



Nutrient returns through litter fall in age series of rehabilitated limestone mined areas of Mussoorie hills

Archana Bachheti¹, H.B.Vasistha² and R.K. Bachheti^{1✉}

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Abstract

Litter fall and nutrient return was studied in four different age stands (11years, 8 yrs, 6 yrs and 4yrs old plantation) of Kiyarkuli catchment of Doon Valley of Garhwal Himalaya around Mussoorie hills (30° 25' to 30° 30' N lat. and 78° 0' to 78° 5' E long., 1700 to 1850 m above MSL). Maximum litter fall was estimated in Site I and minimum in Site IV. The trend of annual nutrient return was in order of Ca > N > K > Mg > P for all sites.

Keywords: *Litter fall, Nutrient return, mined ecosystem, age stands, Himalaya*

Introduction

Doon valley in Western Himalaya is known for its natural resources like minerals, soil, water, healthy climate and scenic beauty was also experiencing several environmental problems due to reckless and unscientific extraction of minerals which were in the form of limestone, phosphorite, marble etc. The area affected by mining in the valley is about 6147.43 ha (Soni *et al.*, 1992).

To regain self-sustaining systems, which can maintain the various ecological processes including that of nutrient turnover, restoration of these abandoned mined areas through applying proper measures has become imperative. Litter production and its decomposition play a key role in turnover of nutrients and maintenance of soil fertility and plant productivity. If surface litter is not removed and allowed to decompose and contribute to nutrient cycling, the soil can support higher productivity of trees (Miller, 1981). Ebermayer (1876) has established the significance of litter fall in the nutrient cycle of the forest. The biological cycle of nutrients in an ecosystem is one of the principal processes that support organic matter production. Therefore, a field study was

Conducted to assess the litter production and quantity of nutrients returned to the soil through litter fall in rehabilitated mined ecosystem.

Materials and Method

A field study was conducted for one year in Kiyarkuli catchment of Doon Valley of Garhwal Himalaya around Mussoorie hills. The site is situated near Hathipaon, 37 km north-west from Dehra Dun and 10 km south-west from Mussoorie town. The area falls between 30° 25' to 30° 30' N latitude and 78° 0' to 78° 5' E longitude in an elevation range of 1700 to 1850 m above msl, under Bhitreli reserved forest of Mussoorie Forest Division. The maximum temperature during winter is not more than 18° C. Summer extends from April to June. May and June are the hottest months, when the temperature generally reaches up to 25° to 29° C. The rainy seasons is marked by heavy rains high humidity and 21° to 26° C temperature. The average annual rainfall of the area is 2,225.2 mm.

Litter fall

Litter accretion studies were carried out by litter plots using ground sampling method (Medweeks - Kornas, 1970; Suckachev and Dylis, 1966). The litter accumulated over the month was collected

Author's Address

¹Department of Applied Science, Graphic Era Deemed University, Dehradun,

²Ecology and Environment Division, Forest Research Institute, Dehradun-248006

and weighed to obtain fresh weight and representative samples were brought to the laboratory for oven dry weight determination at 80°C till the constant weight and then powdered in Thomas Wiley Mill. The powdered samples were used to further chemical analysis (N, P, K, Ca, Mg).

Nitrogen was estimated by using Macro Kjeldahl method (Loomis and Shull, 1937). For analysis of (P, K, Ca, Mg) the stock solutions were made by using wet digestion method. Wet digestion involves digestion of 1 gm of powdered plant samples in a Tri - acid mixture (HNO₃ (10): H₂SO₄ (1): HClO₄ (4) Phosphorus was estimated by the Molybdate blue" method (Vogel, 1961), Magnesium by Thiazole yellow" method (Young

and Gill, 1951) by using Spectrophotometer, whereas Potassium and Calcium were determined by making appropriate dilution of stock solution and taking readings in Flame Photometer after placing the respective filters.

Results and Discussion

Litter in kg/ha along with its percent contribution to the total is shown in Table - 1. Maximum amount of the total annual litter fall was recorded in Site I (11 years old stand) followed by site III (6 years old stand), Site II (8 years old) and least in Site IV (4 years old stand). Thus the trend of litter production (kg ha⁻¹ yr⁻¹) in all these four stands was in order 5286.4 > 1193.2 > 804.0 > 262.0 respectively for Site I, III, II and IV.

Table 1: Monthly litter fall (kg/ha) in four study sites

Sites	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
I	340.0 (6.43)	384.0 (7.26)	404.0 (7.64)	316.0 (5.98)	393.2 (7.44)	289.2 (5.47)	196.0 (3.71)	608.0 (11.50)	820.0 (15.51)	660.0 (12.48)	572.0 (10.82)	304.0 (5.75)	5286.4
II	60.0 (7.46)	44.4 (5.52)	72.4 (9.00)	67.2 (8.36)	172.0 (21.4)	154.4 (19.20)	64.0 (7.96)	12.0 (1.49)	28.0 (3.48)	33.6 (4.18)	80.0 (9.95)	16.0 (1.99)	804.0
III	100.0 (8.38)	60.4 (5.06)	100.0 (8.38)	110.4 (9.25)	152.0 (12.74)	200.0 (16.76)	68.0 (5.70)	108.0 (9.05)	80.0 (6.70)	79.2 (6.64)	75.2 (6.30)	60.0 (5.03)	1193.2
IV	48.0 (18.32)	16.0 (6.11)	24.4 (9.31)	17.2 (6.56)	14.8 (5.65)	5.6 (2.14)	8.0 (3.05)	8.0 (3.05)	20.0 (7.63)	12.0 (4.58)	48.0 (18.32)	40.0 (15.27)	262.0

*Figures in parenthesis refers to percentage contribution

Results presented in Table 2 indicated that the annual nutrient return (Kg/ha) followed the trend in order of Ca > N > K > Mg > P for all experimental sites. The highest annual nutrient returns (kg/ha) was recorded at Site I (283.60) and least by site IV (12.99). Site III has recorded 77.35 kg/ha/yr of nutrients return and Site II 42.33 kg/ha/yr (Table. 2). It was observed that the total

annual return of calcium was highest followed by nitrogen and very small quantity of phosphorus was returned in all the four study sites. The amount of nutrients return through litter fall varies with the amount of litter production and nutrient concentration. Maximum amount of calcium and nitrogen return was also recorded by number of workers in the litter of different climatic zones.



Table 2. Annual nutrients return (Kg/ha) in four study sites

Site	N	P	K	Ca	Mg
I	81.18	3.22	76.62	114.45	8.13
II	12.73	0.36	12.52	15.55	1.174
III	17.40	0.439	17.06	22.92	1.694
IV	3.79	0.080	3.58	5.06	0.478

Similar pattern of annual nutrients return is also reported in restored rock phosphate mined area dominated by *Acacia catechu* and in natural forests characterized by the presence of *Spondias mangifera*, *Toona ciliata*, *Sapium insigne*, *Nyctanthes arborescens*, *Bauhinia retusa* etc. (Negi, 1998). The pattern of annual nutrient return in the present study was also found to be similar to the various other natural and planted ecosystems. Seth *et al.* (1963) and Negi (1984) have reported a similar order of annual return of nutrients *i.e.* Ca > N > K > Mg > P in semi evergreen Sal forest. Vyas *et al.* (1976) reported same order for deciduous forests and Negi (1984) also found the same order of annual return of nutrients in evergreen Eucalypts. Singh (1975) studied the nutrients return through litter fall in *E. tereticornis* on a unit area basis and found that leaf litter contributed the major portion of total calcium, nitrogen and phosphorus. Gill *et al.* (1987) recorded mean annual concentration of nutrients in the litter of *E. tereticornis* followed the order Ca > N > Mg > K > P. Low phosphorus return through litter in all the study sites may be due to the presence of Calcrete nature of soil of limestone mined area which restricted the availability of phosphorus to the plant. The availability of phosphorus to plant is generally declined above pH of 7.5. Being predominance of CaCO₃ the study sites have pH more than 7.5. Similar results was also drawn by Tyagi (2002) who attributed its restricted availability in lime rich soils. This is in agreement with the findings of Garg (1997).

In the present study all the nutrients returned to the forest floor through litter were found to be increasing with the increase in age of the rehabilitated sites. Similar inference was drawn by Tyagi (2002) that all the nutrients returned were increased with the increase in age of plantation in sodic soils. As an exception, in the present study, the eight year old rehabilitated site accounted less return of nutrients than the six years old rehabilitated site. This anomalous behaviour may be because of differences in vegetation composition and resulting variation in litter production.

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