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Comparative Study Of Soil Physicochemical Properties In Grasslands And Scrubs Of Dachigam National Park, Western Himalaya Kashmir

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ABSTRACT

Present study was undertaken to compare the physicochemical soil properties in two different plant communities of scrubs and grasslands. Two study sites of grasslands (G) and scrub (S) were selected in Dachigam National Park, Sixty soil samples were taken at both the sites at two different depths *i.e.* 0-15 cm and 16-30 cm. Values of pH, moisture content, electrical conductivity, soil organic carbon, total nitrogen, total potassium, clay, silt and sand ranged between 7.0 and 8.0, 2.6 and 31.1 %, 189 and 439 µs/cm , 0.06 and 0.29 %, 0.67 and 4.3%, 4.5 and 45.19%,0.29 and 20.11%, 3.86 and 53.88%, 46.3 and 83.12% respectively for grassland soils while as for scrub soils 5.7 and7.9, 4.1 and 31.12 %, 120 and 520 µs/cm, 0.08 and 0.49% , 0.42 and 4.12%, 4.12 and 44.13%, 0.26 and 20.12%, 3.67 and 53.12%, 45.67 and 83.41% respectively. The values of soil chemical properties of the present study were higher for scrub soils than the grassland soils. The specific reason being luxuriant vegetation and lesser disturbance due to low grazing pressures, as is evident from higher values of diversity and other parameters in these areas. Thus the study concludes that soil conditions under scrubs were more rich than in grasslands because of more vegetation cover and less grazing due to thorny species in the scrub site

Key Words:

Dachigam, grassland, physico-chemical properties, soil, scrub

INTRODUCTION

Proper management of the scrubs and grasslands depends on ecological principles and the understanding of the ecological principles is a prerequisite for a specific management practice. Diversity and composition of every plant community is mainly influenced by soil properties and such factors help in identifying different plant species growing in a particular area. Explaining how vegetation and soil factors establish a relationship is helpful in achieving a sustainable management of grass lands and scrubs. On knowing the ecological amplitude of a particular plant species growing for a particular habitat where soil acts as the main component determining the habitat conditions, the species composition can be predicted and its presence can indicate the habitat conditions (Tilman and Dowing 1994).Soil and vegetation exhibit an integral relationship with each other and the distribution of vegetation largely depends on soil conditions (Bauri et al. 2012). Soil is formed naturally from mineral and organic matter and is responsible for vegetation establishment, its growth and distribution.

A rich soil provides support in terms of moisture, nutrient, and substratum for anchorage to vegetation to flourish and in turn vegetation also affects soil features like chemistry, texture and helps to maintain nutrients through litter accumulation and root exudates (Morgan and Rickson 2011 and Caviezel 2014). This reciprocal relationship between plants and soil has acquainted humans with so many benefits and the understanding of this relationship can be put to formulate the exact management practices based on specific ecological principles (Ghorbanian and Jafari 2007). The soil formation factors like parent material, climate, topography, precipitation, organisms and time have a profound effect on the vegetation (Brands and Hoest 2000, Digvijay et al. 2020 and Puglisi et al. 2006). Physicochemical properties of soil have been used to evaluate the ecological functions of the forest soils (Gupta 2010). Grasslands are used as a model of ecosystem research on ecosystem functioning and biodiversity and their structure and functions effect the ecological processes by interaction variability and biotic and abiotic factors (Hartwell and Facelli 2003). Scrubs are the plant communities dominated by shrubs with bunch grasses and these protect the underneath plants against biotic stresses and provide favourable conditions for their establishment (Harpole and Tilman 2007, Malik et al. 2021) and hence act as key stone species of the ecosystem (Flores et al. 2004). The variation in organic matter and total nitrogen result in changes in food cycle of soil which in turn affects the ecosystem functioning which is clearly observed on life forms, production rates, key species and canopy cover of each species that mainly differentiates the two ecosystems of scrubs and grasslands. Reduced vegetation cover makes the soils prone to erosion which causes the loss of soil nutrients by leaching mechanisms, changes in nutrient cycling and dominance of shrubs rather than grasses (Schlesinger et al, 1999). A comparative study of scientific relationship between vegetation and soil factors for both the ecosystems and expanding such conclusions to other similar sites will be of utmost importance for the grassland management.

The present study was carried out with the aim to assess the physicochemical properties of soil in two ecosystems of grassland and scrub so as to formulate and apply the right management practices for improvement of grasslands according to the soil properties.

MATERIALS AND METHODS

Area of study

Dachigam national Park is located 22 km from Srinagar ($34^{0}5'$-34^{0} 10' North Latitude and $74^{0}.50$-$75^{0}.10$ East longitude) with 141 square Km area. The minimum and maximum altitude is 1600m and 4400m respectively. Mean annual precipitation is 546mm with most of the rainfall occurring in winter months. The mean temperature of the area is 22^{0}C and the climate is temperate as described by Domartin method. The key species reported from the grasslands were *Themeda anathera, Artemesea scoparia, Colchicum leteum, Salvia moorcraftiana, Stipa siberica* and *Poa angustifolia* while as *Berberis lyceum, Indigofera heterantha, Plectranthus* *rugosa* and *Rosa webbiana* were dominant species growing in the scrub.

Sampling Methods

The sampling method followed for present protocol was systematic and random. Three 50m transects were laid down in each site randomly and 10 points were selected on the transect systematically to get the soil samples for analysis. Sixty soil samples were taken between 09:00-13 hours from two depths, 0-15 and 16-30cm from each site. After removing the twigs and pebbles, the samples were stored in thick polyethene bags and brought to the laboratory for determination of different soil parameters like pH using an electrode pH meter (Mclean 1988), percentage of clay, sand and silt were measured with the help of a hydrometer, electrical conductivity was estimated with conductivity meter(Rhodas 1982), Organic matter was calculated using Walkley-Black method (Nelson and Sommers 1982), gravimetric method was used to determine moisture content, total potassium was estimated by triacid digestion method (Jackson 1967) and total nitrogen was determined using Kjeldahl method.

Statistical Analysis

A complete descriptive statistics of the soil physicochemical characteristics was estimated for both the plant communities. Mean values of soil properties were compared using T-test for the following; Between the two depths of soil in the grassland and the scrub, between the first depth of the soil of grassland and scrub and between the second depth of the soil of grassland and scrub using SPSS Version 16 (SPSS Inc., Chicago, III) for data analysis.

RESULTS AND DISCUSSIONS

The knowledge of soil parameters in plant ecology is very important because soil characteristics such as fertility is the unique factor that determines the species richness and plant community composition within a climate (Long et al. 2012 and Iwara 2011). Different ecosystems show different soil properties and this renders the change in vegetation distribution, grazing animals and other species of the food chain operating in a given ecosystem. By studying vegetation coupled with various soil factors, the factors correlation with the vegetation and community stability could be achieved which is quite important in grassland community development and rehabilitation (Basiri 2003). The Physicochemical properties of soil can determine the conservation and development practices of grasslands which can be indicated through typical species growing under given ecological set up of the specific region (Gorgin et al. 2006 and Yaqoob et al. 2013) and the specific and exact management practices can minimize the grassland destruction (Gupta 2010).

The statistics of the soil characteristics of both the plant communities are presented in table 1 and 2. To demonstrate the overall change, coefficient of variation was used. As per the results presented in the table 1 and 2, most of the changes were demonstrated by the values of soil pH and Electrical conductivity (EC).The descriptive results of T-test show that the values of moisture content, (EC), clay percentages and organic carbon show significant differences between the two depths in the scrub and no significant difference was observed for rest of the parameters (Fig 1). None of the soil parameters in the grassland showed any significant difference (Fig 2). However, significant differences were observed between the values of EC, percentage of sand, silt, OC and TN in the first depth of both the plant communities ($P \leq 0.05$, table 3). Percentage of clay, total potassium and EC were significantly different at 5% in the second depths of grassland and scrub communities (Table 4). The significant difference in the OC content of the soils for the two depths of the scrub is a result of washing from the surface soils and more litter fall and litter decomposition (Simon et al. 2013 and Jafari et al. 2006).

Table 1. Descriptive statistics of physicochemical soil properties in the grassland

Soil properties	Soil depth (cm)	Min	Max	Mean	SD	Variation	CV (%)
pH	0-15	7.3	7.99	7.64	0.24	0.05	3.33
	15-30	7.05	8.07	7.56	0.25	0.06	2.39
Moisture content (%)	0-15	4.23	31.11	17.66	3.86	9.32	75.64
	15-30	2.60	27.71	15.15	2.87	4.41	45.65
Electrical conductivity (EC µs/cm)	0-15	210	439	281	47.9	229	17.28
	15-30	189	367	265	47.5	227	18.21
Total Potassium (TK%)	0-15	4.36	45.19	29.39	11.59	131.39	38.17
	15-30	4.15	43.51	30.11	7.15	69.92	27.33
Organic carbon (OC%)	0-15	0.08	0.29	0.18	0.07	0.004	34.35
	15-30	0.06	0.21	0.16	0.05	0.003	27.66
Total Nitrogen (TN%)	0-15	0.69	3.84	1.59	0.61	0.39	38.85
	15-30	1.11	4.36	1.84	0.52	0.21	27.12
Clay (%)	0-15	0.30	14.87	5.67	5.06	17.22	87.21
	15-30	0.29	20.11	9.98	6.86	36.77	74.65
Silt (%)	0-15	11.33	47.12	35.16	9.98	90.23	28.74
	15-30	3.86	53.88	33.15	13.87	164.06	39.12
Sand (%)	0-15	46.31	79.21	61.89	11.35	110.61	18.65
	15-30	46.98	83.12	55.13	9.87	96.23	17.15

Table 2. Descriptive statistics of physicochemical soil properties in the Scrub

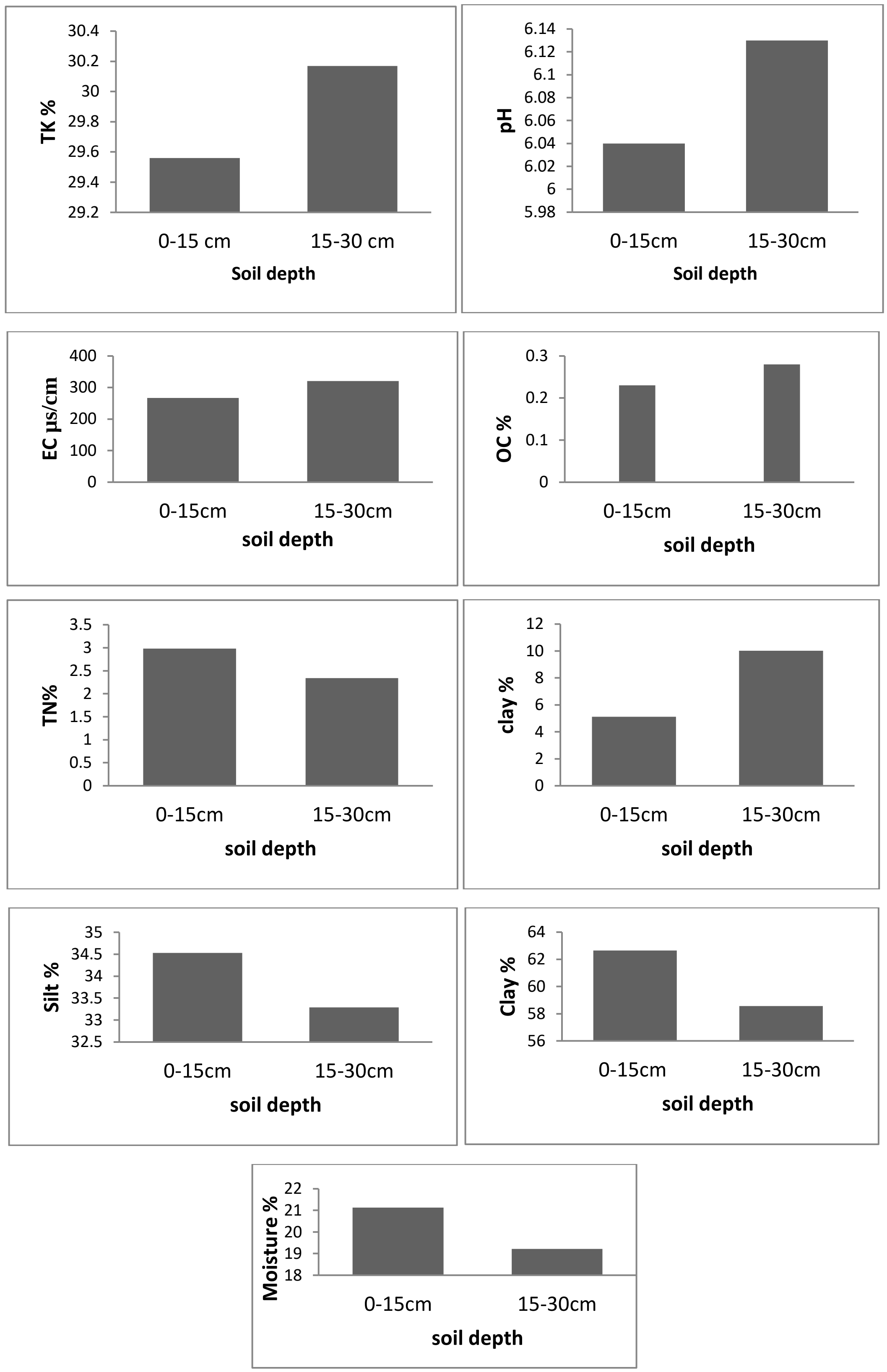
Soil properties	Soil depth (cm)	Min	Max	Mean	SD	Variation	CV (%)
pH	0-15	5.77	7.44	6.04	0.39	0.099	4.35
	15-30	5.88	7.39	6.13	0.34	0.086	4.23
Moisture content (%)	0-15	4.11	31.12	21.13	3.15	4.12	52.12
	15-30	4.61	28.71	19.22	3.12	5.56	46.11
Electrical conductivity (EC µs/cm)	0-15	120	520	267	163	288	40.11
	15-30	140	454	321	88.12	421	27.03
Total Potassium (TK%)	0-15	4.12	44.13	29.56	11.88	133.47	39.12
	15-30	4.10	43.11	30.17	8.23	76.12	26.67
Organic carbon (OC%)	0-15	0.09	0.49	0.23	0.09	0.006	35.98
	15-30	0.08	0.88	0.28	0.17	0.04	84.44
Total Nitrogen (TN%)	0-15	0.48	4.12	2.98	0.98	0.83	41.21
	15-30	0.42	3.98	2.34	0.82	0.67	44.56
Clay (%)	0-15	0.29	11.42	5.12	3.59	12.65	86.32
	15-30	0.26	20.12	10.01	5.52	32.18	64.88
Silt (%)	0-15	11.49	49.0	34.53	9.98	96.45	30.45
	15-30	3.67	53.12	33.23	11.45	137.02	37.17
Sand (%)	0-15	45.67	79.12	62.65	10.51	112.12	18.37
	15-30	45.98	83.41	58.56	9.45	94.12	18.23

Table 3. Comparison of means of soil factors between first depths in the scrub and grassland

Community	pH	Moisture %	EC	TK%	OC%	TN%	Clay %	Silt%	Sand%
Scrub	6.04^a	21.13^a	267^b	29.56^b	0.23^a	2.98^a	5.12^a	34.53^b	62.65^b
Grassland	7.64^a	17.66^a	281^a	29.39^a	0.18^a	1.59^a	5.67^a	35.16^a	61.89^a

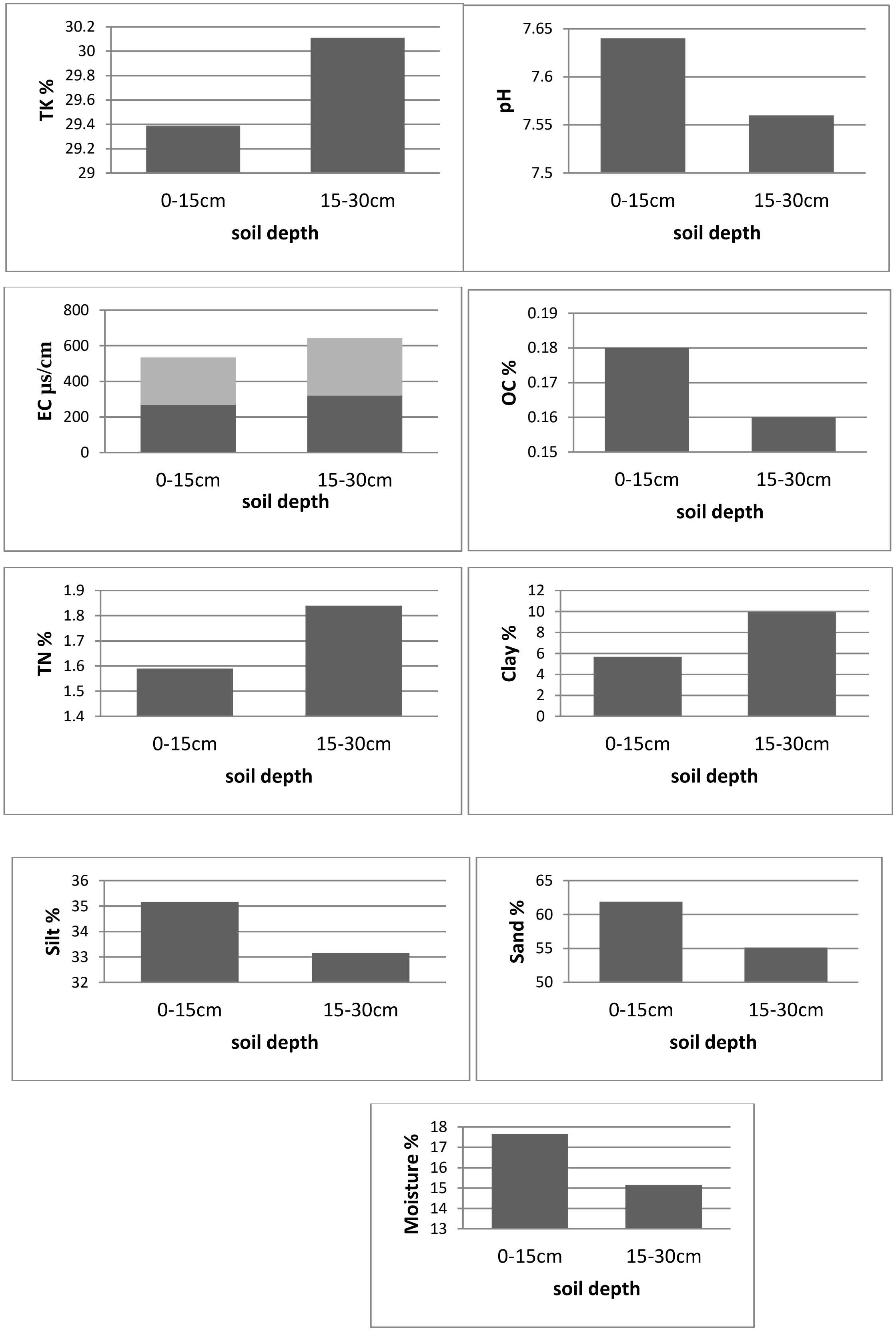
Table 4. Comparison means of soil factors between second depth in the scrub and grassland

Community	pH	Moisture %	EC	TK%	OC%	TN%	Clay %	Silt%	Sand%
Scrub	6.13^a	19.22^a	321^b	30.17^b	0.28^a	2.34^a	10.01^a	33.23^a	58.56^a
Grassland	7.56^a	15.15^a	265^a	30.11^a	0.16^a	1.84^a	9.98^a	33.15^a	55.13^a



Where N= Nitrogen, TN= Total Nitrogen, OC= Organic carbon, EC= Electric conductivity, TK= Total potassium.

Fig 1. Comparison of mean of soil characteristics between two soil depths in the Scrub land



Where TN= Total Nitrogen, OC= Organic carbon, EC= Electric conductivity, TK= Total potassium.

Fig 2. Comparison mean of soil characteristics between two soil depths in the Grassland

TN does not show any significant difference between the two depths, but larger amounts of N is observed in surface soil layer that can be attributed to the considerable amount of N return through increased decomposition (Ghorbanian and Jafari 2007; Bhuyan et al. 2013). The values of EC for the first depth at the scrub site were due to addition of plant biomass, its decomposition and accumulation of salt in the surface layer which suggests a positive correlation of organic matter with EC (Alatar 2012). There was no significant difference being observed in the results of OC and TN for two soil depths in grassland site and the results correspond with the findings of (Nourikia et al. 2010 and Digvijay et al. 2020). There is also no significant difference in the values of pH, TK, OC and TN between the two soil depths but lesser values were observed in the surface layer than the sub layers due to light textured soil present in the region which promotes the washout and transfer to lower soil layers (Falk et al, 2009). The amount of EC was high at the scrub site can be due to low precipitation and high evaporation rate leaving behind the salts on the surface and a consequent increase in soil EC (Ahmad et al, 2011). The increased value of TK at this site could be due to more vegetation cover that releases more potassium due to dissolution of minerals in presence of organic acids secreted by roots (Ajiboye 2008). The lower values of OC and TN at grassland site than the scrub site are in conformity with the findings of Zheng et al. (2008).

CONCLUSIONS

Present study is helpful in understanding the soil health and productivity in terms of nitrogen, potassium, soil texture, moisture content etc. for both scrub as well as grassland ecosystems. The soil conditions were more healthy and desirable under scrub in comparison to grassland due to luxuriant vegetation growth. Besides, there was increased amount of plant litter in scrubs due to non palatable thorny species present giving rise to less grazing intensity that resulted in an increase in soil water, organic matter and subsequently an improvement in soil structure. Increased values of organic carbon indicate that Scrubs have more carbon sequestration potential than grasslands which is seen as a way to reduce atmospheric carbon dioxide levels and thereby mitigating global warming issue. This baseline information will be helpful for the policy makers to design a conservation strategy for scrubs as well as grasslands which are used as corridors and grazing grounds respectively by endangered fauna of Dachigam National Park among their fragmented habitats.

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