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Research Article

STUDIES ON DECOMPOSITION OF TEA LEAF LITTER UNDER FIELD CONDITION IN DARJEELING

***Bhujel, A., Mazumdar, A. Basu and Chhetri, P.**
Darjeeling Tea Research and Development Center, Tea Board, Kurseong, India- 734203
**Author for Correspondence: bhujelavinash@yahoo.in*

ABSTRACT
Litter bag technique was used to study leaf litter degradation in high elevation tea areas in Darjeeling District. Mean leaf litter degradation rate and mean carbon dioxide (CO_2) evolution from litter bag varied depending on the season and about 98 % of tea leaf litters were degraded during the period of 12 months. The mean coefficient correlation (r) between percentage litter degradation and carbon dioxide (CO_2) emission from litter bag was r = - 0.65. Correlation between Met data and decomposition rate of tea leaf litter was calculated. A large diversity of fungi was associated with degradation of tea litters. During early period under dry conditions several species of *Cladosporium, Epicoccum, Penicillium, Aspergillus and Pestalotiopsis* spp were observed to colonise surface of dry tea leaf. Later under wet conditions *Fusarium, Colletotrichum, Phoma, Pestalotiopsis, Trichothecium*, bacteria and several species of *Trichoderma* were observed. *Streptomyces, Chaetomium, Memnoniella, Nirgrospora* were observed during late stage of decomposition.

Keywords: Pruning litter, *Camellia sinensis*, Carbon dioxide

INTRODUCTION
Pruning is a destructive, yet important agronomic operation where tea bushes [*Camellia sinensis* (L) O Kuntze] are cut at predetermined height to encourage growth of young shoots. It has been estimated that 18-20 tons of pruning litters are generated in a pruning cycle accounting for 8-7.2 tons of above ground carbon. Managements practices in tea plantation in North East India allow pruning litters to remain *in situ* in the field as it releases significant quantities of trapped nutrients (N-2%; P_2O_5-0.50%; K_2O- 1.5%) to improve the soil properties and increase yield (Barooah, 2011). Decomposition of leaf litter is a vital ecological process in Carbon balance and nutrient cycling in terrestrial ecosystems (Scheffer *et al*. 2001). Tropical ecosystems which are dominated by warmer climates are important sinks and source of atmospheric GHG. Litter quality and nature of microorganism associated with decomposition and understanding the changes that take place during the process is crucial. The activity of microorganism is generally measured by evolution of carbon dioxide which contributes to soil respiration (Austin and Vitousek 2000, Jacob *et al.* 2009).
Studies on pruning litter decomposition was carried out in Tea plantation in Assam (Dutta *et al*. 2005) and at Dooars region (Debnath *et al.* 2015) in the past. In these studies CO_2 evolution as a measure of microbial activity was not recorded. Reliable information on pruning litter degradation trends and associated microbial activity in high grown tea areas of Darjeeling is not available. The present study was therefore initiated to determine the seasonal variation of tea pruning litter decomposition rate and its relationship with CO_2 emission.

MATERIALS AND METHODS
Study area: The experiment was laid out at mature tea sections planted with chinery tea clones, located in the experimental Tea areas of Darjeeling Tea Research and Development Centre, Kurseong, (Lat 26°52'12" N, Long 88°15'46" E).

Lay out:

Block	Bag No.											
A	12	3	10	8	6	11	2	4	9	5	1	7
B	7	1	5	11	4	12	3	10	8	6	9	2
C	9	11	6	3	10	7	1	5	2	4	12	8
Months	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar

Litter decomposition: Litter bag method of Verhoef (1995) was adopted in this experiment. Pruning litters consisting of air dried leaf 10 gm was accommodate in 36 nylon bag of size 15 x 8 cm with 5 mm mesh size. Bags were placed in the tea area within tea bushes at random in 36 places in three blocks at a distance of about 3.6 m. Three bags, one from each block was taken out at monthly interval, washed properly before recording dry weight. Mean percent weight loss of litter bags collected from the field for twelve month were determined in relation to initial dry weight with the following formula:

W_2-W_1/W_1 X *100*, where

W_1= Initial weight and W_2= Final weight

The mean seasonal decomposition rate is shown in Fig 1.

Evolution of carbon dioxide from decomposing litters*:* Carbon dioxide emission from litter bag was determined as per Sinha and Dayal (1983) by alkali absorption method using phenolphthalein as an indicator and expressed as CO_2 evolution mg/24hrs/bag. The carbon dioxide evolution at monthly interval was shown in Fig 1.

IDENTIFICATION OF MICRO FLORA

Tea litters consisting of leaf of varying age were observed directly and under moist Petri plate method Keyworth (1951). Dominant microbes observed during initial and later stage of degradation were examined under light microscope X400 and identified with the help of literature Subramanium (1971), Barnett and Hunter, (1972) and Gilman (1957). A few leaves in the process of microbial decomposition was shown in Plate: 1.

CORRELATION BETWEEN MET DATA AND LEAF LITTER DECOMPOSITION RATE

Met data were collected from Tea Research Association Meteorological station located at Ging Tea Estate and the correlation matrix between meteorological parameters and litter decomposition rate was determined and shown in Table 1.

Table 1: Pearson Coefficient correlation matrix between leaf litter degradation rate and met data

Parameters	**Mean Max. Temp °C**	**Mean Min. Temp °C**	**Mean SSH**	**Mean Rainfall (mm)**	**Mean RH % (Morning)**	**Mean RH %(Evening)**
Deg. Rate	**-0.64**	**-0.54**	**+0.38**	**-0.12**	**-0.49**	**-0.38**
Mean Max. Temp	0.0	**+0.93**	**-0.35**	**+0.25**	**+0.73**	**+0.70**
Mean Min. Temp	00	00	**-0.49**	**+0.54**	**+0.89**	**+0.90**
Mean SSH	00	00	00	**-0.55**	**-0.66**	**-0.60**
Mean RF (mm)	00	00	00	00	**+0.61**	**+0.70**
Mean RH (Mor.)	00	00	00	00	00	**+0.94**
Mean RH (Eve.)	00	00	00	00	00	00

Plate 1: A few leaves in the process of microbial decomposition:

Fig. A- *Streptomyces spp* on tea leaf; Fig. B- *Trichoderma* on leaf petiole; Fig. C- *Pestalotiopsis spp*; Fig. D- Colletotrichum spp; Fig. E- Sterile fungus on tea; Fig. F- *Trichoderma* on tea leaf; Fig. G- *Pestalotiosis spp* on leaf petiol; Fig. H- Colonization by unidentified fungus; Fig. I- *Chaetomium spp* on tea leaf; Fig. J- *Memnoniella spp* on tea leaf.

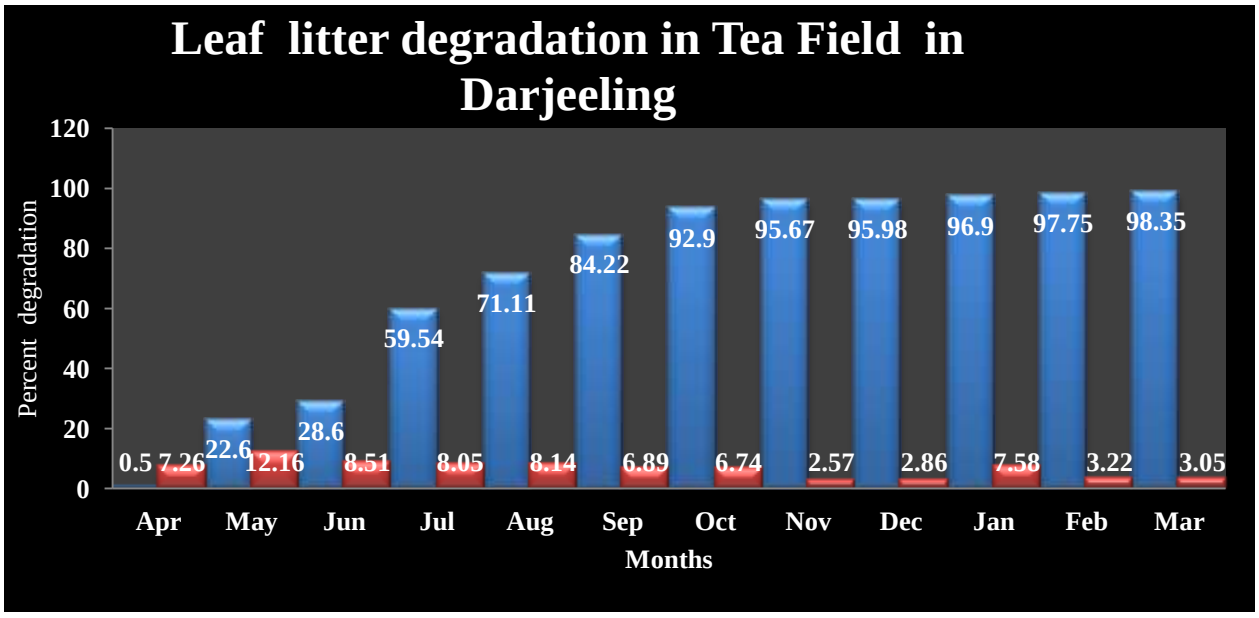

Figure 1: Tea Leaf litter degradation rate (blue bar) and CO_2 evolution [mg/24hrs/bag] (pink bar) under Tea field in Darjeeling, (r = - 0.65).

RESULTS AND DISCUSSIONS

It was evident from Fig. 1 that during the initial stages degradation of leaf litters was 0.5 % which later increased to 58% after 4 months (Apr'16-Jul'16) accounting for mean decomposition rate of 14%. The decomposition rate in August'16 was 71% which increased to 95% during November'16 and showed a mean 6% of decomposition rate. In the late phase decomposition rate was steady and increased slightly from 95% to 98% during December to March'17 registering a mean decomposition rate of 0.7 %. Rapid decomposition rate in the initial stages may be attributed to higher availability of soluble substances (sugars, amino acids and other nutrients) from decomposing leaf and aggressive colonization by saprophytic microorganisms and favorable climatic conditions as evidenced by higher carbon dioxide evolution (7-12 mg 24 hr $^{-1}$) during the period. The coefficient co relation (r) between percentage litter degradation and carbon dioxide evolution was r = -0.65 in dictating fairly good relationship between parameters. Slow decomposition rate as evidenced by low carbon dioxide evolution (2-8mg 24hr $^{-1}$) during late stage may be attributed to poor availability of soluble nutrients and more of cellulosic substances available for saprophytic microorganisms. It was evident from table: 1 that complex relationship exists between met data and their interaction and decomposition rate.

Dutta *et al*. (2005) found that 95-97 % of mixed pruning litters are degraded under field conditions of Assam in six months period and Debnath *et al.* (2015) also found that 69.20 % of mixed tea pruning litter degraded under field condition in Dooars region. Sinha and Dayal (1983) working with fungal decomposition of Teak litter observed that CO_2 evolution from litter bag decreased from 119 mg/m^2/hr to 24 mg/m^2/hr during period of decomposition which is in close agreement with our present observation.

Our present study is also in close agreement with Aber *et al* (1990) who observed that decomposition usually takes place in two phases. In the first phase soluble sugar, amino acid released from litters which attracts soil microorganisms and in the second phase cellulose, hemicelluloses, lignocelluloses are degraded at relatively slower rate by soil microorganisms.

Fungi were found to be predominant in tea litters during the process of decomposition. A large diversity of fungi was observed to colonize tea litters. During early period under dry conditions several species of *Cladosporium, Epicoccum, Penicillium, Aspergillus and Pestalotiopsis* spp were observed to colonize surface of dry tea leaf. Later under wet conditions *Fusarium, Colletotrichum, Phoma, Pestalotiopsis, Trichothecium* and several species of *Trichoderma* were observed. A *Streptomyces, Chaetomium, Memnoniella, Nirgrospora* were observed during late stage of decomposition (Plate: 1). These fungi were earlier reported by various authors and compiled by Agnihothrudu, (1964).

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