	16.56
4.	*Rhizopus nigricans*	-	8.23	11.96	-	-	-
5.	*R. stolonifer*	10.96	13.68	-	17.4	13.11	13.24
6.	*Syncephalstrum racemosum*	-	5.69	-	-	-	10.48
7.	*Alternaria alternata*	19.05	-	-	-	-	-
8.	*Aspergillus flavus*	20.65	26.06	18.93	17.35	22.83	14.49
9.	*A. fumigatus* $_1$	28.31	26.06	14.28	15.34	8.39	19.46
10.	*A. fumigatus* $_2$	22.89	19.05	14.28	18.93	16.37	16.54
11.	*A. glocus*	10.96	-	-	-	-	-
12.	*A. nidulans* $_1$	15.31	22.83	16.62	18.93	8.39	26.47
13.	*A. nidulans* $_2$	27.25	20.67	9.84	15.06	12.38	8.42
14.	*A. niger* $_1$	15.20	26.06	32.66	30.64	29.30	26.47
15.	*A. niger* $_2$	20.65	31.46	22.52	29.14	22.83	18.55
16.	*A. terreus*	13.03	20.67	16.62	15.06	21.23	16.56
17.	*A. ustus*	6.58	5.69	-	-	-	10.48
18.	*Botryotricum piluliferum*	-	-	-	-	15.51	-
19.	*Botrytis cinerea*	-	-	11.96	-	-	-
20.	*Curvularia lunata*	5.56	-	-	-	-	-
21.	*Fusarium chlamydosporium*	-	8.85	-	-	-	-
22.	*F. oxysporum*	5.56	-	-	-	-	-
23.	*F. solani*	8.79	-	-	-	-	8.42
24.	*Humicola fuscoatra*	-	-	-	-	8.39	-
25.	*Myrothecium roridum*	-	-	9.49	12.18	-	11.60
26.	*Paecilomyces inflatus*	-	-	-	-	5.30	-
27.	*Paecilomyces variotii*	-	-	9.84	17.4	-	-
28.	*Penicillium chrysogenum*	-	-	14.7	5.63	16.38	11.56
29.	*P. funiculosum*	5.56	13.66	-	13.05	-	10.48
30.	*Phoma herbarum*	10.96	-	-	-	-	-
31.	*Stemphylum sp.*	-	-	-	-	5.30	-
32.	*Mycellia sterilia* $_1$	5.56	-	24.93	20.06	30.94	18.20
33.	*Mycellia sterilia* $_2$	16.69	6.63	-	-	14.72	24.78
34.	*Mycellia sterilia* $_3$	8.79	11.44	18.93	-	-	-
35.	*Unidentified* $_1$	8.90	-	18.93	18.93	-	-
36.	*Unidentified* $_2$	-	-	-	-	19.58	16.56

Bacterial count were $5.2x10^3$ per gm of soil in control soil but the population fluctuated from $3.3x10^3$ (in 10% amended soil) to a maximum of $4.7x10^3$ (in 25% farm yard manure amended soil). The population of actinomycetes was $4.0x10^3$ per gm soil in control soil but in amended soil it ranged from a low of $2.9x10^3$ (10% farm yard manure amended soil) to a high of $3.7x10^3$ (20% farm yard manure amended soil). The 10% farm yard manure amended soil holed minimum population of fungi (2.5), bacteria (3.3) and actinomycetes (2.9), whereas 20% and 25% amended soil contained for maximum population of fungi, bacteria and actinomycetes (fungi $3.1x10^3$, actinomycetes $3.7x10^3$ in 20%farm yard manure amended soil) and bacteria $4.7x10^3$ per gm soil (in 25% farm yard manure amended soil).

The number of fungi in thousand per gm of soil was minimum (2.8) in 5% compost amendment soil and maximum (3.5) in 25% compost amended soil. It showed an increased in population from 5% to 25% compost amended soil. The population of bacteria was maximum (6.1) in 15% soil and minimum (4.5) in 5% compost amended soil. There was increase in population from 5% to 15% amended soil (4.5 in 5%, 5.8 in 10%, 6.1 in 15%) than the population declined to 5.4 in 25% compost amended soil (5.6 in 20%, 5.4 in 25% soil). The actinomycets showed a high of 5.1 (in 20% soil) and low of 4.1 (in 25% compost amended soil) numbers in the different soil.

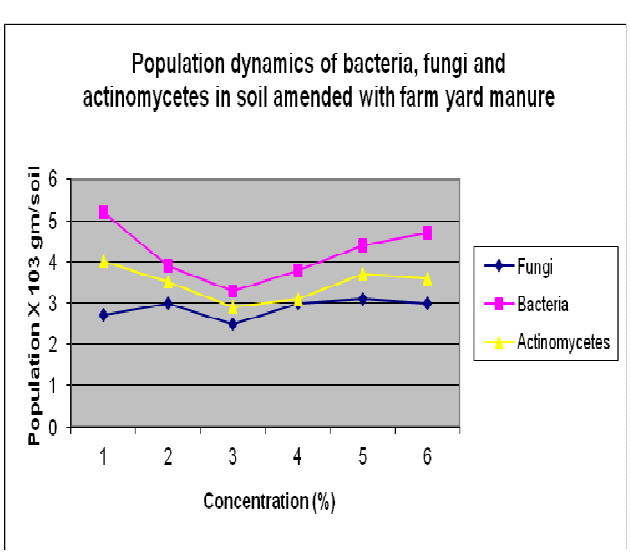
On comparing the efficacy of farm yard manure and prepared compost amended soil on microbial numbers, it can be concluded that prepared compost showed greater improvement in fungal, bacterial and actinomycets population over the control. It is an indicative of improvement in soil reclamation and management of problem soil.

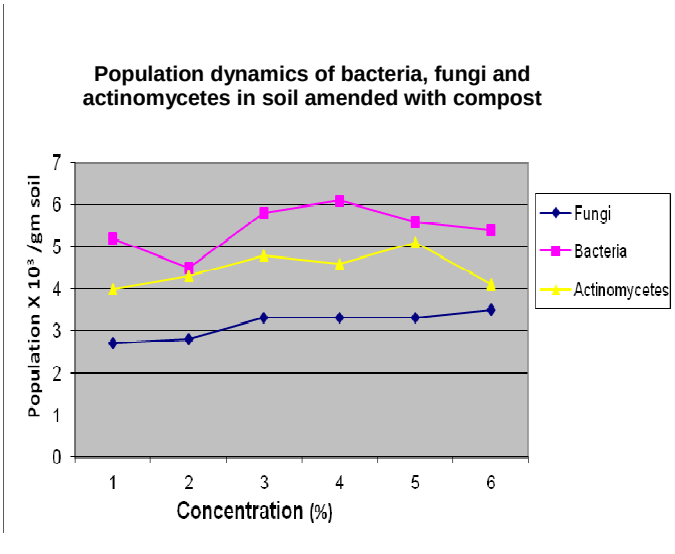
TABLE – 3 IVI of Fungal species obtained in varying doses of treated with compost

S.No.	Name of species	Control soil	5%	10%	15%	20%	25%
1.	*Absidia butleri*	-	18.48	-	16.31	-	15.28
2	*Cunninghamella echinulata*	-	18.48	13.03	-	-	-
3	*A. lichtheimii*	-	-	-	-	13.44	-
4.	*Mucor hiemalis*	15.31	14.44	10.33	16.31	19.91	13.18
5.	*Rhizopus nigricans*	-	-	11.19	11.12	-	12.44
6.	*R. stolonifer*	10.96	13.51	11.19	-	-	-
7.	*Syncephalstrum racemosum*	19.05	-	12.10	-	-	19.52
8.	*Alternaria alternata*	-	-	-	-	15.66	-
9	*A. humicola*	-	-	-	-	-	11.45
10	*Aspergillus flavus*	20.65	13.51	17.6	22.27	22.82	23.76
11.	*A. fumigatus* $_1$	28.31	11.9	23.77	17.69	18.85	-
12.	*A. fumigatus* $_2$	22.89	12.01	8.21	17.69	-	18.08
13.	*A. glocus*	10.76	8.68	-	17.69	16.94	18.08
14.	*A. nidulans* $_1$	15.31	15.21	20.97	20.9	18.40	16.68
15	*A. nidulans* $_2$	27.25	8.79	19.1	11.12	13.41	-
16.	*A. niger* $_1$	15.20	25.51	27.04	19.59	13.44	26.57
17.	*A. niger* $_2$	20.65	27.28	22.37	30.06	24.14	23.57
18	*A. terreus*	13.03	22.13	27.04	-	19.91	20.47
19	*A. ustus*	6.58	8.56	-	-	15.48	-
20	*Curvularia geniculata*	-	-	-	10.51	-	-
21	*Curvularia lunata*	5.56	-	-	-	-	-
22	*Fusarium chlamydosporium*	-	-	-	-	-	13.18
23	*F. arvenaceum*	-	15.21	17.4	-	-	-
24	*F. poae*			10.03	-	-	-
25	*F. oxysporum*	5.56	-	-	-	-	-
26	*F. solani*	8.79	-	-	-	5.00	-
27	*Myrothecium verrucaria*	-	8.68	-	-	-	-
28	*Myrothecium roridum*	-	5.45	-	-	-	-
29	*Penicillium chrysogenum*	-	-	-	8.18	18.40	15.28
30	*P. funiculosum*	5.56	14.94	14.0	19.06	13.44	10.32
31	*Trichothecium roseum*	-	-	-	8.18	-	-
32	*Phoma herbarum*	10.96	-	12.17	-	13.44	-
33	*Mycellia sterilia* $_1$	5.56	22.13	-	22.27	-	15.49
34	*Mycellia sterilia* $_2$	16.69	-	-	26.86	16.94	15.49
35	*Mycellia sterilia* $_3$	8.79	-	17.6	-	-	-
36	*Unidentified* $_1$	8.90	22.13	-	-	19.91	-

Table-4 Distribution of Microbial population in Saline- alkali soils amended with various doses of prepared compost and fym.

S. No.	Doses of amendment (w/w)	Soil amended with farmyard manure material			Soil amended with prepared compost material		
		Microbial Population x 10^3/gm soil			Microbial Population x 10^3/gm soil		
		Fungi	Bacteria	Actinomycetes	Fungi	Bacteria	Actinomycetes
1.	Natural undisturbed soil (Control)	2.7	5.2	4.0	2.7	5.2	4.0
2.	5%	3.0	3.9	3.5	2.8	4.5	4.3
3.	10%	2.5	3.3	2.9	3.3	5.8	4.8
4.	15%	3.0	3.8	3.1	3.3	6.1	4.6
5.	20%	3.1	4.4	3.7	3.3	5.6	5.1
6.	25%	3.0	4.7	3.6	3.5	5.4	4.1





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