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Archives of Applied Science Research, 2011, 3 (3):207-212

(http://scholarsresearchlibrary.com/archive.html)

ISSN 0975-508X
CODEN (USA) AASRC9

Decomposition of Bamboo leaf litter and role of earthworms and microorganisms

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ABSTRACT

The decomposition of bamboo leaf litter was investigated in situ and the role of earthworm in this process was assessed. The microflora increased considerably both qualitatively and quantitatively with addition of bamboo litter and earthworm. Soil got enriched in composition of nutrients.

Key words : Bamboo leaf litter, microflora, decomposition, earthworm.

INTRODUCTION

The decomposition is a complex and prolonged process which depends upon the nature of substrate, environment and the organisms involved. The end product of their process is the humus and liberation of different elements present in the plant. Litter decomposition has basic implications both for the supply of macro-and micronutrients to green plants. Though the interaction of microflora and microfauna are involved in litter decomposition, it is difficult to isolate decomposing litter from faunal activity without disturbing the microbial environment.

Earthworms are soil inhabiting animals and regarded as *"friends of farmers"* and natural tillers of soil. They are recognized as efficient bio-converters of organic residues in to high-grade compost. Earthworms can influence the rate of litter decomposition more than any other group of soil organisms. The rate of disappearance of different litter species due to animal activity, especially that of earthworms has been studied in *in vitro* [1]. Though the role of microorganisms [2] and earthworms [3-6] in improving soil structure and soil fertility was investigated, there are only limited studies dealing with combined influence of microorganisms and earthworms in litter decomposition [7]. In the present investigations, the role earthworms and microorganism in the decomposition of bamboo leaf litter was studied.

MATERIALS AND METHODS

Earthworm population and microorganisms associated with bamboo leaf litter in relation to soil was analyzed. Freshly fallen bamboo leaf litter was collected and cut in to small piecies and weighed quantity of leaf litter was placed in pots filled with sterilized soil. Minimum nine earthworms were introduced in to the pot. Moisture content of soil was maintained by adding

required sterilized water. At every 10 days, 10g of litter was employed for the analysis of microflora (fungi, bacteria and actionomycetes) by soil dilution plate technique (Waksman, 1922). Initial microflora of litter and soil was also recorded, separately.

At the end of incubation period (60 days) the earworm population, physico-chemical properties of soil and the microorganisms were recorded, suitable controls were maintained. The rest of the details were similar to those employed earlier.

RESULTS AND DISCUSSION

Table 1 reveals that only limited number of fungi such as *A.terricola, A.alternata, A.niger, A.sydowi, C.brasilliense, C.cladosporioides, F.moniliforme, M.roridum, P.purpurogenum, P.glomerata, Phoma* sp., *S.racemosum* and *T.sepedonium* were present in the initial stages of bamboo leaf litter decomposition. A significant change in both qualitative and quantitative composition of mycoflora was recorded with progress of incubation period. *C.brasiliense, P.purpurogenum* and *P.glamerata* were eliminated, while the population of *A.alternata* and *A.niger* was static and increased respectively. On the other hand *A.terricola* and *M.roridum* decreased in their population. *T.viride, A.japonicus, A.flavus, C.globosum, C.lunata* and *R.stolanifer* which appeared during later stages became active in litter decomposition *S.racemosum* and *F.moniliforme* were also active during subsequent incubation period. Rest of the fungi were sporadic in their appearance and probably played limited role in litter decomposition.

T. viride and *A. japonicus* were with highest percentage of frequency, while *C.brasiliense, A.ustus, A.nidulans, P.glomerata,* species of *pencilillium* were with least percentage of frequency. *A.japonicus* followed by *T.viride* were with highest percentage of abundance. On the other hand, *A.ustus, C.brasiliense, F.palladoroseum, G.murorum* and *Mucor* sp. Were with least percentage of abundance.

When earthworms were added to this soil-bamboo litter system, significant change in the fungal population was recorded. *A.versicolor, P.aurantiogriseum, F.moniliforme* and *P.glomerata* were eliminated totally, while population of *T.viride* decreased significantly. On the other hand sterile mycelim increased. Similarly *Phoma* sp., *P.purpurogenum, G.murorum, C.lunata* and *C.cladosporioides* became active in earthworm introduced soil-plant litter system. The population of *A.ochraceus* and *A.nidulans* also increased in the presence of earthworm. *A.nidulans* followed by *C.globosum, C.cladosporioides, C.lunata, G.murorum, R.stolanifer, T.viride* and sterile mycelium were with highest percentage of frequency. Similarly *G.murorum, C.cladosporioides, A.niger, A.nidulans, A.ochraceus, Phoma* sp., *P,.pusrpurogenum* and *C.globosum* were with considerable high percentage of abundance, while *A.alternata, A.chevalieri, A.flavipes, F.palladoroseum, G.macrocladum, H.grisea, M.verrucaria, N.crassa,T.sepedonium, S.racemosum* and *S.variabile* were with low percentage of abundance.

During initial stages of observations only *B.mycoides* and *Rhodococcus* sp. could be detected (Table 2). With the progress of incubation period *B.macerans, P.vulgaris, P.aeruginosa, F.orhyzihabitans, M.roseus* and *M.lutea* could be detected with considerable percentage of incidence. Population of *B.mycoides* increased with the progress of incubation period upto and decreased subsequently. *B.mycoides* followed by *B.macerans, P.aerginosa* and *Rhodococcus* sp. were with considerable percentage of frequency. The percentage of abundance was highest with *P.vulgaris* and *B.mycoides, B.macerans, M.lutea, P.vulgaris* and *P.aeruginosa* made their appearance at later stages but became dominant during major part of the observation period. *Rhodococcus* sp. and *B.mycoides* also dominated in the earthworm-soil-litter system.

Table-1: Mycoflora of bamboo (Bambusa - aurandanances) litter in relation to earthworm

Name of the fungus	Control							Percenage of freqnency	Percenage of abundance	B.a + earthwrom						Percenage of freqnency	Percenage of abundance
	Percentage of incidence									Percentage of incidence							
	Incubation period (in days)																
	0	10	20	30	40	50	60			10	20	30	40	50	60		
Acremonium terricola	9.2	-	-	1.3	-	-	-	28.6	1.14	-	-	-	11.5	6.2	-	33.3	1.88
Alternaria alternata	3.4	-	2.5	-	2.3	3.2	-	57.1	2.03	-	-	-	8.2	-	-	16.7	0.99
Asporgillus	-	-	-	-	-	-	-	-	-	-	3.6	-	-	-	-	16.7	0.79
A.flavipes	-	16.8	17.1	5.7	-	-	5.3	57.1	9.21	-	-	-	-	-	4.1	16.7	0.59
A.flavus	-	6.5	-	-	13.6	8.4	4.8	57.1	4.40	11.7	3.2	-	-	-	6.8	50.0	2.68
A.japonicus	-	6.5	10.8	9.4	-	20.0	6.3	71.4	13.10	5.8	-	-	-	-	3.4	33.3	1.48
A.nidulans	-	-	-	30.2	-	-	-	14.3	4.90	5.3	5.0	8.9	-	13.8	7.4	83.3	6.85
A.niger	8.4	18.7	-	-	17.0	16.0	-	57.1	9.70	19.9	2.72	-	-	-	9.5	50.0	5.36
A.ochraceus	-	-	9.5	-	-	-	11.6	28.6	4.28	-	-	11.8	7.4	-	8.1	50.0	4.17
A.sydowi	4.2	-	-	5.0	-	-	-	28.6	2.14	-	-	-	13.2	-	-	16.7	1.68
A.terreus	-	-	-	-	-	-	-	-	-	-	-	6.4	-	-	-	16.7	1.29
A.ustus	-	-	2.5	-	-	-	-	14.3	0.65	3.4	-	9.4	-	-	-	33.3	2.48
A.versicolor	-	-	16.5	-	13.6	-	-	28.6	6.26	-	-	-	-	-	-	-	-
Caetomium brasillense	5.0	-	-	-	-	-	-	14.3	0.98	-	-	-	11.5	-	-	16.7	1.39
C.globosum	-	10.3	4.4	-	13.2	-	-	42.9	3.28	5.8	7.7	-	-	21.1	10.1	66.7	6.65
Choanophora cucurbitarum	-	-	-	-	-	-	-	-	-	-	-	6.4	-	-	-	16.7	1.29
Cladosporiumcladosporioides	1.7	-	12.7	-	-	-	-	28.6	3.78	-	2.7	5.4	6.6	4.8	-	66.7	4.36
Curvularia lunata	-	-	10.8	3.1	-	5.6	-	42.9	3.77	2.9	3.2	3.4	6.6	-	-	66.7	2.68
Fusarium oquiseti	-	-	-	-	-	-	-	-	-	-	-	10.8	-	-	-	16.7	2.18
F.moniliforme	7.6	-	-	16.4	3.4	4.0	-	57.1	4.73	-	-	-	-	-	-	-	-
F.oxysporam	-	-	-	-	-	-	-	-	-	-	8.6	-	9.0	-	-	33.3	2.97
F.palladoroseum	-	-	-	2.5	-	-	-	14.3	0.65	-	-	-	-	6.2	-	16.7	0.89
Gliomastix murorum	-	-	-	-	5.7	-	-	14.3	0.82	-	-	9.4	7.4	6.2	12.2	66.7	5.46
Gonytrichum macrocladum	-	-	-	-	-	-	-	-	-	-	-	-	-	4.1	-	16.7	0.59
Humicola grisea	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	-	16.7	0.89
Mucor sp.	-	-	-	-	-	-	5.3	14.3	0.82	11.7	-	-	-	-	8.8	33.3	3.27
Myrothecium roridum	10.1	-	-	-	-	-	6.3	28.6	1.96	-	8.6	5.4	-	-	-	33.3	2.97
M.verrucaria	-	-	-	-	-	-	-	-	-	-	-	3.4	-	-	-	16.7	0.69
Neurospera crassa	-	-	-	-	-	-	-	-	-	-	-	2.5	-	-	-	16.7	4.90
Pencillium argillaceum	-	-	-	-	-	6.4	-	14.2	1.31	-	-	-	-	-	-	-	-
P.aurantiogriseum	-	-	-	-	-	-	48.4	14.3	2.57	-	-	-	-	-	-	-	-
P.griseofulvum	-	-	-	-	-	-	-	-	-	-	-	-	9.0	-	4.7	33.3	1.78
P.oxalicum	-	12.1	-	-	-	-	-	14.3	1.64	5.8	-	-	-	-	-	16.7	0.99
P.purpurogenum	10.1	-	-	-	-	-	-	14.3	1.97	-	18.2	4.4	-	-	-	33.3	4.86
P.verruculosum	-	-	-	8.8	-	-	-	14.3	2.30	-	-	-	-	7.0	-	16.7	0.99
Phoma glomerata	10.9	-	-	-	-	-	-	14.3	2.14	-	-	-	-	-	-	-	-
Phoma sp.	18.5	-	-	-	-	10.4	-	28.6	3.76	5.8	12.7	3.0	-	-	-	50.7	4.36

Continued (Table 1)

Rhizopus stolanifer	-	6.5	2.5	7.5	-	-	-	42.9	3.78	6.4	-	2.5	4.9	3.4	-	66.7	2.68
S.constrictum	-	-	-	-	-	-	-	-	-	-	-	-	-	11.6	-	16.7	1.06
S.variabile	-	-	-	-	-	-	-	-	-	-	1.4	-	-	-	-	16.7	0.29
Stachybotrys atra	-	-	-	-	-	-	-	-	-	-	9.1	-	-	-	-	16.7	1.98
S. racemosum	4.2	-	4.4	-	9.1	14.4	-	57.1	3.26	3.5	-	-	-	-	-	16.7	0.59
T. sepedinium	6.7	-	-	10.1	-	-	-	28.6	3.95	-	3.2	-	-	-	-	16.7	0.69
Trichoderma viride	-	11.2	6.3	1.4	10.2	12.8	8.4	85.7	10.35	4.7	1.4	3.4	-	-	5.4	66.7	2.58
V. albe-etrum	-	-	-	-	-	-	-	-	-	7.0	-	-	-	-	6.8	33.3	2.18
Sterile mycelium	-	11.2	-	-	6.8	2.4	-	42.9	1.38	-	-	3.4	6.6	4.8	6.8	66.7	3.17

Table-2: Bacterial flora of bamboo (Bambusa - aurandanances) litter in relation to earthworm

Name of the fungus	Control							Percenage of freqnency	Percenage of abundance	B.a + earthwrom						Percenage of freqnency	Percenage of abundance
	Percentage of incidence									Percentage of incidence							
	Incubation period (in days)																
	0	10	20	30	40	50	60			10	20	30	40	50	60		
Bacillus macerans																	
Bacillus macerans	-	10.3	20.1	16.3	-	-	-	42.9	14.62	9.3	28.1	7.6	3.6	-	-	66.7	15.61
Bacillus mycoides	0.8	14.2	10.2	3.4	-	2.1	-	71.4	15.00	-	17.3	13.4	-	-	-	33.3	11.23
Escherichia coli	-	-	-	-	-	-	-	-	-	-	-	14.3	-	14.9	-	33.3	10.97
Flavimonas orhyzihabitans	-	-	-	-	-	1.0	0.2	28.6	3.61	-	6.2	-	4.3	-	-	33.3	4.69
Micrococcus kristinae	-	-	-	-	-	-	-	-	-	1.4	-	13.8	-	-	-	33.3	11.78
Micrococcus lutea	-	-	13.9	-	-	-	-	14.3	10.20	13.5	-	12.1	-	13.1	-	50.0	14.11
Mcrococcus roseum	-	-	-	13.1	-	12.1	-	28.6	14.92	-	-	-	-	-	-	-	-
Proteus vulgaris	-	16.3	11.4	-	-	-	-	28.6	19.92	2.2	-	14.4	13.5	-	-	50.0	12.61
Pseudomonas aerginosa	-	-	10.2	20.1	-	13.1	-	42.9	13.62	1.1	-	3.1	-	3.1	-	50.0	3.11
Rhodococcus sp.	2.1	-	3.1	-	-	-	0.5	42.9	8.17	-	-	13.1	11.3	-	10.7	50.0	12.58

Table-3: Actinomycetes of bamboo (Bambusa - aurandanances) litter in relation to earthworm

Name of the fungus	Control							Percenage of freqnency	Percenage of abundance	B.a + earthwrom						Percenage of freqnency	Percenage of abundance
	Percentage of incidence									Percentage of incidence							
	Incubation period (in days)																
	0	10	20	30	40	50	60			10	20	30	40	50	60		
Micromonospora sp.	-	-	-	-	-	-	-	-	-	-	-	12.2	8.1	-	10.6	50.0	12.79
Streptomyces antibioticus	-	10.8	12.1	-	-	-	-	28.6	10.32	-	-	10.4	3.2	12.4	-	50.0	12.72
Streptomyces atroolivaceus	-	-	-	10.3	18.4	-	-	28.6	16.29	-	-	11.3	3.3	-	-	33.3	9.26
Streptomyces corchorusii	-	8.6	10.9	-	-	-	-	28.6	9.97	-	8.4	1.4	12.1	10.3	21.8	83.3	16.76
Streptomyces longisporus	-	13.0	-	11.3	-	-	-	28.6	9.38	-	11.3	-	12.7	3.5	4.7	66.7	10.72
Streptomyces psammoticus	-	20.6	-	10.6	12.8	-	-	24.9	19.28	-	13.1	-	2.2	-	-	33.3	10.16
Streptomyces rimosus	6.3	-	13.1	10.4	-	-	-	42.9	10.11	-	-	10.6	-	8.3	10.6	50.0	11.28
Streptomyces violans	-	-	-	8.9	8.7	-	-	28.6	16.78	-	10.3	0.4	10.5	-	-	50.0	9.29
Streptomyces violocinareus	-	10.3	-	-	18.3	-	-	28.6	12.35	-	8.3	7.4	-	-	-	33.3	9.28

M.roseus was totally eliminated. *F.orhyzihabitans* and *M.kristinae* made their appearance during litter decomposition with considerable percentage of incidence.

From table 3 it is clear that only *S.rimosus* could be detected at initial day but during subsequent days *S.atroolivaceus, S.psammoticus, S.violans, S.antibioticus, S.corchorusii, S.volocinasreus* and *S.longisporus* not only made their appearance but also became with considerable high dominant. Though *S.rimosus* could not be detected on 10^{th} day, it appeared with high percentage of incidence by 30^{th} day. The actinomycetes population increased considerably in presence of earthworms. All the nine actinomycetes could be spotted with high percentage of incidence which may be attributed to the earthworm activity. *S.corchorusii* was dominant in the presence of earthworm.

Soil which was red in colour turned to brown due to bamboo litter and earthworm activity. The pH was almost uniform moisture content increased and mechanical composition was altered. Humus content bicarbonates, chlorides and phosphorus increased relatively in soil-bamboo litter earthworm system. Nitrogen content was more in soil litter system which increased considerably in soil-bamboo litter-earthworm system.

Analysis of mycoflora in the soil with bamboo litter and earthorm at the end of 60 days incubation revealed significant difference. The sterilized soil of the experimentation was supporting the growth of *A.flavus, A.japonicus, A.niger, H.grisea* and *S.constrictum and* underwent significant change. *A.flavus, H.grisea* and *S.constrictum* disappeared, while *A.nigher, A.versicolor* and *M.roridum* increased in their percentage of incidence. On the other hand, *M.echinata, P.aurantiogriseum* and *A.alternata* were with least percentage of incidence. The soil supporting the bamboo litter was rich in mycoflora both qualitatively and quantitatively. *A.niger, A.alternata, C.cladosporioides, C.lunata, C.pallescens, M.echinata, M.roridum* and *P.aurantiogriseum* which could be spotted in the soil disappeared in soil supporting the bamboo litter. Addition of earthworm to the soil-bamboo litter system further changed the mycoflora. *A.flavipes, A.nidulans, C.herbarum, G.murorum, P.varioti, S.atra, S.racemosum* and *T.sepeonrdium* which were absent in the soil bamboo-litter system, could be detected when earthworm was added to this system. *S.atra, P.varioti, A.flavipes, R.stolanifer, A.nidulans* and *A.versicolor* were also with considerable percentage of incidence. Addition of earthworm to the soil-litter system not only increased mycoflora qualitatively but also quantitatively. From the present investigations it can be concluded that bamboo litter and earthworm combination contributed to increase soil fertility.

Acknowledgments
Thanks are due to the Head, Department of Botany for providing necessary facilities and UGC for financial assistance.

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