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Influence of Soil Environment and Surface Vegetation on Soil Micro Flora in a Coastal Sandy Belt of Orissa, India

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ABSTRACT A total of 141 species belonging 64 genera of fungi were isolated from coastal sandy belt of Orissa. The most dominant genera were *Aspergillus, Penicillium, Trichoderma* and *Fusarium spp.* Higher fungal and bacterial population was encountered in soil B than in soil A. Surface layer possessed higher fungal population, more soil nutrients and less moisture. Fungal population was positively correlated with total organic carbon, moisture content and total soil respiration but negatively correlated with soil temperature. Bacteria studied were maximum in June-July and minimum in January-February.

INTRODUCTION

The saprotrophs, one of the major functional components of a terrestrial ecosystem, are diverse in their occurrence. The role of the saprophytes in decomposition and its potentiality depends upon their count, composition and the higher plant/s with which the later coexist. Fungal population from diverse vegetation sites has earlier been studied (Miller et al.1957; Thornton 1960; Christensen et al. 1962; Gochenaur1978) and it has been concluded that soil microfungi show ecological and geo climatic specificity with response to environmental parameters (Orput and Curtis 1957; Christensen and Whittingham 1965; Christensen 1969). No work in this aspect has yet been done in coastal soil of Orissa, India. Therefore, the present work aims to find out the occurrence, distribution, dominance and variation of soil fungi and bacteria in the noted belt and the factors influencing their ecophysiology.

STUDY SITE

The site of study was Ganjam district of Orissa, 19°.15' N. Latitude and 84°.50' E. Longitude having 60 Km. of sea coast along the Bay of Bengal at a height of 6-8 above MSL. Cashew plantation at this site covers more than 150 hectares extending 4-5 Km. along the coast with a width of 250-450 m. and a shelter belt plantation of *Casuarina equisetifolia* L. having 10-15 rows covering 10-20 m. along the coast.

The unproductive up-lands, coastal sand dunes and sandy beds are extensively covered by *Casuarina equisetifolia* L. for soil conser-vation due to possessing tolerance against desiccation. The climate of the region is monsoonic with coastal characteristics. The atmospheric temperature ranges from 47°C in summer to 13°C in winter. The annual rainfall is about 130cm.

MATERIAL AND METHODS

Two experimental sites were selected from two different localities of the coastal belt situated quite apart from each other and were designated as Soil A and Soil B. Soil A represented a barren unproductive coastal sandy belt without vegetation. Soil B represented a coastal sandy bed with uni-culture plantation of *Casuarina equisetifolia* L. Sampling was done at monthly intervals. Distribution pattern of fungi and bacteria was assessed by adopting dilution (Waksman 1927) and direct plate technique (Warcup 1950) using potato dextrose agar medium. Physico-chemical properties of the soil were estimated adopting Jackson (1967). Soil metabolism was estimated by alkali absorption method (Witcamp 1966).

RESULTS

The temperature of the surface layer was higher than the sub surface layer (Table 1, 2) just reverse to the moisture content. Soil B with low

temperature and high moisture content has more fungal and bacterial population than soil A (Table 1, 2). Other factors like total organic carbon, total nitrogen and pH were relatively higher in soil B. In contrast, the soil A with higher temperature, low moisture and less soil nutrients was found to possess minimum fungal and bacterial propagules. Fungal population attained to its maximum in September and minimum in May in both the soils. Bacterial population attained its maximum in June-July and minimum in January-February in both the sites. Fungal population in both the sites and both the layers had positive correlation with soil moisture and total organic carbon, while the temperature was negatively correlated. The pH and total nitrogen proved insignificant.

Total of 3407 colonies, soil A contributed 1629 colonies of which surface soil had a share of 834 colonies, 54 genera and 91 spp. While sub surface soil produced 795 colonies, 46 genera and 80 species. Soil B contributed 1778 colonies; the surface soil contributed 903 colonies, 36 genera and 78 species while sub surface soil produced 875 colonies, 38 genera and 85 species. Deuteromycotina contributed maximum population followed by Ascomycotina and Zygomycotina (Table 3, 4). The fungi that contributed more than 2.0% towards the total occurrence are enlisted with their ranks (Table 5, 6). This showed that *Aspergillus spp.* were the dominant followed by *Penicillium, Trichoderma and Fusarium spp.*

The evolution of CO_2 was maximum during August-September and minimum in May in both the soil types. Similar trend of fungal population was observed which also had positive correlation with soil respiration

DISCUSSION

Thornton (1960), Christensen et al. (1962), Gochenaur and Whittingham (1967) and Kamal and Bhargava (1973) have reported that the prevailing climate and above ground vegetation are known to influence the abundance and quality of fungi in a particular soil. The presence of more fungi and bacteria in soil B with low temperature and high moisture than the soil A is similar to the findings of Rama Rao (1970), Kubat et al. (1979) and Behera and Mukherji (1985). The correlation between the fungal population and soil moisture and temperature accord to Eicker (1970). Marginal variations in pH at sites fail to

Table 1: Characteristics and total population of fungi and bacteria g^{-1} dry soil in samples of soil B (average of two years)

Months	*Temperature (°C)*	*Moisture content (%)*	*Total organic carbon (%)*	*Total Nitrogen (%)*	*pH*	*Fungal population X 10^2*	*Bacterial population X 10^3*	*CO_2 Evolution MG/MT²/HR*
DEC.	26.0 *	0.38	0.38	0.0112	7.4	44.4	32.4	156
	24.8**	0.53	0.25	0.0098	7.5	40.8	42.1	-
JAN	25.5*	0.35	0.38	0.0102	7.2	45.1	27.3	177
	25.0**	0.69	0.22	0.0095	7.6	46.4	30.6	-
FEB.	27.0*	0.34	0.36	0.0137	7.1	48.7	36.9	211
	26.0**	0.62	0.22	0.011	7.4	43.5	33.4	-
MAR.	31.8*	0.28	0.25	0.0156	6.9	43.8	33.7	150
	30.1**	0.56	0.18	0.0113	7.2	34.7	36.2	-
APR.	35.5*	0.21	0.23	0.0152	7	33.2	40.5	124
	32.8**	0.51	0.15	0.0103	7.4	26.7	31.8	-
MAY	38.8*	0.16	0.18	0.015	6.9	21.8	43.8	93
	34.7**	0.39	0.15	0.0103	7.2	17.1	37.9	-
JUN.	33.0*	0.59	0.29	0.0156	7.1	34.4	46.9	136
	332.5**	0.36	0.26	0.0118	7.3	37.9	44.6	-
JUL.	30.5*	0.9	0.34	0.0184	7	45.8	50.7	184
	29.7**	2.3	0.27	0.0123	7.2	47.1	41.3	-
AUG.	30.0*	1.29	0.39	0.0159	7.1	47.5	45.4	189
	29.0**	3.09	0.3	0.0108	7.3	48.1	39.8	-
SEPT.	29.5*	1.21	0.39	0.0137	6.9	53.2	52.3	215
	28.4**	3.02	0.33	0.011	7.2	51.9	43.9	-
OCT.	28.5*	0.61	0.33	0.0143	7.1	42.4	47.3	248
	27.5**	1.52	0.3	0.0098	7.4	33.7	52.5	-
NOV.	27.5*	0.48	0.35	0.0121	7.1	41.8	37.5	150
	26.5**	0.87	0.23	0.0098	7.8	29.9	44.3	-

* Surface soil
** Sub surface soil

Table 2: Characteristics and total population of fungi and bacteria g^{-1} dry soil in samples of soil A (average of two years)

Months	*Temperature (°C)*	*Moisture content (%)*	*Total organic carbon (%)*	*Total Nitrogen (%)*	*pH*	*Fungal population X 10^2*	*Bacterial population X 10^3*	*CO_2 Evolution MG/MT^2/HR*
DEC.	27.5*	0.24	0.24	0.011	7.8	36.1	26.7	135
	27.0**	0.36	0.19	0.016	7.7	44.2	24.9	-
JAN	27.0*	0.28	0.28	0.011	8	40.8	21.9	141
	26.8**	0.41	0.23	0.01	7.9	46.2	22.1	-
FEB.	29.3*	0.19	0.2	0.013	8	37.2	19.5	134
	28.4**	0.56	0.18	0.01	7.9	35.8	18.5	-
MAR.	35.0*	0.17	0.19	0.009	8	35.1	25.1	87
	31.0**	0.51	0.17	0.009	7.7	28.1	24.8	-
APR.	37.3*	0.17	0.14	0.01	7.5	25.4	29	80
	35.5**	0.46	0.13	0.01	7.5	23	39.8	-
MAY	40.8*	0.12	0.13	0.011	7.4	22.1	32.4	71
	38.8**	0.31	0.12	0.013	7.3	18.1	43.4	-
JUN.	36.5*	0.44	0.17	0.014	7.4	39.3	46.8	138
	32.0**	0.8	0.14	0.0093	7.3	31.5	45.8	-
JUL.	32.5*	0.62	0.18	0.0093	7.2	43.7	35.2	126
	30.8**	1.71	0.16	0.012	7.3	41.3	37.2	-
AUG.	31.0*	0.92	0.21	0.01	7.3	43.8	41.5	147
	30.6**	2.32	0.17	0.01	7.2	41.9	39.5	-
SEPT.	31.0*	0.63	0.23	0.011	7	48.5	32.4	172
	30.5**	2.07	0.19	0.01	7.2	44.3	34.3	-
OCT.	30.5*	0.48	0.22	0.01	7.2	33.3	48.8	181
	29.5**	1.35	0.15	0.009	7.4	36.2	28	-
NOV.	28.5*	0.3	0.17	0.011	7.4	32.3	32.2	120
	28.3**	0.7	0.15	0.01	7.5	35.3	26.3	-

* Surface soil
** Sub surface soil

Table 3: Special group distribution of fungus spp. in samples of soil B.(Observed by both methods)

Name of the groups	*Surface (depth in cm.)*							
	0 – 3				*8 – 15*			
	Numberof genera	*% of total*	*Number of spp.*	*% of total*	*Numberof genera*	*% of total*	*Number of spp.*	*% of total*
Zygomycotina	5	13.9	7	9.0	3	7.9	5	5.9
Ascomycotina	2	5.6	2	2.6	3	7.9	4	4.7
Deuteromycotina	29	80.5	69	88.4	32	84.2	76	89.4
Moniliales	24	82.8	64	92.8	21	65.6	65	85.6
Sphaeropsidales	3	10.4	3	4.2	7	21.8	7	9.2
Melanconiales	1	3.4	1	1.5	2	6.3	2	2.6
Mycelia sterilia	1	3.4	1	1.5	2	6.3	2	2.6
	36	100	78	100	38	100	85	100

Table 4: Special group distribution of fungus spp. in samples of soil A. (Observed by both methods)

Name of the groups	*Surface (depth in cm.)*							
	0 – 3				*8 – 15*			
	Numberof genera	*% of total*	*Number of spp.*	*% of total*	*Numberof genera*	*% of total*	*Number of spp.*	*% of total*
Zygomycotina	6	11.1	6	7.7	3	6.5	4	5.0
Ascomycotina	5	9.3	7	6.6	4	8.7	5	6.2
Deuteromycotina	43	79.6	78	85.7	39	84.8	71	88.8
Moniliales	30	55.6	65	71.4	27	58.6	59	73.8
Sphaeropsidales	9	16.7	9	9.9	8	17.4	8	10
Melanconiales	1	1.8	1	1.1	2	4.4	2	2.5
Mycelia sterilia	3	5.5	3	3.3	2	4.4	2	2.5
	54	100	91	100	46	100	80	100

Table 5: Relative ranks of dominant fungi based on their % abundance (above 2.0%) recorded from the soil B.

S. No.	Fungi	Surface soil			Sub surface soil		
		Number of colonies	% Contribution	Rank	Number of colonies	% Contribution	Rank
1	*Trichoderma viride*	65	7.2	1	96	10.97	1
2	*Penicillium verruculosum*	63	6.98	2	85	9.71	2
3	*Aspergillus flavus*	62	6.86	3	19	2.17	14
4	*Aspergillus niger*	55	6.09	4	72	8.22	3
5	*Penicillum citrinum*	52	5.76	5	22	2.51	11
6	*Fusarium* spp.	47	5.2	6	39	4.46	7
7	*Aspergillus terreus*	34	3.77	7	69	7.89	4
8	*Cladosporium cladosporioides*	32	3.54	8	-	-	-
9	*Aspergillus fumigatus*	30	3.32	9	45	5.14	6
10	*Aspergillus awamori*	29	3.21	10	58	6.62	5
11	*Cladosporium oxysporum*	26	2.88	11	-	-	-
12	*Curvularia lunata*	23	2.55	12	28	3.2	8
13	*Penicillium rubrum*	22	2.43	13	22	2.51	12
14	*Drechslera australiensis*	21	2.32	14	-	-	-
15	*Absidia butleri*	20	2.21	15	21	2.4	13
16	*Rhizopus nigricans*	20	2.21	16	26	2.97	9
17	*Aspergillus candidus*	19	2.1	17	-	-	-
18	*Penicillium minio-leuteum*	-	-	-	23	2.63	10

Table 6: Relative ranks of dominant fungi based on their % abundance (above 2.0%) recorded from the soil A.

S. No.	Fungi	Surface soil			Sub surface soil		
		Number of colonies	% Contribution	Rank	Number of colonies	% Contribution	Rank
1	*Aspergillus nidulans*	124	14.97	1	40	5.03	2
2	*Aspergillus awamori*	75	8.99	2	44	5.53	1
3	*Aspergillus fumigatus*	58	6.95	3	33	4.15	4
4	*Cladosporium cladosporioides*	56	6.71	4	34	4.28	3
5	*Aspergillus niger*	45	5.38	5	28	3.52	8
6	*Penicillum citrinum*	41	4.92	6	32	4.03	6
7	*Curvularia lunata*	40	4.8	7	26	3.27	9
8	*Curvularia eragrostidis*	36	4.32	8	-	-	-
9	*Cytosporella* spp.	30	3.6	9	-	-	-
10	*Paecilomyces varioti*	29	3.48	10	31	3.9	7
11	*Chaetomium homopilatum*	28	3.36	11	32	4.03	5
12	*Trichoderma viride*	25	3.0	12	25	3.14	10
13	*Aspergillus terreus*	23	2.76	13	22	2.77	12
14	*Cladosporium oxysporum*	19	2.28	14	-	-	-
15	*Penicillium verruculosum*	18	2.16	15	23	2.89	11
16	*Aspergillus flavus*	17	2.04	16	-	-	-

influence the fungal population due to its trifle role (Menon and Williams 1957). Tresner et al. (1954) have reported that the composition of fungal species in communities is affected by aerial vegetation. Different vegetations supporting different communities of soil fungi have also been reported by Orput and Curtis (1957), Thornton (1960) and Christensen (1969). A comparison of the fungal population at two sites indicates that, the quantitative and qualitative differences of the surface vegetation were reflected by similar alterations in the micro fungal inhabitants. In fact, soil B harboured maximum and soil A, the minimum fungal population.

The seasonal variations seem to influence the density of an individual fungus and population as a whole. The rainy carried higher population followed by winter and summer. Higher moisture content and temperature of sand corresponding to the rains and summer might be the reason for such fluctuation. The species composition at two sites shows marked difference with change in habitat and surface vegetation. Also, the fluctuation of ranks of the dominant species can

be attributed to the change in the nutrient status of the soil. The order Dueteromycotina < Ascomycotina < Zygomycotina of occurrence might be due to ability of the fungi for survival of adversity and adjustment with the environment. CO_2 output has been reported to be influenced by the soil temperature and the moisture (Kucera and Kirkham 1971; Clark and Coleman 1972) and possessed the correlation with microbial population (Ray and Srivastava 1982) is observed presently.

CONCLUSION

Colonization and decomposition of litter in soil is carried out by micro-organisms. Fungi are good competitive saprophytes able to exploit substrates fully. From this investigation some fungi may be detected which will decompose the leaves at a faster rate. As a result the nutrient status of the sand dune will be changed and the energy plantation can be replaced by suitable economic plants which will increase the economic status of the state.

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