(RESEARCH ARTICLE)

Nutrients richness in soil and in some common favourite food species of Cheetal deer (*Axis axis*) and Sambar deer (*Cervus unicolor*) in Corbett National Park Uttarakhand India

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Abstract

Soil is the only source for fulfilment of nutrient requirement of plants in a forest (natural ecosystem). Macro and micro Nutrients present in the soil are available to the plants only because no external fertilizers are used in the forest. In this study the analysis of soil for its pH (soil acidity), key elements (organic Carbon & P, K) and secondary elements (S), with micronutrients (Fe, Cu, Mn, Zn) is done in monsoon season and autumn season. In monsoon season the soil is slightly acidic and in autumn season soil changes to slightly alkaline. The essential nutrients are present in medium to higher level for plants growth. The micronutrients are present in medium level in acidic soil while micronutrients are in low level in alkaline soil. The nutrients analysis (protein, Calcium and NPK) of some favourite food species of Cheetal and Sambar deer i.e., Shisham, Jujube, Kush grass and Narkul grass is done. The nutrients like Protein, Calcium with NPK is present in good amount in these species. So the nutrient rich soil of Corbett Park is helpful to make plants more nutritious, which directly affects the life of Cheetal deer (*Axis axis*) and Sambar deer(*Cervus unicolor*). Plants nutrients are necessary in structural growth, body-weight, physical activities, in running, in pregnancy, in lactation etc. of Cheetal and Sambar deer.

Keywords: Soil; Calcium; Protein; Phosphorus; Soil-acidity; pH; Monsoon; Autumn

1. Introduction

Corbett National Park is rich in green vegetation with its diverse flora (miscellaneous grasses, dense shrub and bushes, Sal-dominant forest with mixed tree species). Soil is the only source for fulfilment of nutrient requirement of plants in a forest (natural ecosystem). Macro and micro Nutrients present in the soil are available to the plants only because no external fertilizers are used in the forest. Hence, adequate amount of nutrients in the soil regulates the proper growth of the plants.

In this study the analysis of soil for its pH (soil acidity), key elements (organic Carbon & P, K) and secondary elements (Sulphur), with micronutrients (Fe, Cu, Mn, Zn) is done. In order to maintain a proper productivity aspect of the soil, it is rudimentary for soil to have a good physical and chemical property, organic matter content, proper aeration with an optimum pH and nutrient status [1]. The plant growth is greatly affected by different pH level. In acidic soil pH metal toxicity may arise (N, P, and S may be hampered, Calcium becomes deficient and symbiotic N fixation can be affected [2].

The nutrients in soil are essential for proper growth of plants as the Carbon in form of CO_2 is essential for photosynthesis and Nitrogen (N) is essential for plant growth (Amino-acid formation) and Potassium (K) for Nitrogen metabolism

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(enzyme-activator) [3]. Potassium (K) is the most abundant inorganic cation, and it is important for ensuring optimal plant growth [4].

Phosphorus is directly impact on the plant productivity (in photosynthesis and in respiration). Phosphorus plays a major role in energy storage and transfer as ADP and ATP, DPN and TPN [5]. Plants respond to low Phosphorus supply by growing more roots as they responsible for its uptake [6]. Once Phosphorus supply is limited, plants exhibit lower leaf surface and reduced photosynthesis capacity all of which contribute to reduction of productivity and total plant biomass [7]. Calcium is an essential nutrient for the plants; it is required for structural needs for the cell wall and cell membranes formation as divalent cations (Ca^{2+}) [8].

The richness of the above essential elements in plants is required by Cheetal and Sambar deer (herbivore) for their structural growth (weight and height, bone-formation, nails-formation, hairs-formation, antlers-formation, in pregnancy and in lactation etc.) and physical activities (for feeding, dominance, movement and running etc.). Therefore, the nutrients value of soil and plants have a significant impact on the food behaviour of Cheetal and Sambar (herbivores) inside the forest.

2. Material and methods

2.1. Overview of the Research Area

The research area (Corbett Park) is located in the foothills of the Himalayan geographical area of India [9]. The Himalayan and peninsular flora and fauna both are found in the Reserve on account of their location in the foothills [10]. The total area of Jim Corbett National Park is 520.82 sq. km. and its latitude and longitude is respectively 29°13'-29°35'N and 78°33'-79°46'E, while altitude varying from 380-1040m above sea level [11].

The study sites composed of different vegetative area like Sal-mixed forest, dense shrub area and large grassland. The Sal-mixed forest contains different tree species like Sal, Shisham, Khair, Haldu, Bael, Semal, Kanju, Harad, Bahad, Gular, Pipal, Badh, Rohini and Jamun etc. The dense-shrub area contains bushes like Lantana, Jujube, Peelu, Kari plant, Jukai and Vasaca shrubs. The grassland area contains mixed species of grasses like Sawai, Kush, Narkul, Kumeria, Sirav, Bhuri, Bans, Sarkanda, Munj, Ganeria, Kansa, Dub and Ulla etc [12]. So, the vegetation is rich in study area, and indicates the soil with rich nutrients composition.

2.2. Methodology

For soil analysis, the samples are collected from buffer area (roadside) of Corbett National Park. The soil samples are collected form surface soil (10cm) in August-September (rainy season) and in October-November (Autumn/falling season). The collected soil samples were dried in Sun, powdered and filtered from 0.2 mm sieve to make a fine powder, and finally kept in airtight poly-bags.

The pH was done using electric Digital pH meter in the laboratory of P.N.G Govt PG College Ramnagar. For pH, the soil and water is taken in the ratio of 1:5. The soil solution is prepared by dissolving 1 gm of soil with 50 ml of water in a flask and kept it covered for 5 minutes. After this, one sample solution is transfer to pH tester and placed in Digital pH meter for 1 minute and the reading was noted. Similarly all samples were tested in Digital pH meter. For nutrient analysis (macronutrients i.e., C, N, P, K with micronutrients i.e., S, Mn, Fe, Cu and Zn) soil samples were send to District Soil testing Laboratory Bhimtal Uttarakhand.

For Plant Nutrient analysis, the vegetation found in the study area was identified and confirmed with the help of a nature guide during field visits. The most repeated food species of Cheetal and Sambar deer are noted at the time of direct observation. For nutrient analysis collection of edible parts like leaves, fruits and grasses from common favourite food species is done. The common favourite food species collected for nutrient analysis are Shisham, Jujube, Kush and Narkul grass. The collected leaves, fruits and grasses are dried in Sun.

For nutrient analysis, it is required that the crude samples are changed to fine powdered form. The dried leaves are crushed and grind in a pestle and mortar, to make a fine powder. The large size grasses were cut with the help of a scissor into small pieces and then grind in a grinder machine. Finally, these powdered samples were weighed and filtered through a 0.2 mm sieve. Certain samples from the most preferred species were sent to Vivekananda Parvatiya Krishi Anusandhan Sansthan-ICAR, Almora-263601 Uttarakhand laboratory to test the percentage of the available nutrient. The Foss Kjelteck-2300 method was used to determine the percentage of Protein and Nitrogen (N); Agilent

ICP-OES (Optical Emission Spectrometers) was used to determine the percentage of Calcium (Ca) and Potassium (K); and UV-VIS Spectrophotometer 2600 Thermo Fisher method was used to determine the percentage of Phosphorus (P).

3. Results and discussion

3.1. Soil analysis report in Samples of August-September (monsoon season)

The analysis report shows that the soil is slightly acidic nature in monsoon season (pH 6.4 to 6.8). In these samples the organic Carbon is medium to high level (0.63 to 0.98). The Phosphorus for all samples is medium level (37.31 to 39.90). The Potassium for all samples is high level (348 to 627). The Sulphur is low (0.06), medium (10.0) and high (13.0). While the Fe is medium to high (8.904 to 10.41), Cu is low to medium level (0.072 to 0.279). Mn for all samples is lower limit (0.288 to 0.884). Zinc is also in lower limit (0.200 to 0.221) (Table 1).

3.2. Soil analysis report in Samples of October-November (autumn/falling season)

The soil analysis report shows that the soil is slightly basic in nature (pH 7.1 to 7.5). The organic Carbon is medium to high (0.56 to 1.16). The Phosphorus for all samples is medium level (38.30 to 39.50). The Potassium for all samples is medium (215 to 347). The Sulphur level is low to high (8 to 13). After monsoon season all micronutrients are present in lower level (Table 2).

Table 1 Soil-Analysis Report of Monsoon season and autumn season in Corbett National Park (August to November 2019)

Months	Sample	pH	Key-Nutrients			Micronutrients					
			Carbon (C)	Phosphorus (P)	Potassium (K)	Sulphur	Fe	Cu	Mn	Zn	E.C.
September 2019	1	6.7	0.70 (M)	39.9 (M)	627 (H)	0.06 (L)	8.904 (M)	0.279 (M)	0.288 (L)	0.200 (L)	1.4
	2	6.4	0.63 (M)	37.7 (M)	629 (H)	10 (M)	10.20 (H)	Nil	0.884 (L)	0.137 (L)	1.5
	3	6.8	0.98 (H)	37.31 (M)	348 (M)	13 (H)	10.4 1 (H)	0.072 (L)	0.663 (L)	0.221 (L)	1.5
November 2019	1	7.5	0.56 (M)	38.52 (M)	347 (M)	8 (L)	5.681 (L)	0.007 (L)	0.317 (L)	0.023 (L)	1.7
	2	7.2	1.12 (H)	38.30 (M)	215 (M)	13 (H)	9.566 (M)	0.028 (L)	0.437 (L)	0.130 (L)	1.6
	3	7.1	1.16 (H)	39.50 (M)	339 (M)	13 (H)	8.888 (M)	0.021 (L)	0.312 (L)	0.112 (L)	1.6

*Level: H =High, M=Medium, L=Low; *Site 1=Bijrani zone; Site 2=Jhirna zone; *E.C.=Electric conductivity; Fe=Iron; Cu=Copper; Mn=Manganese; Zn= Zinc.

3.3. Nutrients analysis report in Some Food Species

In the Shisham leaves, **t**he protein is present in good amount (10.62%) and Calcium is high (7892ppm). The percentage Nitrogen is 1.699, Phosphorus is 0.255, and Potassium is 0.786. In Jujube fruits, the protein is in good amount (5.68%) and Calcium is also high (6761ppm). The percentage Nitrogen is 0.9082, Phosphorus is 0.276 and Potassium is 0.624. In Narkul grass (near the water side) protein is also in good amount (8.12) and calcium is 3404ppm. The percentage Nitrogen is 1.2925, Phosphorus is 0.191 and Potassium is 0.521. In Kush grass, the protein is present (4.21) and the Calcium is present in 4960ppm. The percentage Nitrogen is 0.6743, Phosphorus is 0.268 and Potassium is 0.521 (Table 3).

Table 2 Nutrient Analysis in Some Favourite Plant Species of Cheetal and Sambar Deer from Corbett National Park

Sr. no.	Name of Plant Species	Protein %	Calcium ppm (Ca)	Phosphorus % (P)	Nitrogen % (N)	Potassium % (K)
1	Shisham Tree *(Dalbergia sisso)*	10.62	7892	0.255	1.6999	0.786
2	Jujube Shrub *(Ziziphus mauritiana)*	5.68	6761	0.276	0.9082	0.624
3	Narkul Grass *(Phragmites roxburghii)*	8.12	3404	0.191	1.2925	0.521
4	Kush Grass *(Desmostachya bipinnata)*	4.21	4960	0.268	0.6743	1.191

4. Conclusion

This study concludes that, soil changes slightly acidic to slightly alkaline nature from monsoon season to autumn season. The essential nutrients are present in medium to higher level for plants growth. The micronutrients are present in medium level in acidic soil while micronutrients are in low level in alkaline soil. The protein and Calcium is present in good amount in study food species. Also the NPK value is rich in these common food species. The common plants are rich in nutrients with rich nutrients of soil. This helps in proper growth and physical activities of Cheetal and Sambar deer in Corbett Park.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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