ECOLOGIA BALKANICA

2012, Vol. 4, Issue 1 June 2012 pp. 31-38

Physico-Chemical Characteristics of the Grassland Soils of Yusmarg Hill Resort (Kashmir, India)

Moieza Ashraf [1]***, G. A. Bhat*** [1,2]***, Idrees Yousuf Dar*** [1]***, Mudasir Ali*** [1,*]

[1] Department of Environmental Science, University of Kashmir, Srinagar-190006, INDIA
[2] Centre of Research for Development, University of Kashmir, Srinagar-190006, INDIA

* Corresponding author*:* wild_defenders@yahoo.com

Abstract. Physico-chemical analysis was carried out on the grassland soils of Yusmarg Hill Resort, Kashmir during the months of May, June, November and December 2010, at four micro sites with some minor variations in the abiotic and biotic factors including anthropogenic pressures. The following soil characteristics were examined: temperature, texture, moisture, organic matter, pH, and conductivity, content of calcium, magnesium, sodium, potassium, total phosphorus, and organic carbon. Soil texture analysis revealed the soils at all the study sites with major proportion being comprised by the sand fraction and having a sandy silt character. The moisture content was found to be directly related to the herbaceous vegetation cover with the highest value at Site 3 (fenced meadow area). The moisture content showed low percentage at Site 2, which was more affected by grazing and thus resulted in less cover of grasses and probably more evaporation of soil moisture from the exposed site. The soils at all sites were from acidic to mildly acidic in character. The amount of organic matter was fairly good except at Site 2 (non-fenced grazing area) probably due to overgrazing during which much of herbage vegetation was picked up by the grazing animals like sheep and cattle. The values of important cations, such as Ca^{2+} and Mg^{2+}, showed a gradual decrease from May to December except at Site 4 (transition between a coniferous forest and a meadow) which may be attributed to a good cover of vegetation and good amount of organic matter.

Key words: soil chemistry, microhabitat variations, anthropogenic activities, Kashmir, India.

Introduction

Soil may be defined as a natural body, synthesized in profile form from a variable mixture of broken and weathered minerals and decayed organic matter, which covers the earth in a thin layer and which supplies, when containing the amounts of air and water, mechanical support and imparts sustenance for plants (BRADY & WEIL, 2000). Partial heterogeneity in nutrient availability affects not only the spatial patterning of vegetative cover but overall community structure and productivity (BRADY & WEIL, 1990). The importance of the soil as a reservoir of nutrients and moisture for the production of forage and plant species has been recognized since the beginning of the forest management as a science (SCHLESINGER *et al*., 1990). Grasslands have deep soils that are very nutrient rich because of the large amount of plant tissue (biomass) that dies off and is added to the soils through decomposition every year. Vegetation distribution and development largely depends on the soil conditions (DE DEYN *et al*., 2004; KARDOL *et al*., 2006). Nutrient limitation occurring in the soils is one of the most important factors affecting the structure of plant communities (GRIME *et al.*, 1997). On the other hand, the changes in vegetation can cause shifts in the soil properties (WARDLE, 2006) because individual plants concentrate biomass in soils beneath their canopies and modify biogeochemical processes occurring in the soils (BURKE *et al.*, 1989; SCHLESINGER *et al.*, 1990). Chemistry of soil covers chemical reaction and process in the soil pertaining to plant and animal growth and human development. Soil chemical processes are fundamental to the evolution of geoderma, the biosphere and the human environment. Therefore, understanding of soil chemical reactions and processes is essential for developing innovative resource management strategies, and understanding and regulating the behavior of the terrestrial ecosystem at regional and global scales (SCHNITZER, 1986).

The main aim of the present study was to assess the physico-chemical characteristics of the grassland soils of the Yusmarg Hill Resort (Kashmir) subjected to different treatments.

Material and methods

Study area

The present study was conducted on the grassland soils of the Yusmarg (N33°49′42′′; E74° 39′59″; Elevation 2743±6 m), Kashmir, located at 47 km south-west from the Srinagar City (Fig. 1), during the months of May, June, November and December, 2010. Four study sites were chosen as is shown on Fig. 2. Site 1 (N33°49′51.5″; E74°39′51.5′′; Elevation 2395±6 m) was situated in a commercial/ tourist site. Site 2 (N33°49′58.3″; E74°39′58.4″; Elevation 2405±6 m) was selected in the non-fenced area highly influenced by anthropogenic activities. Site 3 (N33°49′58.0″; E74°40′02.2″; Elevation 2418±6 m) was a fenced meadow area which remained dominated by grasses, and the Site 4 (N33°50′00.5″; E74°40′04.6″; Elevation 2428±6 m) was located at the edge transitioned between a coniferous forest and a meadow land; few shrubs and grasses occupied this area, and immediately above the site coniferous trees predominated.

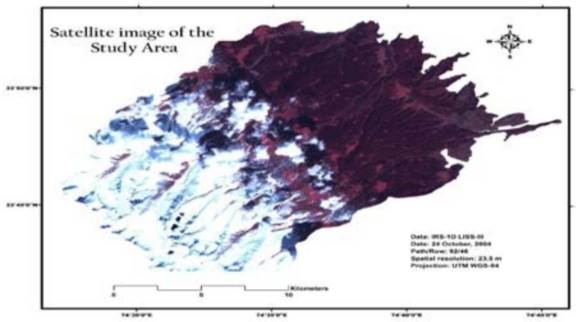

Fig. 1. Satellite image of the study area – Yusmarg Hill Resort, Kashmir (India).

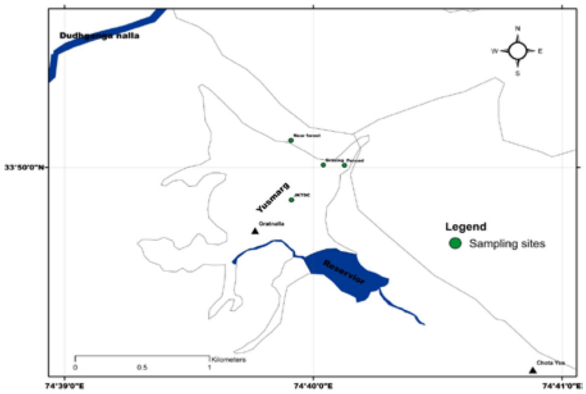

Fig. 2. Location of examined sites in the study area.

Methods

Soil physico-chemical characteristics were determined by collecting composite surface (0-10 cm depth) soil samples with the help of a soil corer from the four sites in order to give due representation to the micro-environment at each site. Soil samples were stored in air tight polythene bags for subsequent laboratory investigations. The samples were air-dried, mashed using a pestle and mortar and passed through 2mm sieve before analysis (GHOSH & KUNDUN, 1991).

Soil temperature was measured under shade usually in between 1:00 and 2:00 PM IST by a soil thermometer (Model RT 0124; Raj Thermometers; India) at a depth of 10-15 cm. Soil texture was determined through modified Udden-Wentworth Grade scale (sieve method) as demonstrated by LINDHOLM (1987). 100g of dry soil sample was placed on the uppermost sieve in a set of stacked sieves of different mesh sizes ranging from 2mm to 0.037mm size. The stack of the sieves was arranged in order so that the coarsest sieve was at the top with finer ones below and the pan at the bottom. The stack of sieves was then placed on the shaking machine. After ten minutes of shaking, the sample collected on each of the sieves and the pan was removed and weighed to determine the textural class of each sample. Conductivity and pH were determined by electrometric method (Conductivity Meter, model: CD 601, Company: Milwaukee; pH Meter, Model: 101 E, Deluxe, Company: MS Electronics India) using 1:2 soil-water (w/v) suspension. Moisture content was determined following MICHAEL (1984). 50 g of soil sample was dried in an oven at 105 °C for 24 hours till constant weight was obtained. The soil was then allowed to cool in a desiccator and weighed again to find out the loss in weight. The loss in weight corresponds to the amount of water present in the soil sample. Percent moisture content of soil was calculated by the following formula: (loss in weight/initial weight) X 100. The organic carbon and organic matter percentage were determined by rapid titration method (WALKLEY & BLACK, 1934). Loss on ignition (in %) was determined by the muffle furnace method (HANNA, 1964), the Muffle Furnace (Model: Instron IN 301, Company: Jindal; India) temperature was maintained at 700 °C for half an hour. Exchangeable calcium and magnesium were estimated in 1N ammonium acetate – shaking and filtration method (SCHOLLENBERGER & SIMON, 1945) followed by EDTA-titration. Sodium and potassium were determined by using Flame Photometer (Systronics Flame Photometer 128; Ahmedabad, India). Total phosphorous was estimated by Tri-acid digestion method (PIPER, 1966) and the measurements of absorbance were carried out at 690 nm using a spectrophotometer (Model: Elico SL 171 Mini Spec; Hyderabad, India).

Means and Standard Deviation was computed through Microsoft Office Excel (2007) program (ETHERIDGE, 2007).

Results and Discussion

During the present study, the soil temperature depicted a progressively decreasing trend as the season shifted towards colder weather with a maximum value of 20°C recorded at Site 2 in June and the minimum temperature of 1.2°C found at Site 4 in December (Table 1). The cover, normally plants and litter, shades the soil; that is, it intercepts some of the incoming radiation, heating the cover itself instead of the soil below (SINGER & MUNNS, 1991). The maximum value of soil moisture content i.e. 21.6% was recorded at Site 3 in May and the minimum value of 12.2% was found at Site 2 in June. The highest value of moisture content, recorded at Site 3 in May, could be attributed to the high precipitation both with the dense vegetation at the site, resulting in lesser amount of radiation being received at the surface and consequently less evaporation of the soil moisture. The lowest value of moisture content at Site 2 in June could be due to the reason that lot of evaporation takes place from the exposed site in the hot summer days.

Soil texture analyses revealed the soils at all the study sites with major proportion being comprised by the sand fraction and having a sandy silt character.

The soil pH values averaged between 5.9±0.59 and 6.23±0.23. Based on pH values, the soils of all examined sites were found to be slightly acidic to acidic, the low pH values at Site 4 can be attributed to the presence of pine needles which contribute in increasing the soil acidity when they being decomposed. The presence of higher content of organic matter in the soil can be another plausible reason for lowering of the pH (HODGES, 1996). Higher levels of organic matter result in a greater number of cation exchange sites which tend to decrease the pH (NAIMAN *et al.*, 1994).

Table 1. Physico-chemical characteristics of the grassland soils of Yusmarg, Kashmir.

Parameter	*↓Site**	*Month, 2010*				*Average*	*SD*
		May	*June*	*Nov.*	*Dec.*		
Soil temperature, °C	*1*	15	17.5	11.5	1.5	11.37	± 7.02
	2	15.2	20.2	11.5	2.8	12.42	± 7.34
	3	15.5	19.2	12.5	2.5	12.42	± 7.16
	4	12.5	16.1	10	1.2	9.95	± 6.34
	Average	14.55	18.25	11.37	2		
	SD	± 1.38	± 1.81	± 1.03	± 0.77		
Moisture, %	*1*	20.3	13.6	19.5	17.2	17.65	± 3
	2	17.4	12.2	15.8	14.8	15.05	± 2.18
	3	21.6	14.1	20.6	14.6	17.72	± 3.92
	4	18.2	13.3	17.1	10.8	14.85	±3.42
	Average	19.37	13.3	18.25	14.35		
	SD	± 1.92	± 0.80	± 2.19	± 2.64		
pH	*1*	6.19	6.39	6.63	6.71	6.48	± 0.23
	2	6.52	5.9	6.6	5.9	6.23	± 0.38
	3	6.41	6.3	6.26	6.48	6.36	± 0.10
	4	5.82	5.7	5.25	4.51	5.32	± 0.59
	Average	6.23	6.07	6.18	5.90		
	SD	± 0.3	± 0.32	± 0.64	± 0.98		
Conductivity, *µS/cm*	*1*	270	290	250	245	263.75	± 20.56
	2	181	188	185	150	176	± 17.56
	3	258	210	230	243	235.25	± 20.35
	4	246	225	195	190	214	± 26.34
	Average	239	228	215	207		
	SD	± 39.72	± 43.88	± 30.27	± 45.74		
Loss on ignition, %	*1*	10	10.85	11.57	10.24	10.66	± 0.70
	2	6.2	5.82	5.8	5.64	5.86	± 0.23
	3	13.86	11.93	11.6	11.15	12.13	± 1.19
	4	13.4	16.99	15.3	11.5	14.30	± 2.37
	Average	10.86	11.39	11.06	9.63		
	SD	± 3.55	± 4.58	± 3.92	± 2.71		
Organic carbon, %	*1*	3.7	3.12	3.11	3.13	3.26	± 0.29
	2	1.83	1.55	1.43	0.97	1.44	± 0.35
	3	2.19	2.08	2.05	2.39	2.17	± 0.15
	4	3.01	4.47	4.06	4.02	3.89	± 0.62
	Average	2.68	2.80	2.66	2.62		
	SD	± 0.83	± 1.28	± 1.16	± 1.29		
Organic matter, %	*1*	6.37	5.37	5.36	5.39	5.62	± 0.49
	2	3.15	2.67	2.46	1.67	2.48	± 0.61
	3	3.77	3.58	3.53	4.12	3.75	± 0.26
	4	6.39	7.7	7.59	6.93	7.15	± 0.61
	Average	4.92	4.83	4.73	4.52		
	SD	± 1.70	± 2.21	± 2.24	± 2.22		

Calcium, *me/100 g*	*1*	3.65	3.45	2.49	2.45	3.01	± 0.62
	2	3.12	2.25	1.89	1.77	2.25	± 0.61
	3	3.1	2.88	2.31	2.23	2.63	± 0.42
	4	3.43	3.42	2.56	2.74	3.03	± 0.45
	Average	3.25	3	2.31	2.29		
	SD	± 0.26	± 0.56	± 0.30	± 0.40		
Magnesium, *me/100 g*	*1*	1.55	0.84	0.42	0.41	0.80	± 0.53
	2	0.72	0.69	0.41	0.35	0.54	± 0.18
	3	0.88	0.63	0.48	0.45	0.61	± 0.19
	4	1.06	1.21	0.55	0.41	0.80	± 0.38
	Average	1.05	0.84	0.46	0.40		
	SD	± 0.35	± 0.26	± 0.06	± 0.04		
Sodium, *mg/100 g*	*1*	8.4	7.8	9.3	8.5	8.5	± 0.61
	2	5.9	6.2	5.3	4.5	5.47	± 0.75
	3	9.7	7.7	6.6	7.8	7.95	± 1.28
	4	9.7	8.4	11.7	9.3	9.77	± 1.39
	Average	8.42	7.52	8.22	7.52		
	SD	± 1.79	± 0.93	± 2.85	± 2.10		
Potassium, *mg/100 g*	*1*	6.3	5.6	5.5	5.2	5.65	± 0.46
	2	6.9	5.1	5.8	5.6	5.85	± 0.75
	3	8	9.3	7.3	8.2	8.2	± 0.82
	4	5.5	5.6	5.2	5	5.32	± 0.27
	Average	6.67	6.40	5.95	6.00		
	SD	± 1.05	± 1.94	± 0.93	± 1.48		
Total phosphorus, *µg/g*	*1*	22	24	20	18	21	± 2.58
	2	12	18	16	18	16	± 2.82
	3	30	28	24	24	26.5	± 3
	4	32	36	30	27	31.25	± 3.77
	Average	24	26.5	22.5	21.75		
	SD	± 9.09	± 7.54	± 5.97	± 4.5		

**Site 1 – Commercial/ tourist site; Site 2 –Non-fenced grazing area; Site 3 –Fenced meadow area; Site 4 –Transition zone /edge between a coniferous forest and a meadow.*

Electrical conductivity showed variation between 150µS/cm at Site 2 in December to that of 290µS/cm at Site 1 in June. Generally it is believed that higher the concentration of ions in the soil solution more is its electrical conductance. Therefore, the higher value at Site 1 in June could possibly be attributed to the presence of higher amounts of calcium, magnesium and potassium ions at the site.

Organic carbon and organic matter content was found to vary respectively between the minimum of 0.97% and 1.67% at Site 2 in December to the maximum value of 4.47% and 7.7% at Site 4 in June. Site 4 recorded high organic matter content with an average value of 7.7% as compared to the other sites which may be attributed to the rich litter deposition and due to the low mineralization caused by relatively lower temperature under the shade of dense trees and therefore to the slow rate of decomposition of organic matter (MOORE, 1981). It has been reported that the decomposition rates of organic matter has a tendency to increase as weather warms and to furnish maximum plant growth conditions (RUSSELL, 1950). The lower values of organic matter and organic carbon at Site 2 can possibly be a consequence of grazing and leaching.

The calcium content in the soil was found to vary between 1.77 me/100 g at Site 2 in December to 3.65 me/100 g at Site 1 in May. GUPTA *et al.* (1980) have reported the exchangeable calcium content in the soils of

Jammu & Kashmir (India) varying from 1.73 – 13.30 me/100 g and the presently observed results thus lie within this range. Magnesium showed lower concentrations at all sites during the study period. The magnesium was recorded with the minimum value of 0.35me/100 g at Site 2 in December to the maximum value of 1.55 me/100 g at Site 1 in May. The exchangeable calcium was found to be higher than exchangeable magnesium and potassium probably because calcium is more strongly bound to exchangeable sites than magnesium and potassium (BECKETT, 1965).

Sodium is generally regarded as essential nutrient for all higher plants. Sodium is involved in regeneration of phosphoenol pyruvate in C4 plants. Sodium is essential for animals, and herbivores depend on its content into the plants. Highest value of sodium (11.7 mg/100g) was recorded at Site 4 in November and the lowest value of 4.5mg/100g at Site 2 in December. In case of potassium, the highest value of 9.3mg/100g was estimated for the samples of Site 3 in June against the lowest value 5.0mg/100g at Site 4 in December.

Total phosphorus content was recorded highest (36 μg/g) for Site 4 in June which could be due to the high organic matter content. The soils with high organic matter content have better supplies of organic phosphates for plant uptake than have the soils with low organic content (MILLER & DONAHUE, 2001). Site 2 recorded the lowest value (12 μg/g) of phosphorous which might be due to the leaching. The soils with minimum leaching are known to contain high amount of phosphorous as compared to the soils with maximum leaching. Site 2 was found to be low in electrical conductivity also with a minimum value of 150μS/cm in December indicating low amount of soluble salts probably due to the leaching from surface to sub surface layers and the accumulation of these salts at the lower layers due to poor internal drainage (KATTI & RAO, 1979).

Among the human activities that degrade grasslands, overgrazing by livestock is perhaps one of the most significant (MAINGUET, 1994). The effects of overgrazing on the plant community and soils are considered destructive because of the reduction of canopy cover, the destruction of topsoil structure, and compaction of soil as a result of trampling (TAYLOR *et al.*, 1993; MANZANO & NA´VAR, 2000). Loss of fine fractions in soils has major influences on such properties as moisture, soil consistence, and organic carbon and nutrient presence and availability (HENNESSY *et al.*, 1986). These changes in turn, influence the kind and amount of vegetation the area would support.

Conclusions

The study focused on the impact of change in land-cover type on soil quality inferred by the changes in chemical and physical properties of relatively non-disturbed and disturbed soil systems. Continuous grazing at Site 2 (non-fenced grazing area) apparently has resulted in a decrease in ground cover which probably in turn leads to a further coarseness in surface soil, loss of moisture and soil organic carbon. Variations in these parameters infer that the grassland is in the stage of degradation.

References

BECKETT P.H.T. 1965. The cation exchange equilibrium of calcium and magnesium. - *Soil Science*, 100: 118-12.

BRADY N.C., R.R. WEIL. 1990. *The nature and properties of soils*. Tenth edition. Pearson Education, Inc., Singapore.

BRADY N.C., R.R. WEIL. 2000. *The nature and properties of soils*. Fourteenth edition. Pearson Education, Inc., Singapore.

BURKE I.C., W.A. REINERS, D.S. SCHIMEL. 1989. Organic matter turnover in a sagebrush steppe landscape. - *Biogeochemistry*, 7: 11-31.

DE DEYN G.B., C.E. RAAIJMAKERS, W.H. VAN DER PUTTEN. 2004. Plant community development is affected by nutrients and soil biota. - *Journal of Ecology,* 92: 824-834.

ETHERIDGE D. 2007. Microsoft Office Excel 2007 Visual Quick Tips. Illustrated

Edition [Computer Software]. John Willey & Sons, Inc., New York, USA.

GHOSH M.K., N.K. KUNDUN. 1991. Soil profile studies as a part of environmental management in coal mining areas. - *Indian Journal of Environmental Protection,*11(6): 413-417.

GRIME J.P., K. THOMPSON, R. HUNT, J.G. HODGSON, J.H.C. CORNELISSEN, I.H. RORISON. 1997. Integrated screening validates primary axes of specialisation in plants. - *Oikos*, 79: 259-281.

GUPTA R.D., K.K. JHA, B.P. SAHI. 1980. Studies on physico-chemical and mineralogical nature of soils of Jammu and Kashmir. - *Current Agriculture,* 4: 133-144.

HANNA W.J. 1964. Methods for chemical analysis of soils. In: Bear, F.E. (Ed.), *Chemistry of the soils*, Oxford and IBH Publishing Company.

HENNESSY, J.T., B. KIES, R.P. GIBBENS, J.M. TROMBLE. 1986. Soil sorting by forty-five years of wind erosion on a southern New Mexico range. - *Soil Science Society of America journal*, 50: 391– 394.

HODGES, S.C. 1996. *Soil fertility basics: N.C. certified crop advisor training.* Soil Science Extension, North Carolina State University. 75p.

KARDOL P., T.M. BEZEMER, W.H. VAN DER PUTTEN. 2006. Temporal variation in plant-soil feedback controls succession. - *Ecology Letters*, 9: 1080-1088.

KATTI, V.M., J.S. RAO. 1979. Chemical characteristics of some salt affected soils in the Ghataprabha left bank area, Karnataka. - *Madras Agricultural Journal,* 66: 192–194.

LINDHOLM R. 1987. *A practical approach to sedimentology*. Allen and Unwin, London, 278 pp.

MAINGUET, M. 1994. Desertification: natural background and human mismanagement, 2nd Ed. *Speringer-Verlag*, Berlin, Germany. 314p.

MANZANO, M.G., J. NA´VAR. 2000. Processes of desertification by goats overgrazing in the Tamaulipan thornscrub (matorral) in north-eastern Mexico. - *Journal of Arid Environments,* 44: 1–17.

MICHAEL P. 1984. *Ecological methods for field and laboratory investigations*. Tata McGraw Hill Publishing Company.

MILLER R.W., R.L. DONAHUE. 2001. *Soils in our environment*. Seventh edition. Prentice Hall, Inc. Upper Saddle River, New Jersey.

MOORE T.R. 1981. Litter decomposition in a subarctic spruce - lichen woodland, eastern Canada. - *Ecology,* 65: 299-304.

NAIMAN, R.J., G. PINAY, C.A. JOHNSTON, J. PASTOR. 1994. Beaver influences on the long-term biogeochemical characteristics of boreal forest drainage networks. - *Ecology*, 75: 905–921.

PIPER C.S. 1966. *Soil and plant analysis*. Hans Publisher, Bombay.

RUSSELL E.J. 1950. *Soil conditions and plant growth*. Biotech Books, New Delhi, India.

SCHLESINGER W.H., J.F. REYNOLDS, G.L. CUNNINGHAM, L.F. HUENNEKE, W.M. JARRELL, R.A. VIRGINIA, W.G. WHITFORD. 1990. Biological feedbacks in global desertification. - *Science,* 247: 1043-1048.

SCHNITZER M. 1986. Binding of humic substances by soil colloids. In: Huang P.M., M. Schnitzer (Eds.), *Interactions of soil minerals with natural organics and microbes*, pp. 77E 1. Special Publication No.17, Soil Science Society of America, Madison, WI.

SCHOLLENBERGER C.J., R.H. SIMON. 1945. Determination of exchange capacity and exchangeable bases in soil-ammonium acetate method. - *Soil Science*, 59:13-24.

SINGER M.J., D.N. MUNNS. 1991. *Soils: An Introduction.* Second edition. Macmillan Publishing Company, New York.

TAYLOR, JR. CH. A., N.E. GARZA, T.D. BROOKS. 1993. Grazing systems on the Edwards Plateau of Taxas: are they worth the trouble?. - *Rangelands,* 15(2): 53–57.

WALKLEY A.J., I.A. BLACK. 1934. Estimation of soil organic carbon by chromic acid titration method. *Soil Science,* 34:29-38.

WARDLE D.A. 2006. The influence of biotic interactions on soil biodiversity. *Ecology Letters*, 9: 870-886.

Received: 15.02.2012
Accepted: 28.03.2012

Union of Scientists in Bulgaria – Plovdiv
University of Plovdiv Publishing House