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Original Research Paper

Litter Production Studies in a Lake Margin Ecosystem

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ABSTRACT

The paper deals with an evaluation of magnitude of periodic change in biomass and productivity of litter in the neglected or abandoned land (Site-I) and winter season cultivated land or crop lands (Site-II) at 'Gujar Tal' lake margin Jaunpur (U.P.). The slight sloping lake-land ecotones of both the sites were distinguished into two zones, i.e. upper and lower. The peak biomass value of litter at Site-I was 79.44 $g.m^{-2}$ in the upper zone and 43.12$g.m^{-2}$ in the lower zone both in the month of May. The maximum litter accumulation during the fallow period of Site-II was 52.46$g.m^{-2}$ in October in the lower zone after recession of flood-water. In contrast, in crop period of Site-II, it was 59.12 $g.m^{-2}$ and 69.15 $g.m^{-2}$ at the age of 120 days in upper and lower zones, respectively. The peak productivity value of litter at Site-I was 1.50$g.m^{-2}day^{-1}$ in the upper zone and 0.70 $g.m^{-2}day^{-1}$ in the lower zone both in the month of May. The highest productivity values of litter of plant community in the fallow lands of Site-II were 1.25$g.m^{-2}day^{-1}$ in upper zone in the month of March, and 1.10$g.m^{-2}day^{-1}$ in October in the lower zone. The net productivity of litter during crop period of Site-II was 2.63 and 2.98 $g.m^{-2}day^{-1}$ at the age of 15 days of crop during November in the upper and lower zones. The annual litter production at Site-I was 87.67 $g.m^{-2}yr^{-1}$ in the upper zone followed by 67.79 $g.m^{-2}yr^{-1}$ in the lower zone .Their respective peak annual production at Site-II was 91.12 and 141.24 $g.m^{-2}yr^{-1}$. Analysis of variance for litter biomass at Site-I showed that variation due to zones and months both was significant ($p< 0.001$), while at Site-II it was not significant both due to months and depths.

INTRODUCTION

Lake margins are highly dynamic but slightly fragile ecosystems. Lake and other wetland margins are passing through the critical phase of ecological transition and are being converted into 'weed-bowls' at alarming rate leading to swampification (Sinha & Jha 2008). Lake margins are transitional areas between aquatic and terrestrial ecosystems. They are usually referred as marshy and swampy habitats, usually transitional between land and water bodies (Ambasht 2008). There is impact of flooding during rainy season, winter season cropping and extreme dry condition during summer on plant diversity and litter production. It is specialized habitat characterized by slight sloping topography. The efforts of crop cultivation fails during rainy season due to cyclic inundation or submergence, and sometimes due to extreme dry condition as a result of the scarcity of the rainfall during rainy season.

The structural parameter, litter biomass and functional parameter, production, both are essential in process of ecosystem analysis. In a community consisting of diverse species, the maturity and mortality occur throughout the growing season and lead to a condition in which peak standing crop has little relation to total production. The organic matter synthesized during photosynthesis is partly returned to the soil in the form of litter which on decomposition restores the fertility status of the soil.

In the present investigation all dead shoot material detached from the plant body lying on the surface of soil has been considered as litter. The present work has been carried out to estimate the rate of litter biomass and the rate of disappearance, i.e. productivity pattern in two distinct zones on abandoned or neglected land (Site-I) and during winter crop and fallow period (Site-II). There are some ecological studies pertaining to the litter of plant community on riparian ecosystem (Singh & Ambasht 1991, Nilsson & Grelsson 1990). There is still paucity of information of such study at lake margin. Therefore, present study has been conducted at lake margin of 'Gujar Tal' (Jaunpur) for the first time.

MATERIALS AND METHODS

Study site and climate: The present investigation was carried out at lake margin of 'Gujar Tal' (24°6'-25°5'N latitude and 80°-82° E longitude) in the north western region of Jaunpur (U.P.) 28 km from the city by selecting two distinct sites, i.e. Site-I neglected or abandoned lands (80 × 125m) and Site-II winter season cultivated lands or crop lands (50 × 200m). After the harvesting of winter crop, Site-II was left fallow for remaining eight months. Each site was divided into two zones, i.e. upper and lower from top upland two lower region near water margin according to lake water level, slope factor, number of days of inundation, moisture availability and soil texture. The upper zone is beyond flood level and gets inundated in high flood years that is only for

Table 1: ANOVA for litter biomass ($g.m^{-2}$) of total plant community across the months at the two sites (I&II) and in two zones

Sites	Source of variation	S.S.	d.f.	M.S.	F
I	Zones	1965.16	1	1965.16	29.113*
	Months	6111.87	12	509.32	7.57*
	Error	1.68	12		
	Total	8078.71	25		
II	Zones	30.82	1	30.82	0.286ns
	Months	2390.69	12	199.22	1.85ns
	Error	2.118	12		
	Total	2423.63	25		

ns Not significant, *Significant at $p < 0.01$.

the few days, and lower zone gets readily inundated during the rainy season, i.e. in the month of July and August. The climate is typically monsoonic with three different seasons viz., summer, winter and rainy. The total rainfall during the study period (April, 2008 to March, 2009) was 1346.8 mm out of which about 1295.4 mm was during rainy season. The maximum temperature ranged between 23.8°C (January, 2009) to 40°C (April, 2008), and minimum between 10.9°C (January, 2008) to 26.5°C (May, 2009) during the study period. The soil was alkaline in pH.

Sampling method and periodicity: Sampling of litter at interval of 15 days was done at Site-II during winter crop (wheat and mustard mixed), due to its short life span. Sampling at Site-I and for rest of period during fallow land of Site-II was carried out at monthly intervals.

Litter present on the ground surface of the area 25 × 25 cm was collected in triplicate from both zone, in all the samplings by ranking and brushing. Samplings were freed from soil contamination by flotation in water. The sampling points were distributed homogeneously in all the zones of the study sites. Washed samples were dried at 80°C for 48 hr and determined dry weight for biomass determination. The net productivity of litter of the plant community was calculated separately by deducting the biomass values of preceding samplings from current samplings. Sum of positive increase in litter biomass values were used for annual production of litter (Singh & Yadav 1972). Analysis of variance (ANOVA) of litter biomass was done in order to signify the relevancy of observations (Campbell 1974).

RESULTS AND DISCUSSION

Variation in litter standing crop: The trend of variation in the litter standing crop through the year at two sites (I & II) in two different zones has been determined (Fig. 1). Due to difference in the periodicity, rate of production and disappearance of litter was a wide variation in the accumulated litter biomass in different months. Flooding of lower zone and partly upper zone during rainy season has also played significant role in the accumulation of litter at both the sites. The litter biomass at Site-I varied from 20.25 $g.m^{-2}$ (September) to 79.44 $g.m^{-2}$ (May) in the upper zone and 20.72 $g.m^{-2}$ (April, 2009) to 43.12 $g.m^{-2}$ (May, 2008) in the lower zone. The peak litter accumulation of 79.44 $g.m^{-2}$ was recorded in May in the upper zone, whereas the peak value was comparatively less (43.12 $g.m^{-2}$) in the lower zone in the same month. In the upper zone the amount of litter decreased sharply from June (55.88 $g.m^{-2}$) to September (20.25 $g.m^{-2}$) indicating rapid disappearance of old litter during this period. But due to longer inundation of the lower zone, there was abrupt increase in the amount of litter (37.40 $g.m^{-2}$) in the month of October where water has slightly receded. Thereafter litter has shown decreasing trend up to March with slight increase (20.72 $g.m^{-2}$) in April, 2009.

Variation in the litter standing crop in the fallow lands of Site-II is apparent from Fig. 1. The values were highest in the fallow lands after harvesting of the winter crop, i.e. 59.12 $g.m^{-2}$ and 69.15 $g.m^{-2}$ in the upper and lower zones respectively in the last fortnight of March. The value of standing crop of litter was always high during dry months of summer, but the lower zone has shown considerably higher value during the month of October in the lower zone in comparison to upper zone due to greater mortality of plants in the lower zone during preceding months due to inundation. The value of litter biomass during winter crop period at Site-II was high in the beginning 15 days after the crop sowing and then declined sharply at 30 and 45 days of crop age during the month of December in both the zones. The value has shown increasing trend thereafter till the maturity at 120 days of the crop plant in the two zones, i.e. upper and lower. Maximum litter biomass was 40.40 $g.m^{-2}$ and 53.7$g.m^{-2}$ at maturity of the crop plant at the age of 120 days of crop sowing in the upper and lower zones.

It is clear from the earlier findings that the fluctuations in the dry weight of litter are mainly affected by seasons, flooding, cropping and other biotic operations. The maximum dry weight of litter at Site-I in upper and lower zones

Table 2: Variation in total annual litter production ($g.m^{-2}yr^{-1}$ and per nine months) for total community at the two sites (I and II), in the two different zones.

Months	Site I		Site II	
	Upper Zone	Lower Zone	Upper Zone	Lower Zone
May, 2008	46.62	21.79	7.12	11.94
June	-23.56	-12.97	-11.41	-13.59
July	-26.14	Inundated	-21.95	Inundated
Aug.	-5.59	Inundated	-4.00	Inundated
Sept.	-3.9	Inundated	-1.97	Inundated
Oct.	13.7	37.40	-1.86	34.10
Nov.	7.65	-9.36	39.45*	44.70*
Dec.	-11.24	-3.75	-14.25* -3.00*	-4.50* -8.85*
Jan., 2009	-9.89	-9.17	-7.50* 14.55*	-6.60* 10.95*
Feb.	12.78	2.00	2.25* 5.70*	6.15* 6.45*
Mar.	2.33	1.21	3.30* 18.75	11.55* 15.45
Apr., 2009	4.59	2.39	-16.80	-40.92
Total	87.67	64.79	91.12	141.24

*Values from November to first fortnight of March at Site-II are both for crops and weeds. The two rows of the crop periods represent first and second fortnight values in each month, except in November.

was in May. In contrast, at Site-II during the last fortnight of March in both the zones, i.e. upper and lower, the peak litter biomass was recorded. In the succeeding months of July, August, September and October there was more or less sufficient soil moisture. The litter biomass has declined. It might be due to rapid decomposition of litter biomass during the above period, though it had varied in different zones.

There was gradual increase in the litter biomass after flooding in the lower zone of both the sites (I & II) due to death of plant parts. A sharp decline in the standing litter crop at Site-I during winter season is the result of slight winter rains responsible for accelerated decomposition. Similar findings have been reported by Pandey (1977) for grasslands of Varanasi. In contrast, the amount of litter has shown increasing trend throughout the crop period due to the fact that leaves die and fall down at later stages of growth in the crop plants. Grazing also alters and influences considerably the amount of litter, since grazing animals remove portions of green herbage as well as dead standing crop and both of these contribute to the litter as also reported by Singh & Ambasht (1991) for Gomati riparian winter cropping. Annual litter accumulation values were 87.67 $g.m^{-2}$ and 64.79 $g.m^{-2}$ at Site-I in the upper and lower zones, respectively whereas at Site-II the values were 91.12 $g.m^{-2}$ and 141.24 $g.m^{-2}$ in the two respective zones. It indicates higher litter accumulation at Site-II in comparison to Site-I. It is due to greater biomass produced at Site-II as well as due to usual practice of winter crop and this fact accounts for greater litter biomass too (Fig. 1). Analysis of variance for litter biomass at Site-I showed that variation due to zones and months both was significant ($p<0.001$), while at Site-II it was not significant both due months and depths (Table 1).

Variation in the litter productivity: Rate of litter production values at the two sites has been depicted in Fig. 2. The values were always high in dry months of the study period. There were fluctuations in production rate throughout the year in different zones. In the beginning in the upper zone in May the productivity value was maximum 1.50 $g.m^{-2}day^{-1}$ and its value was minimum 0.08 $g.m^{-2}day^{-1}$ in March. Its trend was negative during the months of June, July, August, September, December and January. In contrast, the rate of productivity was maximum 1.21 $g.m^{-2}day^{-1}$ in October and minimum 0.049 $g.m^{-2}day^{-1}$ in March in the lower zone, as this zone was inundated with water from July to September. During dry periods (Summer) productivity value of the community was more in upper zone and less in the lower zone.

Annual production of litter: The annual production of litter for the entire plant community at the two study sites showed greater variation in two different zones (Table 2). At Site-I, the highest value of $87.67g.m^{-2}yr^{-1}$ was in the upper zone followed by $67.79g.m^{-2}yr^{-1}$ in the lower zone. Their respective peak net annual production at Site-II was 91.12 $g.m^{-2}yr^{-1}$ and 141.24 $g.m^{-2}yr^{-1}$ in the upper and lower zones, respectively. It is clear from the earlier findings that the annual production of litter was slightly higher in the upper zone of Site-I which was more dry during summer season in comparison to lower zone as the latter was inundated for most of the period during rainy season. Crop operation was other factor, which has shown variability in production of litter at Site-II, in comparison to Site-I in two different zones.

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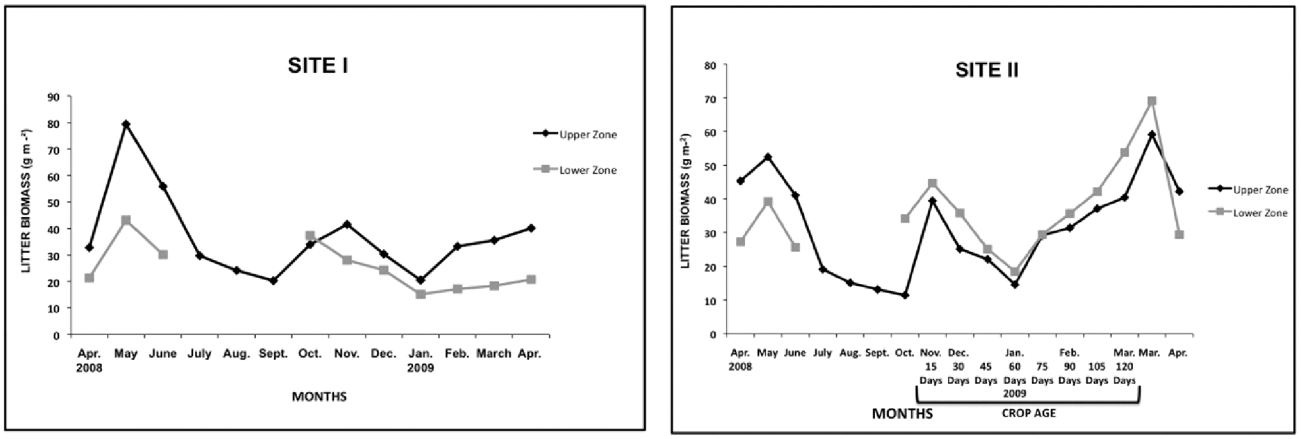

Fig. 1: Variation in the litter biomass ($g.m^{-2}$) at the two sites and in two different zones. There are breaks in line during the inundation of the lower zone.

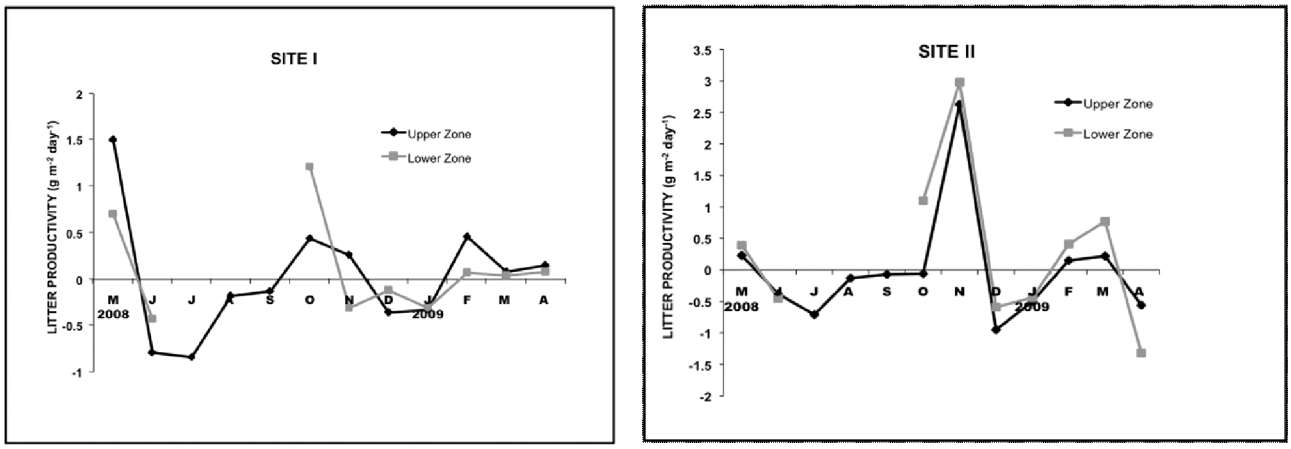

Fig. 2: Variation in net productivity ($g.m^{-2}day^{-1}$) of the litter of plant community at the two sites and in two zones. There are breaks in lines during the phase of inundation of lower zone.

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