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Net Primary Production of a Grassland Community of Mayurbhanj District in Odisha, India

KEYWORDS: *Grassland, Community, Compartments, Net Primary Production*

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ABSTRACT *Net primary production of a grassland community was carried out at Odisha (22011' N; 860 41' E). The community productivity of various compartments was determined from the respective biomass values. It was found that the total live green production was maximum during September and minimum in the month of June. Maximum standing dead production was observed during March and minimum in June. Litter compartment did not show any increment during May and also from July to December. Below ground production exhibited peak in the month of August and minimum during May. The total net primary production of the community was found to be 884.03 g m-2 yr-1.*

Introduction

Primary productivity is the amount of organic matter incorporated in the plant body by the green plant per unit area per unit time. It includes both photosynthetic product and mineral elements present in the plant tissues. When respiratory losses are taken into account in the process it is termed as "gross primary production" and the net organic matter stored in the tissues before respiratory loss is referred as "net primary production". Productivity is a rate function and can be expressed as change in dry weight per unit area per unit time.

Review of literature reveals a lot of information on primary productivity in various vegetation type in different climatic regions by Odum (1960), Vershney (1972) Ambasht ***et al.*** (1972), Singh and Yadava (1972), Misra (1973), Billore and Mall (1977), Misra (1978), Malana (1981), Pradhan (1994), Behera (1994), Barik (2006) and many others. However, very little work has been made so far on net primary production of grassland community, especially in the northern region of the state, Odisha. Hence an attempt was made to study the net primary production of a grassland community of Mayurbhanj district in Odisha.

Study site and Environment

The experimental site was selected at Jharpokharia (86˚41' E; 22˚11' N) situated at a distance of 40 kms from the North Orissa University and 35kms from Baripada, the district headquarter of Mayurbhanj in the state of Odisha. The altitude of the site is above 92.4 m. The climate of the locality is monsoonal with three distinct seasons i.e. rainy (July to October), winter (November to February) and summer (March to June). The minimum and maximum atmospheric temperatures recorded during the study period were found to be normal. December showed the lowest temperature (11.53˚ C) whereas May exhibited the highest temperature (37.35˚C). The total rainfall during the study period was 1108 mm of which a maximum of 452 mm was recorded during July and minimum in the month of November (5mm). Total number of rainy days was found to be 85 days during the study period (Tabel-1).

Analysis of soil revealed that the soil was strongly acidic (pH= 4.77). The available phosphorus, potassium and organic carbon contents in the soil were found to be very low. Table – 2 shows the pH, conductivity, organic carbon, available phosphorus and potassium contents of soil of the experimental site.

Table-1. The atmospheric temperature, no. of rainy days and rainfall during the study period.

Months	Minimum temp. (°C)	Maximum temp. (°C)	Number of rainy days	Rainfall (mm)
Dec. 2006	13.22	26.71	__	__
Jan. 2007	11.97	26.63	01	19
Feb. 2007	16.55	28.66	04	22
Mar. 2007	19.57	33.18	02	19
April 2007	23.65	37.28	07	26
May 2007	25.09	37.35	06	64
June 2007	25.21	34.60	11	117
July 2007	24.70	32.37	21	452
Aug. 2007	24.40	31.88	14	231
Sept. 2007	23.86	30.43	14	140
Oct. 2007	20.55	31.46	02	13
Nov. 2007	17.40	28.13	03	05
Dec. 2007	11.53	25.97	__	__
TOTAL			85	1108

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Table -2. The pH, conductivity, organic carbon (%), available phosphorus and potassium content of the soil of the study site (Values are in mean ± SD, n = 5 each)

Surface depth (cm)	pH	Conductivity (S cm^{-1})	Organic carbon (%)	Available phosphorus (ppm)	Available potassium (ppm)
0 to 10	4.84 ± 0.134	0.5 ± 0.000	0.406 ± 0.153	0.14 ± 0.089	25.2 ± 1.987
10 to 20	4.76 ± 0.134	0.52 ± 0.045	0.316 ± 0.103	0.26 ± 0.089	25.4 ± 7.385
20 to 30	4.72 ± 0.130	0.5 ± 0.000	0.278 ± 0.091	0.24 ± 0.114	28.5 ± 6.473

Materials and Methods

"Short term harvest" method (Odum, 1960) was employed for determination of primary production. The productivity for each category of plant material i.e., live green, standing dead, litter and below ground parts was calculated by summing up of the positive increments in biomass of respective compartment during the study period and expressed as g m^{-2} yr^{-1}. Above ground net production was estimated by summing up of the increment values of live-green and standing dead compartments. Total net primary production was calculated by summing the values of above ground net production and below ground production of the community.

Results and Discussion

Table – 3 shows the monthly variation of positive increments of various biomass compartments of the community. It indicates that the total live green production attained peak during the month of September (176.62 g m^{-2}) which might be due to favourable climatic conditions. Live green grass production and live green non-grass production were found to be maximum during September and August respectively. This variation was due to physiological and phenological differences of the species occurring in the community. The total live green production of the community gradually increased from June to September and then decreased considerably in the month of October. However live green production was not observed in the months of January, February, March, April, May, November and December. This might be due to adverse climatic conditions and higher rate of standing dead production.

The standing dead production exhibited a gradual increase in value from January to March and then it decreased during April. This increasing trend in the value from January to March might be due to gradual drying of live green parts of the grass and non- grass species in the community. The decline in standing dead production during April was due to higher rate of litter decomposition. The climatic condition as well as soil nutrient during May and from July to November might have been suitable for plant growth for which no standing dead production was observed. Some amounts of standing dead production were also recorded in the months of June and December which might have been due to fluctuation in climatic conditions that initiated senescence followed by drying of foliage in the community.

Litter production of the community was observed during January, February, March, April and June. Litter production was not found during May and from July to December which might have been due to rapid decomposition of litter that subsequently got mixed with the soil. The atmospheric temperature, rainfall and soil conditions were probably favourable for such litter decomposition. Besides, the wind velocity of a locality may be responsible for low/ high amount of litter production as it washes out /deposits the litter component from / in the community, as a result no such increasing / decreasing trend of litter production was noticed throughout the sampling period.

Below ground production was observed only during the months of May, June, July, August September and December. A maximum of 67.76 g m^{-2} below ground production was observed during August which declined in the subsequent month i.e during September. Gradual increase in below ground production from May to August might be due to suitable climatic conditions. In the succeeding month the climatic conditions of the site were, probably, not in favour of below ground production as a result of which a decline in below ground production was observed during September.

The above ground production of the community was found to be maximum during September (176.62 g m^{-2}) and minimum in the month of June (15.98 g m^{-2}). The production was nil during the months of May and November. The net above ground production exhibited a gradual increase in trend from January to March. The value then decreased in April. June onwards the above ground production again showed an increasing trend upto September. Thereafter the value decreased in the month of October. December, somehow showed a high rate of production to that observed in the month of October. The annual net above ground production of the community was found to be 596.93 g m^{-2} yr^{-1}.

Accordingly, the net primary production (NPP) was calculated to be 884.03 g m^{-2} yr^{-1}, of which the above ground parts contributed 596.93 g m^{-2} yr^{-1} and the below ground parts contributed 287.10 g m^{-2} yr^{-1}. Table- 4 represents the annual net primary production of some Indian grassland communities. It indicates that the net production in this study was in no way similar to the findings of other workers as reported earlier. It shows a much lower value when compared with the findings of Ambasht ***et al.*** (1972), Varshney (1972), Singh & Yadava (1972), Misra (1973), Misra (1978), Malana (1981), Pradhan (1994) and Barik (2006) and a little higher value than the findings of Billore & Mall (1977) and Behera (1994). The results obtained in this study and by other workers revealed that rainfall was not the only factor responsible for the variation in primary production. There were some other factors including rainfall that influenced the net primary production in the community. The topography, Phenology of the species, rate of evaporation, temperature variability, fertility of soil etc. might have been responsible for variation in net primary production of the community.

Table-3. Monthly variation of positive increments of various biomass compartments of the grassland community during the study period.

Months	Primary Production							Net Primary Production
	Live green		Total Live Green	Standing dead	Litter	Below ground	Above ground	
	Grasses	Non-grasses						
Dec.	—	—	—	—	—	—	—	—
Jan.	—	—	—	33.64	10.84	—	33.64	33.64

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Feb.	__	__	__	37.4	9.64	__	37.4	37.4
Mar.	__	__	__	59.46	13.84	__	59.46	59.46
April	__	__	__	22.52	17.52	__	22.52	22.52
May	__	__	__	__	__	20.64	__	20.64
June	__	8.68	8.68	7.3	12.78	54.28	15.98	70.26
July	23.88	34.62	58.5	__	__	64.98	58.5	123.48
Aug.	80.14	36.26	116.4	__	__	67.76	116.4	184.16
Sept.	143.2	33.42	176.62	__	__	33.06	176.62	209.68
Oct.	33.64	-	33.64	__	__	__	33.64	33.64
Nov.	__	__	__	__	__	__	__	__
December	__	__	__	42.77	__	46.38	42.77	89.15
Total	280.86	112.98	393.84	203.09	64.62	287.10	596.93	884.03

Table-4. Total annual net primary production (g m^{-2} yr^{-1}) in different grassland communities.

Author (s)	Year of study	Location	Type of community (dominated)	Annual rainfall (mm)	NPP (g m^{-2} yr^{-1})
Ambasht ***et al.***	1972	Varanasi	Dichanthium	725	1420
Varshney	1972	New Delhi	*Heteropogon*	800	1330
Singh & Yadava	1972	Kurukhetra	Pancium	770	2980
Misra	1973	Ujjain	*Dichanthium*	1030	989
Billore & Mall	1977	Ratlam	Sehima	1257	846
Misra	1978	Berhampur	Aristida	1200	1447
Malana	1981	Berhampur	Aristida	1355	1180
Pradhan	1994	Bhubaneswar	Aristida	858	1474
Behera	1994	Phulabani	Heteropogon	1763	809
Barik	2006	Berhampur	Aristida	1341	929
Present study		Jharpokharia	Chrysopogon	1108	884

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