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Original Research Article

Carbon Nitrogen Dynamics during Decomposition of *Pinus longifolia* Leaf Litter in the Presence of Cow Dung

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ABSTRACT

The present studies find out the effect of cow dung on litter decomposition rate in *Pinus longifolia* leaf litter in the Chandak forest of Pithoragarh. The aim of the present study is to determine the carbon nitrogen releasing pattern from decomposing Pine leaf litter treated with cow dung (1:1). Litter bags technique was used to determine the decomposition rate. Monthly litter decomposition rate was positively related ($P < 0.05$) with the climatic factors (rainfall, temperature and relative humidity). The Carbon and Nitrogen releasing rate ($P < 0.05$) was also positively related with decomposition rate. The decomposition rate decreased in the autumn and summer seasons as compared to rainy seasons because rainy season was more favorable for the decomposers.

Key words: Carbon, nitrogen, decomposition, *Pinus longifolia*, litter, cow dung.

INTRODUCTION

Pinus roxburghii Sarg. (syn. *Pinus longifolia* Roxb.) (Pinaceae), commonly known as chir pine, is one of the five pines found in India - Pinus roxburghii Sarg, Pinus wallichiana Jackson, Pinus gerardiana Wall, Pinus kesiya Royle ex Gordon and Pinus armandii French and the most widely occurring. It is also known as Himalayan long needle pine, long leaved Indian pine, Indian chir pine, chir or chil, is a tall tree with a spreading crown found in the Himalayan from Kashmir to Bhutan, Afghanistan and in southern Indian hills (Shuaib et al., 2013). In eastern Uttarakhand it is very localized, occurring in the lower parts of the valleys (Semwal et al., 2009; Singh et al., 2014; Sheikh et al., 2012). Litter fall and litter decomposition are key processes in nutrient cycling of forest ecosystems. Litter fall in pine forest provides the main above-ground contribution of carbon and nutrients to the forest floor (Bray and Gorham 1964) and has often been related to climate (Bray and Gorham 1964; Kouki and Hokkanen 1992; Pausas 1993). Litter decomposition involves the mineralization and humification of lignin, cellulose and other compounds and the leaching of soluble compounds whose carbon and nitrogen are progressively mineralised or immobilised (Aber and Melillo 1980, 1991; Coûteaux et al., 1995). Decomposition process plays an important role in maintaining soil fertility in terms of nutrient cycling and the formation of soil organic matter (Bargali et al. 1993; Singh and Gupta 1977; Pandey and Singh 1982; Singh et al. 2007; Usman et al. 2000).

Much literature has accumulated in recent years on litter decomposition. In Himalayan region many studies on leaf litter

decomposition of many useful plants are available (Singh and Gupta 1977; Upadhyay 1988; Upadhyay and Singh 1989; Bargali et al. 1993). However, there is no any study has conducted in Chandak forest area in Pithoragarh. Pine leaves are highly acidic in nature, can easily get fire and take much time to decompose. The current study seeks to evaluate the effect of cow dung on pine leaf litter decomposition rate and carbon, nitrogen releasing pattern of cow dung mixed Pine leaf litter.

MATERIALS AND METHODS

Study area and climate

The study was conducted in pure Pine forest of Chandak at Pithoragarh district of Kumaun Himalayas at an altitude of 1600 m. (Fig.1). Pithoragarh district is located between 29° 13' 50" N and 80° 11' 30" E to 29°58'1" N and 80°22'1" E with a geographical area of 7100 km2. The climatic data is given in Fig.2.

Litter bags and litter treatment

The pine litter (only fresh fallen leaf litter) was collected in the summer season (from April to June) in horizontally placed hanging net from Chandak Pine forest and brought to the laboratory for further research work. The collected needle were weighted and sampled for litter decomposition treatment. Thirty six litter bags were filled with homogenously mixed cow dung and Pine needles (1:1 ratio). All litter bags (mash size 2 mm.) were carried to the study area and partially covered under the previously fallen litter on the forest floor.

The litter bags were collected in the triplicate in every month. The process continues up to one year. The litter bags were brought to the laboratory in polythene bags to maintain the original moisture content. In the laboratory the material was carefully washed, weighted and divided into two equal proportions, first for weight loss determination of litter and another for chemical analysis. The mean relative decomposition rate (g g^{-1} day^{-1}) of litter was calculated by using the following formula (Gupta and Singh 1981):

$$R = \frac{\log_e W_0 - \log_e W}{t_0 - t_1}$$

R= relative decomposition rate
W= the weight at time t_1
W_0= the weight at time t_0

The Kjeldahl method is used to determine nitrogen content of decaying leaf litter (Jackson 1958). Carbon content from litter was determined by the method describe by Mishra (1968) with little modification. The data of each month and each parameter were collected in triplicate and averaged for analysis in excel 2010.

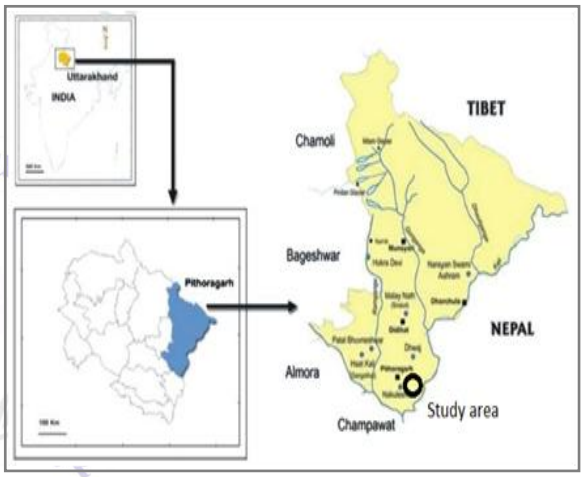

Fig.1. Location of the study area

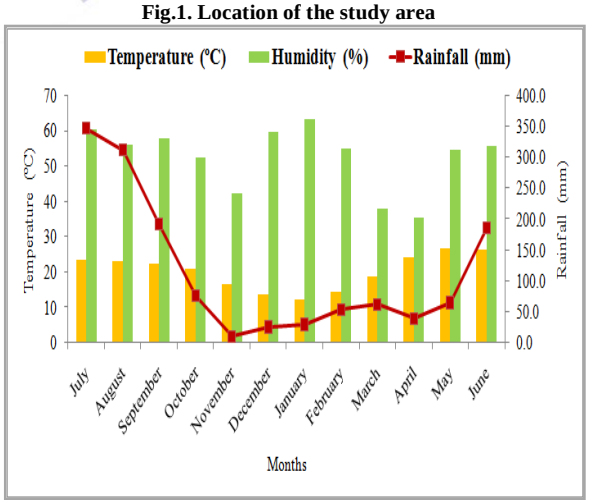

Fig.2. Annual temperature, humidity and rainfall of the study area. (Data source: Meteorological department Pithoragarh)

RESULTS

The decomposition rate was found maximum in the month of September (3.087 g/g/day) and minimum in the month of June (0.695 g/g/day). The overall decomposition

rate decreased in the autumn and summer seasons as compared to rainy seasons. The correlation between monthly decay rate and treatment also revealed that application the cow dung solution may increase the decomposition rates up to 66 % than normal condition (Fig. 3. A).

The carbon release rate was found maximum in the month of September (7.36). The minimum monthly carbon release rate was (3.99) in the month of December (Table.1). The overall release rate decreased in the autumn and summer seasons as compared to rainy seasons. The correlation between monthly organic carbon release rate and treatment also revealed that application of the cow dung may increase the carbon release rate up to 92% (Fig.3.B). The maximum nitrogen release rate was 7.15 and minimum 3.77 in the months of September and December respectively. The correlation between monthly nitrogen release rate and treatment also revealed that application of cow dung may increase the nitrogen release rate up to 38 % (Table.1 & Fig.3.C).

The maximum C: N ratio was found (1.75) in the month of July. The correlation between monthly C: N ratio and treatment also resulted that the application of the cow dung may sharply alter C: N ratio (Table.1 & Fig.3.D).

Table 1: Litter decomposition rate and carbon nitrogen dynamics in cow dung treated pine needles litter

Months	Days elapsed	Litter decomposition percent (%)	Litter decomposition rate (g/g/day)	C release rate (g/g/day)	N release rate (g/g/day)	C:N
July (2012)	30	8.65	2.596	6.04	5.83	1.75
August	60	9.28	2.785	6.16	5.95	1.74
September	90	10.29	3.087	7.36	7.15	1.74
October	120	8.32	2.496	6.10	5.89	1.74
November	150	6.28	1.885	4.32	4.11	1.73
December	180	5.32	1.597	3.99	3.77	1.73
January (2013)	210	4.61	1.382	4.16	3.95	1.72
February	240	3.33	0.998	4.27	4.06	1.72
March	270	4.87	1.462	4.24	4.03	1.72
April	300	5.35	1.606	5.23	5.02	1.71
May	330	6.32	1.896	5.18	4.97	1.71
June	360	2.32	0.695	4.18	3.96	1.71
Maximum	-	10.29	3.087	7.36	7.15	1.75
Minimum	-	2.32	0.695	3.99	3.77	1.71
Average	-	6.25	1.87	5.10	4.89	1.73

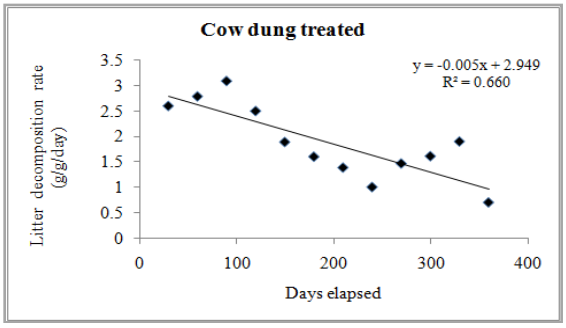

Fig.3. A. Litter Decomposition rate

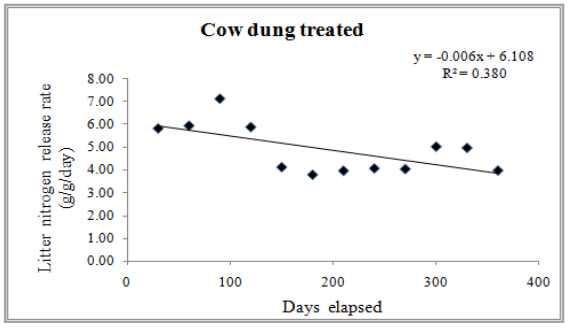

Fig.3.C. Nitrogen release rate

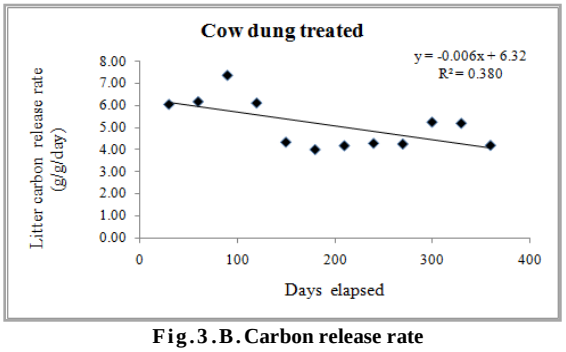

Fig.3.B. Carbon release rate

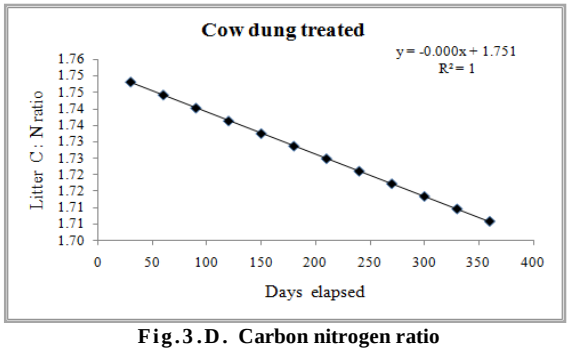

Fig.3.D. Carbon nitrogen ratio

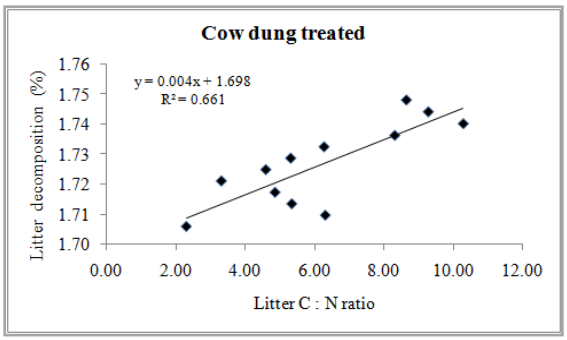

Fig.3.E. Relation between litter decomposition and C: N ratio

DISCUSSION

The results in this study indicated that the Pine litter when treated with cow dung accelerates the decomposition rate and also affected the carbon nitrogen release rate. It promotes decomposition rate and C: N ratio. Similar study has been reported by Suthar (2008); Van et al., (2000). The minimum Carbon and Nitrogen release rate in the winter and summer seasons as compared to the rainy seasons revealed that climatic factors are responsible for carbon and nitrogen release. Similarly results found with the previous work done by Cornejo et al., 1994; Giardina and Ryan, 2000; Melillo, et al., 1989).

The positive correlation between litter decomposition and C: N ratio suggested that the C: N ratio increased with decomposition percent (Fig.4.E). The findings are in agreement to Henriksen and Breland (1999) and Meidute et al., (2008).

CONCLUSION

The study concluded that mixing of cow dung on Pine litter the decomposition rate increased because cow dung was also helpful for degradation of carbon and nitrogen by giving the litter more moisture and humidity which also promotes fungal growth. The overall decomposition rate decreased in the autumn and summer seasons as compared to rainy seasons because of higher microbial activity in rainy season.

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