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Impact of Grazing on Biomass Structure and Mineral Dynamics in the Grasslands of Champa, Chhattisgarh

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Abstract:

This study investigates the effects of grazing on biomass structure and mineral dynamics in the grasslands of Champa, Chhattisgarh, India. Monthly sampling was conducted using the harvest method for aboveground biomass and the monolith method for belowground biomass. The highest aboveground productivity (235.21 gm^{-2}) was recorded in September, while the peak belowground productivity (248.52 gm^{-2}) occurred in February. Annual net live green production was estimated at 1344.73 gm^{-2}/year. The grassland community comprised 17 species, including 9 grasses and 8 non-grasses. Grazing significantly impacted biomass accumulation, nutrient cycling, and litter decomposition, with litter production peaking in November (74.18 gm^{-2}) and completely absent during June, July, and August. Heavy grazing pressure was observed, leading to reduced aboveground primary production and species richness. Rainfall, temperature, and soil conditions were found to influence the seasonal variations in biomass production.

Keywords:

Grazed grassland, Net primary productivity, Biomass structure, Aboveground biomass, Belowground biomass, Mineral dynamics, Litter decomposition

Introduction:

Grasslands, characterized by vegetation dominated by grasses, often include sedges, rushes, legumes, and other herbs. These ecosystems consist primarily of monocotyledons, with narrow leaves that grow from the base, making them relatively resistant to intensive grazing (Devine, 2016). Grasslands are typically found between temperate forests and subtropical deserts and are essential habitats for grazing animals. They play a critical role in preventing soil erosion, maintaining the nitrogen and phosphorus cycles, and contributing significantly to food and fodder production. However, Indian grasslands often face overgrazing, resulting in reduced plant cover, soil erosion, and biomass degradation.

Biomass, defined as the total dry weight of material present in an ecosystem at any given time, is a key parameter of productivity. Several studies have focused on the biomass and productivity of grassland ecosystems globally (Murphy, 1975; Numata, 1979; Wielgolaski et al., 1981). Grazing influences the availability of essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), and pH values, impacting both plant and soil dynamics (Yates, 2000, 2010). Approximately 50% of the world's terrestrial land is grazed by domestic livestock (Havstad, 2008).

This study evaluates the impact of grazing on biomass productivity, mineral status, and nutrient cycling in the grazed grasslands of Champa, Chhattisgarh, during 2020–2021. It highlights the role of litter decomposition in maintaining productivity and regulating nutrient availability, which is influenced by biological action, withering, and leaching (Kar, 2013).

Material and Methods :

Study Area and Climate:

The study was conducted in a grassland at Champa, Chhattisgarh, situated at an elevation of 253 meters (830 feet), between latitudes 21°39'54" N to 22°18'05" N and longitudes 82°15'55" E to 83°22'17" E. The region experiences a hot, semi-humid climate, with summer temperatures reaching up to 46°C. The soil at the study site was moderately acidic (pH = 6).

Sampling and Biomass Estimation:

A harvest method was used to estimate aboveground biomass, and a 0.25 m^2 quadrat was used for monthly sampling. The quadrat size was determined using the species-area curve method. Clippings of aboveground plant parts were collected species-wise and stored in polythene bags. Belowground plant parts were collected using the monolith method (25 x 25 x 30 cm) following Weaver and Darland (1949), and ground litter was collected separately from each quadrat.

Calculation of Biomass and Productivity:

- **Aboveground Net Primary Productivity (ANPP):** Summation of increments in live green and standing dead compartments.
- **Belowground Net Primary Productivity (BNPP):** Calculated using the monolith method.
- **Litter Disappearance (LD):** Estimated by subtracting the total litter during the year from the difference between final and initial litter biomass (Golley, 1965).
- **Total Net Primary Productivity (TNPP):** Sum of aboveground and belowground net production.

Results and Discussion:

Biomass Variations:

The monthly variation of different biomass compartments indicated that green biomass peaked in September (92.42 gm^{-2}) and was lowest in May (21.08 gm^{-2}). Non-grass biomass was highest in September (66.21 gm^{-2}) and lowest in June (22.57 gm^{-2}). Aboveground biomass peaked in September (76.58 gm^{-2}), while litter production was highest in November (74.18 gm^{-2}) and absent from June to August. Belowground biomass ranged from 76.96 gm^{-2} in April to 248.52 gm^{-2} in February.

Table -1 : Biomass (gm-2) of different species during the study period

Month	Live Green			Standing dead	Litter	Aboveground		Below ground	Total
	Grasses	Non grasses	Total			LG+SD	LG+SD +L		
July	36.05	32.08	68.13	28.3	--	96.43	96.43	188.54	284.97
August	65.04	50.12	115.16	29.01	--	144.17	144.17	87.25	231.42
September	92.42	66.21	158.63	76.58	23.75	235.21	258.96	192.68	451.64
October	90.28	61.35	151.63	36.54	37.52	188.17	225.69	198.55	424.24
November	85.7	56.16	141.86	31.26	74.18	173.12	247.3	190.44	437.74
December	76.14	55.24	131.38	62.16	68.19	193.54	261.73	210.29	472.02
January	89.34	60.45	149.79	73.25	71.86	223.04	294.9	199.33	494.23
February	59.12	49.05	108.17	63.05	36.41	171.22	207.63	248.52	456.15
March	34.82	51.11	85.93	67.5	72.02	153.43	225.45	89.73	315.18
April	28.22	29.16	57.38	45.01	71.25	102.39	173..64	74.62	248.26
May	21.08	23.84	44.92	32.04	24.54	76.96	101.5	76.59	178.09
June	31.65	22.57	54.22	48.53	--	102.75	102.75	158.61	261.36
July	42.17	35.36	77.53	27.91	--	105.44	105.44	195.7	301.14
Total	752.03	592.7	1344.73	621.14	479.72	1965.87	2445.59	2110.85	4556.44

Grazing Impact:

Grazing significantly affected biomass accumulation, species richness, and nutrient cycling. The total annual net live green production was 1344.73 gm^{-2}, with 52.94% contributed by grasses and 47.05% by non-grasses. Standing dead production was 621.14 gm^{-2}/year, while the total annual aboveground production was 752.03 gm^{-2}/year. Litter decomposition was rapid, contributing to nutrient recycling in the ecosystem.

Ecological Implications:

Heavy grazing pressure led to species degradation and reduced aboveground primary production. Rainfall, atmospheric temperature, and soil conditions played crucial roles in determining seasonal variations in biomass production. These findings emphasize the need for sustainable grazing practices to maintain ecosystem balance and productivity.

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