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Full Length Research Paper

Comparative assessment of edaphic features and phytodiversity in lower Dachigam National Park, Kashmir Himalaya, India

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The present study was conducted to investigate the comparative assessment of edaphic factors and phytodiversity of herbaceous vegetation on seasonal basis spring (March to May), summer (June to August), autumn (September to November) and winter (December to February), at two different ecosystems in lower Dachigam National Park, Kashmir Himalaya. Phytosociological attributes of plant species were studied by randomly laying 25 quadrats of 1×1 m^2 size at both sites. The vegetation data recorded was quantitatively analysed for density, frequency and abundance. Plant diversity was evaluated using different diversity indices. The abundance to frequency ratio (A/F) for different species was determined by eliciting the distribution pattern (regular <0.025, random 0.025-0.05 and contagious >0.05). The results indicated edaphic factors highest at site II (MC, 35.55%), (OC, 4.73%) and (TN, 0.36%). pH showed acidic to nearly alkaline kind of nature at both sites with site I at higher side (5.95 to 7.52). Phytodiversity revealed site II comparatively higher in Shannon diversity and species richness during summer season (3.66, 7.92). However, evenness index showed similar trend with equal value at both sites (0.94). Dominance showed an inverse relationship to diversity (H′). Species at both sites were contagiously distributed followed by random one whereas regular distribution was almost negligible. The study concluded that seasons have great influence on edaphic factors and species diversity. An increase in species diversity was observed during spring and summer season which declined thereafter as autumn and winter approached resulted in decrease in diversity due to multitude of factors.

Key words: Soils, biodiversity, community structure, seasons, species, grazing, forest.

INTRODUCTION

The convention on biological diversity was adapted in Rio de Janerio in 1992. Since that time the issues dealt with under the convention have received wide recognition (Ricotta, 2003; Wamelink et al., 2003). Biodiversity represents an important renewable natural resource with scientific, agricultural, medical, pharmaceutical, educational, cultural and ecological values. The developmental activities such as overexploitation, pollution, war, habitat destruction and degradation by physical and chemical means which affect biodiversity are causing significant and often irreversible loss of biodiversity (Hegazy, 1999). Increased biodiversity has been found to increase primary productivity (Hector et al., 1999), change plant allocation pattern (Tilman et al., 2007), and reduce invisibility by unsown species thus changing herbage composition (Kirwan et al., 2007). Biodiversity is defined as the kinds and numbers of organisms and their patterns of distribution (Barnes et al., 1998). Generally, biodiversity measurement typically focuses on the species level and species diversity is one of the most important indices which are used for the evaluation of ecosystems at different scales (Ardakani, 2004). Local diversity can be studied with various indices, such as number of species per unit area (species

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richness) or the Shannon index, amongst other. These are used as indicators of the degree of complexity of the under study communities and provide information on the homeostatic capacity of the system to unforeseen environmental changes (Magurran, 1988).

Vegetation ecology includes the investigation of species composition and sociological interaction of species in communities (Mueller-Dombois and Ellenberg, 1974). The structural property of a community is the quantitative relationship in between the species growing around. The quantitative study of vegetation is called phytosociology and its principal aim is to describe the vegetation, explain or predict its pattern and classify it in a meaningful way (Ilorkar and Khatri, 2003). It indicates species diversity which determines the distribution of individuals among the species in a particular habitat. Soil is an essential component that has sustained life on this planet, favoring the growth of plants that have survived human competition. The soil resource is limited in space and the soil evolution is a slow process. The chemical and physical properties of soils are controlled largely by clay and humus as it acts as the center of activity around which reactions and nutrient exchange occurs (Buckman and Brady, 1967). Soil is a medium of all plant productivity. The vegetation in turn influences the physical and chemical properties of soil to a great extent. It improves the soil structure, infiltration rate and water holding capacity. Grazing pressure has a simultaneous effect on both soil and range vegetation cover. Many scientists believe that vegetation destruction in rangeland is because of the increment of the grazing pressure and soil deterioration in the same time (Blackburn, 1982; Leck et al., 1989). Soil physical properties play an important role in the establishment and growth of range plants. Range vegetation grazed by livestock results in compaction of the soil surface which affects soil seed bank germination and establishment.

Forests are the essential and most precious renewable natural resource which plays a key role in the lives of people living both in mountains and lowland areas by supplying fresh water and oxygen as well as repositories of terrestrial biological diversities (Kala, 2004). Today, this resource is in imminent danger due to adverse abiotic and biotic stresses resulting from population explosion, industrial development, agriculture and global warming (Bawa and Dayanandan, 1998). With increase in human activity in and around forest ecosystem, biodiversity in terms of number of species may decline (Swaine et al., 1987; Abdulhadi et al., 1987). Moreover, diversity has become an increasingly popular topic within the discussion of sustainability in the last decade, though the maintenance of diversity of forest ecosystems is required since many years (Schuler, 1998; Swindel et al., 1984). The Indian subcontinent, with its rich biodiversity, is one of the 12 mega-diversity centres in the world ranked in 10th position in the world and 4th in Asia in plant diversity (Singh et al., 2003), harbouring 49000 species of flowering and non-flowering plants representing about 12% of the world's recorded flora. The herbaceous layer composition is changing continuously in space and time due to multitude of factors such as grazing, fire, and rainfall which differs in intensity and duration. Kashmir Himalaya, due to its rich repository of vegetation has attracted naturalists and botanists for more than two centuries (Dar et al., 2001). Numerous studies dealing with diverse aspects of vegetation from different areas of the region have been carried out from time to time (Stewart, 1982; Dar et al., 2001). The general vegetation of Dachigam has been dealt with in detail by Singh and Kachroo (1976). They have recognized a number of vegetational types based on habitat, form and density of dominant species, though the vegetation patterns are controlled by such factors as habitat, slope, exposure to sunlight and altitude, besides biotic factors. 2. The present study was conducted to investigate the comparative assessment of edaphic factors and phytodiversity of herbaceous vegetation on seasonal basis in two different ecosystems of lower Dachigam National park, Kashmir.

MATERIALS AND METHODS

Study area

Dachigam National park is located 34° 04′ -34° 14′ N latitudes and 74°48′ to 75° 85′ E longitudes. The park is located about 20 km away from Srinagar city of Kashmir valley with an undulating mountain valley topographic system. The entire area of the park is distinguishable into two sectors upper and lower Dachigam which is spread over an area of 141 km^2. The present study was confined to the lower Dachigam National park conducted on seasonal basis at two different ecosystems viz., site-I (pastureland falls within the catchment of Dachigam but located outside the official boundary of the Park) and site-II (mixed forest located inside the official boundary of the Park).

Soil analysis

Composite soil samples (0 to 30 cm depth) were collected using soil auger from the two selected sites. The collected samples were homogenized by hand mixing and sieved through a 2 mm mesh to remove large fresh plant material (roots and shoots) and pebbles. Finally, the samples were air dried for further analysis (Jackson, 1967). The samples were analysed for determination of soil temperature (Gliessman, 2000), moisture content (Michael, 1984), organic carbon (Walkey and Black's rapid titration method: Walkey and Black, 1934) and total nitrogen by Kjeldahl method (Piper, 1966). pH was assessed by a digital pH meter (model Delux-101E) after 1:2.5 soil: water ratio was prepared.

Vegetation analysis

To study the community composition and other phytosociological characteristics of the herbaceous vegetation at the two selected sites, thorough field surveys were conducted during four prominent seasons Spring (March to May), Summer (June to August), Autumn (September to November) and Winter (December to February).

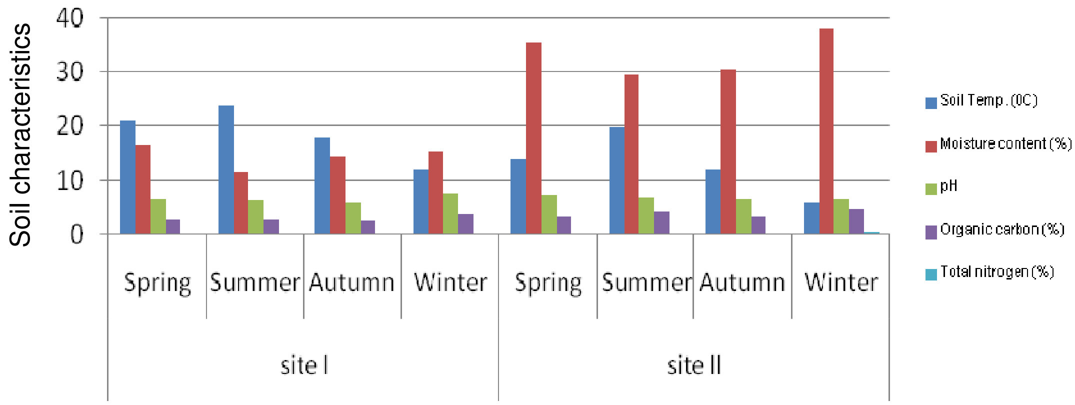

Figure 1. Physico-chemical attributes of soil recorded at two sites during different seasons.

Phytosociological attributes of plant species were studied by randomly laying 25 quadrats of 1×1 m^2 size at each site (Sharma et al., 1983; Rajvanshi et al., 1987). Specimens of each plant species were collected per site and were identified at Centre of Plant Taxonomy University of Kashmir/Botany Division, Forest Research Institute Dehradun, Uttarakhand.

Data analysis

The vegetation data recorded was quantitatively analysed for density, frequency and abundance following Curtis and McIntosh (1950). The relative values of these indices were determined as per Phillips (1959). These values were summed up to get importance value index (IVI) of individual species (Curtis, 1959). The ratio of abundance to frequency (A/F) for different species was determined for eliciting the distribution pattern. This ratio has indicated regular (<0.025), random (0.025 to 0.05) and contagious distribution (>0.05) (Curtis and Cotton, 1956). Plant diversity in the two study sites were evaluated using the following indices. Diversity index (H') Shannon and Wiener (1963):

$$H' = -\sum_{i=1}^{s} p_i \mathrm{Ln} p_i$$

H', is Shannon and Wiener's diversity index, S is the total number of species (richness) and *pi,* is the proportion of individuals in the ith species (*Pi*= ni/N, ni is the number of individuals in the ith species and N is the total number of individuals). Simpson Index (Simpson, 1949):

$$D = \Sigma\, pi^2$$

Evenness Index (Pielou, 1966):

$$J' = \frac{H'}{\mathrm{LnS}}$$

Richness Index (Margalef, 1958):

$$R = \frac{S-1}{\mathrm{Ln(N)}}$$

RESULTS

Physico-chemical attributes of soil

The physico-chemical attributes of soil are presented in Figure 1. The results revealed that minimum soil temperature was 6°C during winter season at site II while a maximum temperature of 24°C occurred at site I during the summer season. Moisture content ranged from 11.54% in summer to 16.68% in spring at site I. A similar trend in moisture percent was observed at site II, with spring season recording a higher moisture content 35.55% than summer season 29.66%. pH value showed overall acidic to nearly alkaline kind of nature at both sites (5.95, autumn) to (7.52, winter) at site I. However, at site II it varied from 6.81 (winter) to 7.32 (spring) season. Winter conditions were favourable for higher organic carbon at both sites (site I=3.82%, and site II=4.73%). Like organic carbon total nitrogen content of soil revealed higher values for forest site II (0.24%, spring to 0.36%, winter) compared to pasture site (0.20%, autumn to 0.28%, winter) at site I. Generally moisture content, organic carbon and total nitrogen in soil were higher at site II compared to site I.

Species diversity

During the study period total number of herbaceous species reported during prominent seasons was 49 at site I (pastureland) and 75 at site II (forest). The seasonal break-up of species recorded at both sites showed maximum species occurrence during spring and summer season (site I, spring= 28; summer= 25), (site II, spring= 31; summer= 51). During autumn and winter season species number at both sites showed overall a declined trend (site I, autumn=14; winter=8) and (site II, autumn=17; winter= 15) Figure 2. However, 11 species at site I and 17 species at site II were highly dominant based on importance value index (IVI) Table 1.

Different diversity indices are present in Figure 3.

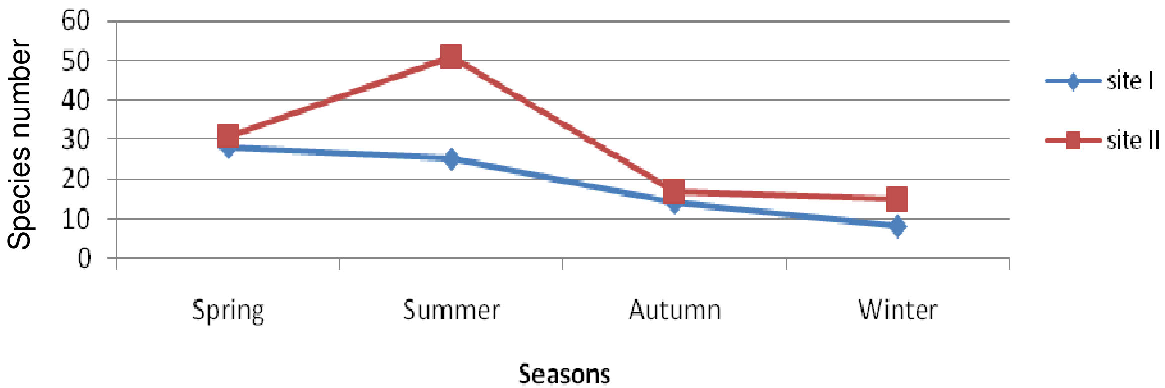

Figure 2. Autumn, spring and winter season.

Table 1. Twenty eight highly dominant herbaceous plant species recorded at two sites during different season.

Artemisia sp.	-	-	-	20.31	-		-	-
Arthraxon prinoides	-	-	-	-	-	23.78	-	-
Bothriochloa pertusa	39.51	-	-	-	-	-	-	-
Cynodon dactylon	37.29	27.66	12.1	22.27	-	-	-	-
Fragaria nubicola	-	-	-	-	-	15.84	-	46.28
Galinsoga parviflora	-	-	-	-	-	-	26.02	-
Galium asperuloides	-	-	-	-	41.17	-	-	-
Galium sp.	-	-	-	-	-	-	-	20.37
Geranium pusillum	-	-	-	-	-	17.46	37.98	-
Hemerocallis fulva	-	-	-	-	-	12.64	-	-
Hypericum perforatum	-	-	-	-	58.47	-	-	-
Iris sp.	-	-	-	-	-	-	24.05	24.49
Origanum vulgare	22.13	-	-	-	-	-	-	-
Oxalis corniculata	-	22.56	-	-	-	-	-	-
Plantago lanceolata	-	20.26	18.57	57.56	-	-	-	-
Poa sp.	-	-	-	-	-	17.87	-	-
Potentilla sp.	-	-	-	-	-	-	34.59	38.91
Ranunculus aquatilis	-	-	-	-	-	-	-	25.51
Ranunculus sp.	17.56	-	-	-	-	-	-	-
Rorripa sylvestris	-	-	-	-	19.99	-	21.08	-
Salvia moorcroftiana	35.3	26	140.97	108.97	-	-	-	-
Stellaria media	-	-	-	-	12.31	11.97	55.32	30.08
Stipa sibirica	13.45	16.82	18.1	26.22	-	-	-	25.79
Thymus serphyllum	15.79	34.01	40.6	41.59	-	-	-	-
Trifolium pratense	-	-	-	-	11.68	13.77	-	-
Tulipa stellata	21.66	-	-	-	-	-	-	-
Viola indica	-	-	-	-	-	-	-	15.03

Comparative results of Shannon diversity (H′) at both sites showed a variation of 1.80 (site I) during winter to 3.66 (site II) during summer season. Overall maximum value of diversity was reported in summer season at both sites (3.03 site I and 3.66 site II) followed by minimum in winter season (site I, 1.80 and site- II, 2.55). In general diversity (H′) showed overall all an increasing trend from spring to summer season and thereafter a decreasing trend was observed till the commencement of winter at both sites. Dominance showed a reverse trend to that of diversity index (H′) at both sites with lowest value reported during summer season (0.06, site I and 0.03, site II). Equability or evenness index showed maximum variation (0.94-summer, sites I and II) and minimum

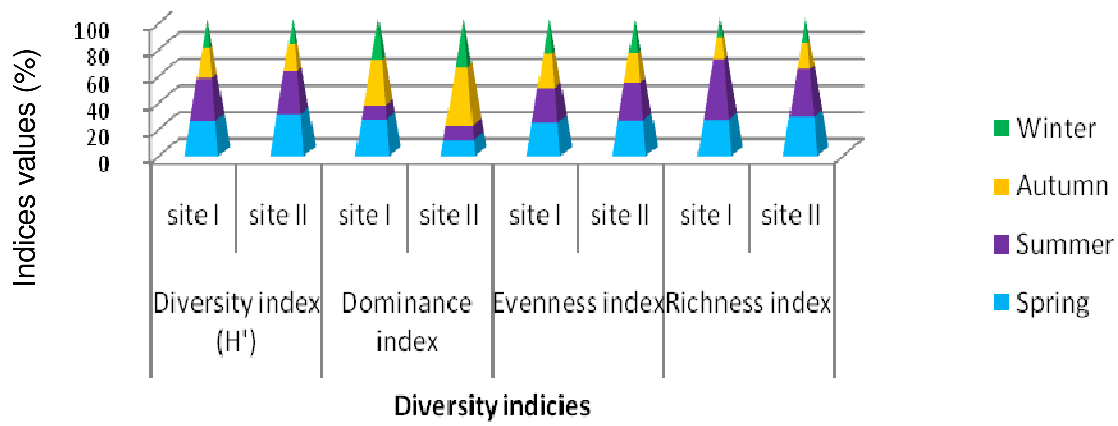

Figure 3. Diversity estimates of the herbaceous vegetation at site I and site II using different diversity indices.

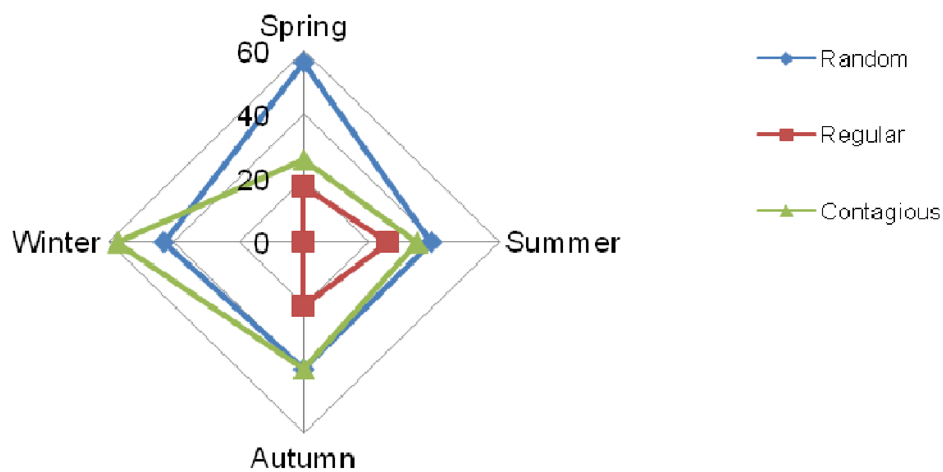

Figure 4. Distribution pattern (%) of herbaceous vegetation at site I during different seasons.

(0.73-autumn) at site I. However, at site II lowest evenness (0.88) was recorded in spring season. The index of species richness overall reported highest value in summer (7.92) at site II which declined thereafter with lowest value (2.50) in winter season at the same site. Site I showed similar approach with increased trend from spring reaching highest in summer (3.70) and lowest in winter (1.87). Comparing the average values of diversity index (H′), equability index and richness index, it is evident that site II is slightly better than site I with respect to these indices: (2.435, site I and 2.945, site II), equability index (0.9125 site II and 0.852 site I) and richness index (4.497- site II and 2.652- site I).

Distribution pattern

At site I (pastureland) about 26 and 57.15% of the species showed contagious distribution in spring and winter seasons respectively. On the other hand 39.14% of the species showed random distribution in summer and 56.53% in winter (Figure 4). At site II most of the species were contagious in distribution with maximum species (80%) in winter followed by summer (64.70%), spring (58.06%) and autumn (58.82%) seasons. Randomly distributed species showed maximum occurrence in spring (41.93%) followed by autumn (35.29%), summer (31.37%) and winter season (20%). Regular distribution of species at this site was almost negligible with only three species *Poa pratensis* and *Impatiens* sp. (3.92%) showed regular distribution in summer season and *Arthraxon prinoides* (5.88%) in autumn season (Figure 5).

DISCUSSION

Soil attributes

Temperature at site II was relatively lower compared to site I, due to the fact that the former received more shade than the latter. Generally high soil temperature is

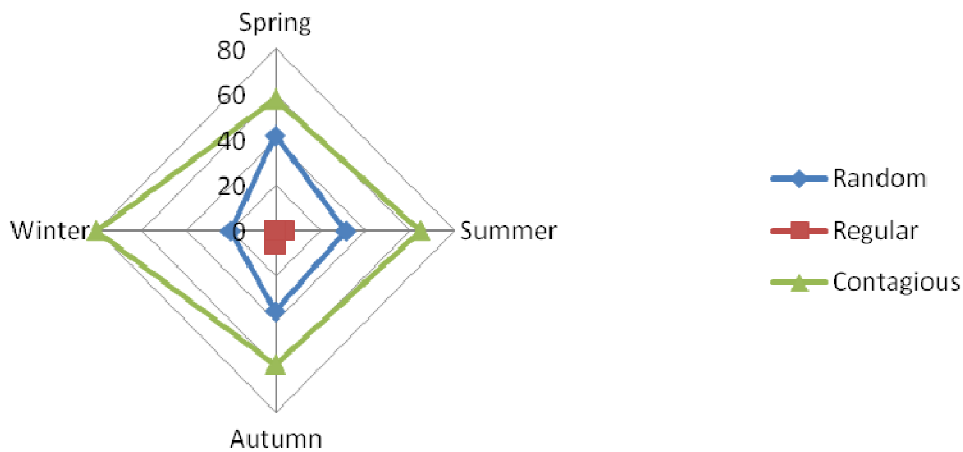

Figure 5. Distribution pattern (%) of herbaceous vegetation at site II during different seasons.

recorded in areas where soil surface is not covered by vegetation (Kuhnelt, 1970). Comparatively soil moisture was lowest at site I (11.54, summer and 16.68, spring). This may be attributed to grazing effects by livestock in the area. The grazing of rangeland plants by livestock has concurrent adverse consequences in terms of the soil surface becoming compacted, which in turn adversely affects the infiltration of moisture into the soil (Amiri et al., 2008). Chaichi et al. (2005) investigated the effect of trampling of soil on changes of vegetation cover and physical characteristics of soil and found decrease in grass-green cover at the end of grazing period. This was attributed to cessation of growth of certain herbaceous species. However, the most prominent change could be the decrease of soil water availability with increase of grazing intensity (Dormaar and Willms, 1998; Krzic et al., 2000; Sarmiento et al., 2004). The results highlighted that the compaction from livestock trampling likely contributed soil surface and botanical composition and vegetation impacts on the decreasing soil infiltration rate. Hence the present findings of site II are compatible with (Mapfumo et al., 2000). Also lowest percentage of soil moisture present in the soil is mainly due to grazing as grazing and trampling by cattle increases the compactness of soils. The highly compacted soil in general shows a lower permeability and increased runoff (Saxena and Singh, 1984). Further, due to inadequate vegetation cover and occurrence of denuded patches created as a result of over-grazing by domestic livestock, the direct sunlight received by soil surface at site I enhances the chances of evaporation. A reduction in soil moisture content due to grazing was also reported by Branson et al. (1981). The general observation revealed that forest site is ahead to pasture site in soil moisture percent (29.66 to 35.55 site II) and (11.54 to 16.64, site I). Das et al. (1980) showed that nature and content of organic debris returned to the forest floor varying with vegetation affecting the physic-chemical properties of the soil from the direct impact of raindrops, thereby controlling erosion on slopes and increases the moisture status in soil (site II). Soil pH influences the availability of plant nutrient and it is a good indicator of forest fertility (Black, 1968). pH value showed overall an acidic to nearly alkane kind of nature at both sites. It ranged from 5.95-7.52 (site I) and 6.81-7.32 (site II). Seasonal trend of pH depicted lowest values during autumn season at both sites (5.95-site I) and (6.67- site II). Buckman and Brady (1967) and Keoghh and Maple (1972) reported lower pH values during dry seasons. The acidic nature of soil was also reported by Kala (2005) in grazed and un-grazed soils of western Himalaya. Low pH reduces the mineralization of soil organic matter and other nutrient reserves, inhabiting root growth and consequently, adsorption of nutrients (Vermeer and Berendse, 1983). Soils with higher pH generally have poorer capacity for regeneration (Suoheimo, 1995). The lower pH value at site II may be due to the continuous decomposition of surface litter over the years. The acidic nature of the soil at this site can also be attributed to various climatic factors. Similar observations were also obtained by Miller (1965); Shrestha (1992) and Kharkwal et al. (2009). Pagliali et al. (1995) reported factors such as land use type, tillage and aspect can affect all soil properties. The pH values reported by Karki (1999) in Koshi Tappu Wildlife Reserve were in accordance to site II. However, present observations were slightly higher than the values reported by Sidgel (1994) in Royal Chitwan National Park (5.90 to 6.42). Other workers (Bisht and Lodhiyal, 2005) who investigated pH in different forest ecosystems were of the same view as reported for site II. Soil organic matter is one of the most important soil components, along with stabilization soil structure and improving infiltration rate. Nowadays, soil organic matter stabilization is perceived as a mechanism for organic carbon storage in the soil in the context of current climate change (Goh, 2004). Indeed, soil organic carbon is the main terrestrial carbon pool (Batjes, 1996). Organic matter supplies energy and cell building constituents for most microorganisms (Allison, 1973) and is a critical factor in soil fertility (Brady, 1984). Organic carbon showed minimum variation (3.23%) in spring to (4.73%) in winter at site II. These observations are within the range of the study reported by Kharkwal et al. (2009) and Kharkwal and Rawat (2010). Brady (1984) mentioned that the higher soil organic matter occurred more commonly in cooler than warmer climates can be well correlated with the seasonal variations in the organic matter occurrence during winter season at both sites (3.81 site I, 4.73 site II). Intensive grazing reduces soil organic matter, compacts the soil surface layer and ultimately increases surface runoff (Faizul et al., 1995). Overgrazing has led to significant changes in plant cover composition and in some places to the complete absence of vegetation cover. The degradation of the vegetation exposes the soil surface directly to wind and water erosion leading to a loss of fertile top soil and its content of nutrients and seeds. The soil becomes compacted by animal trampling, thereby affecting the water-infiltration and thus impairing plant germination, regeneration and growth (ESCAP, 1995; Evans, 1997, 1998; FAO, 1988, 1998). Branson et al. (1981) investigated the effects of long term grazing on rangeland soil characteristics compared to a short term grazing period, and reported a reduction in the soil organic matter and moisture content. High grazing intensity resulted in the lowest amount of soil nitrogen content at site I. Some study revealed that if grazing intensity is increased, a high rate of soil organic matter is achieved (FAO, 1988, 1998). Loss of nutrients under extensive grazing conditions is minimal but is much pronounced under intensive grazing conditions (Anonymous, 1979; Proulx and Mazumder, 1998). Physicochemical characteristics of forest soils vary in space and time due to variations in topography, climate, physical weathering processes, vegetation cover, microbial activities, and several other biotic and abiotic variables (Paudel and Sah, 2003). Soils with abundant roots and plant-residues have tendencies of more nitrogen and organic matter (max. 0.36%, site II–winter). The higher amount of humus and total nitrogen percent in forest site could be explained by higher amount of available organic material at this site (Shourkaie et al., 2007). Organic matter and total nitrogen followed a similar trend in their approach at both sites. Similar kind of trend has also been reported by Shourkaie et al. (2007). Total nitrogen was also reported highest in different forest communities by Kala (2005) hence the findings are in concurrence with site II. Comparative values of total nitrogen at both sites revealed highest value at site II falls in parallel to the findings (Lyaruu, 2010). In general, soil nutrients are most available in the spring and early summer when summer temperature and moisture are favourable, and mineralization, is rapid. Cold winter temperature limit microbial activity mitigated mineralization and one would expect availability to decrease, however, considerable soil mineralization and nutrient uptake by microbes can occur beneath and insulting snowpack (Brooks et al., 1996; Grogan and Jonasson, 2003).

Vegetation attributes

The general structure of species at both sites indicated increasing trend in their occurrence during spring and summer season (site I, Spring=28; Summer=25), (site II, Spring= 31; Summer= 51). Availability of moisture during rainy season favoured the occurrence of most of the herbaceous plant species. The variations in the dominance of plant occurrence are associated with micro-climate and edaphic conditions at the study sites (Sharma and Upadhyaya, 2002). Alhassan et al. (2006) reported similar factors responsible for the changes in species number and diversity. Comparative results of Shannon diversity (H′) at both sites fluctuated between 1.80 (site I) in winter to 3.66 (site II) in summer season respectively. However, maximum value of diversity was reported in summer season at both sites (3.03- site I and 3.66 – site II). It becomes thus evident that diversity is moreover highest at protected site (site-II) than unprotected site-I (Sharma and Upadhyaya, 2002). Kharkwal et al. (2009) while studied the forest communities in Nanital catchment of Kumaun Himalaya reported herb layer diversity within the optimum range for site II. The species richness of herb layer reported by the authors where comparatively higher than the present study. However, comparative richness assessment for site II were supported by Heydari and Mahdavi (2009). Plant diversity depicts higher trend in the national park with intermediate human influence (IHI) than other land uses has been reported by Lyaruu (2010). In general diversity (H′) showed overall an increasing trend from spring to summer season and thereafter a decreasing trend was observed till winter at both sites (Figure 3). This character is attributed to the fact that during spring/ summer season new species go on sprouting depending upon the root/ seed stock in the soil and thereby adding to species in total resulted more diversity. During autumn and winter season the rate of sprouting of root/ seed stock is diminished and species number declined owing to adverse climatic conditions (Shadangi and Nath, 2005). The lower diversity during autumn and winter at both sites could be due to lower rate of evolution and diversification of communities (Fischer, 1960; Simpson, 1964) and severity in environment (Connel and Oris, 1964). Many authors reported similar view for Shannon diversity (H’) compared to the present study (Kiss et al., 2004; Kharkwal et al., 2004; Yadav and Gupta, 2007). Lalfakawma et al. (2009) also reported similar trend in Shannon-diversity in concurrence to the present study. Dominance showed a reverse trend to the diversity index (H′) at both sites. Similar inverse relationship was also reported by Kharkwal et al. (2004). Hegland et al. (2001) and Sher et al. (2005) stressed that protection might help in the revival of original vegetation and recovery of natural habitats where degradation resulted due to heavy grazing and other biotic pressures. The dynamics of vegetation in a rangeland are determined by array of factors which include fire frequency and intensity, grazing regime, climatic fluctuations and to some extent the soil characteristics. The role of plant species diversity in pastures mainly from a plant and soil view point was reviewed by Sanderson et al. (2004). Shannon diversity varied from of 1.80 (winter) to 3.03 (summer) at site I. Ristan and Horsley (2001) reported species diversity within a range (2.0-2.22) which are slightly lower than observed at site II. Favourable observation of ungrazed site being more diverse than grazed site was investigated by El-Khouly (2004). Moreover, the work on biodiversity indicated that diversity tend to be highest under moderate grazing intensity (Zhou et al., 2006). This result seems to provide evidence for the moderate grazing hypothesis (Tilman, 1997). Further evidences should be accumulated to explain how different species acclimatize or adapt to microclimates under different grazing conditions. However, other suggestions made by Lubchenco (1978) and (Huston, 1979) considered it as a positive force that might increase species diversity in the community by preventing competitive exclusion by dominant species. Research has shown that depending on the seasons, the density of grazers influences both species diversity, spatial heterogeneity and the vegetation structure (Adler et al., 2001; Metzger et al., 2005). The effects of grazing on plant species richness and diversity have been frequently documented and debated (Milchunas et al., 1998; Wang et al., 2002; Hichman et al., 2004; Sarmiento et al., 2004). Intensive grazing is known to increase species diversity, species richness and total amount of crude protein in plants (McNaughton, 1979; Western and Gichohi, 1995; Vesk and Westoby, 2001). Livestock impacts on biodiversity through trampling and removal of biomass, alteration of species composition through selective consumption and changed inter-plant competition. However, species diversity and richness decrease under conditions with very high grazing intensity or no grazing (Hobbs and Huennneke, 1992). Species richness indicated lowest trend during autumn to winter at both sites (Figure 2). The loss of natural associations may probably be the reason for supporting low number of species (Walker, 1992). Grazing animals influence species composition, change in biomass and distribution of biodiversity (Sher et al., 2010). Sher and Hussain (2009) also observed that overgrazing reduces the ground cover vegetation, plant density and productivity. In the limelight of these observations it can be conquered that during autumn and winter impacts of grazing reduced the plant cover etc. Kakinuma and Takatsuki (2008) investigated the change in plant communities by grazing in northern Mongolia and observed that species diversity and biomass of forbs decreased with increasing grazing intensity. Moreover pasture site reported species diversity highest during summer season which might be due to moderate disturbance by grazing and invasion of new species. Connell (1978) and Decocq et al. (2004) also reported species diversity highest in intermediate disturbed ecosystem or when the grazing intensity is accelerated. Many other studies mentioned similar observations pertaining to the present study (site II) emphasizing moderate level of grazing promoted species diversity (Rikhari et al., 1993; Singh et al., 2003). Pandey and Singh (1985) while estimates diversity in disturbed ecosystem of Kumaon Himalaya is in the same agreement that species diversity increased in disturbed ecosystem. Species diversity reported by Yadav and Gupta (2007) were within the parameters of this study. Evenness or equability index showed highest value (0.94, summer-site I and site II winter) whereas average equability index (0.9125) was highest at site II. The values of evenness were supported by Lalfakawma et al. (2009) in conclusion that undisturbed site achieved highest equability than disturbed site. The evenness index reported by El-Khouly (2004) in grazed site (1.25 and 0.91) and (0.99 and 0.78) in ungrazed site were comparably more or equal to the equability analysed for site I. Ristan and Horsley (2001) reported evenness index slightly lower compared to site II. High importance value index (IVI) value of a species indicated its dominance and ecological success, its good power of regeneration and greater ecological amplitude. It does vary with the season. The reason that certain species grow together in a particular environment is usually because they have similar requirement for existence in terms of environmental factors such as light, temperature, water, soil nutrients and drainage etc. They may also share the ability to tolerate the activities of animals and humans such as grazing, burning, cutting or trampling (Wood et al., 1994). Plants can be categorized as increasers or decrease’s, corresponding to their shifts in relative abundance in response to grazing but this will depend on the total amount of rainfall available in that rangeland (Vesk and Westoby, 2001). In accordance with this for site I, *Salvia moorcroftiana* and *Thymus serphyllum* showed maximum importance value (IV) during autumn and winter season indicating its dominance due to environmental suitability and ability of the species against grazing during these season seasons. Their dominance in a particular season may be due to availability of optimum conditions for their growth. Similar observations in context with the present study were also reported by Kukshal et al. (2009) based on seasonal changes among species in the importance value index (IVI) that makes them dominant during different seasons. Changes in grazing intensity and selectivity will inevitably change biodiversity; under grazing and overgrazing can both have negative effects, nevertheless overgrazing by livestock is increasingly problematic (Khan, 1994). The increase of the fertilization through sheep and goat excrements, which increase the nutrient availability compotation with the dominant grazed species. It can also be attributed that selective grazing by sheep influenced plant composition by increasing the dominance of unpalatable species such as *S. moorcroftiana* etc at site (I) and hence responsible for decreasing the (IVI) values of other co-dominant species (Zhou et al., 2006). Watkinson and Ormerod (2000), Landsbery et al. (2001) documented that overgrazing caused the destruction due to trampling as green parts are being removed and damaged. Studies have shown where the nomadic grazing has stopped, better vegetation cover, improvement in medicinal plants diversity were observed (Sher et al., 2005). Krahulec et al. (2001) found that increase in the availability of nutrients causes increase in cover of the range species after grazing. Vesk and Westoby (2000) and Sher et al. (2005) observed that overgrazing is a dove tail to the degradation of existing vegetation and reduces the spread of species not only through direct consumption but due to alteration in their habitats. Removing grazers in a protected ecosystem may have a number of consequences such as increase of above ground biomass and dominance of herbaceous vegetation (Vesk and Westoby, 2001). The browsing animals remove buds and twigs and so can dramatically affect the shapes of the plants they browse (Crawley, 1986).

Frequency is a measure of the uniformity of the distribution of a species; thus a low frequency indicates that a species is either irregularly distributes or rare in a particular stand or forest. Frequency distribution of plant density, cover, biomass per unit area, and height, as a measures for expressing biological abundance and biological dominance of vegetation have been used to describe species composition and spatial patterns of vegetation in different plant communities (Chen et al., 2008). Composition of the forest is diverse and varies from place to place because of varying topography such as plains, foothills and upper mountains (Singh, 2006). Among human influence, commercial exploitation, agricultural requirements, forest fire, and grazing pressure are the important sources of disturbance (Singh and Singh, 1992). Various parameters like topography, soil, climate, aspect, altitude and geographical location influence the vegetation diversity of forest. In context to this maximum importance value (IV) at site II was shared by *Fragaria nubicola*, *Geranium pusillum, Potentilla* sp., *Rorripa sylvestris, Stellaria media* and *Tifolium pratense* during most of the season. Their dominance during a particular season can be well correlated with the study conducted by Kukshal et al. (2009). The disappearance of some species may be due to the mechanical damage by the man and animals (El-Khouly, 2004). It is generally argued that each individual species depends on some set of other species for its continued existence and the species have co-evolved in the ecosystem on which they depend (Paine, 1966). Abdullah et al. (2009) also mentioned climatic factors as a reason that influenced the distribution of species in certain habitats. Moreover, high importance value (IV) by any individual species indicated that most of the available resource are being utilized by that species and left over are being trapped by another species as the competitors and the associates. This could be the reason why (IVI) was always reported highest by few species during autumn than rest of the seasons. Other factors affected the vegetation distribution at site II include biotic such as dispersal limitation, competition, and predation (Wright, 2002; Munzbergova and Herben, 2005), and abiotic factors such as nutrient availability (Hall et al., 2004), light availability (Bunker and Carson, 2005), and topographic variation (Itoh et al., 2003; Yasuhiro et al., 2004). It is can be hypothesized that distribution of niche space or availability of resource was equally distributed among all species that showed maximum dominance during autumn season at site II. In terms of overall high importance values index (IVI) of species recorded for both sites ecological dominance of species are commonly (wide niched) throughout the study period. Further, it can be maintained that the dominance of certain species at both sites in a particular period could be as the other co-dominant species do not reach maturity to complete their life cycle.

Distribution pattern

The nature of plant community at a place is determined by the species that grow and develop in such environment (Bliss, 1962). Difference in the species composition from site to site is mostly due to micro-environmental changes (Mishra et al., 1997). Abundance and frequency ratio (A/F) ratio was used to assess the distribution pattern of species. It reveals that most of the species were contagiously distributed at both sites whereas as regular distribution was reported at lower side during different seasons. The studies carried out by Shadangi and Nath (2005) reported maximum species in contagious distribution. Ilorkar and Khatri (2003) while investigated herb layer species reported contagious pattern of distribution followed by random. Khatri et al. (2004) also reported contagious pattern of distribution and mentioned negligible presence of species in regular distribution. Contagious distribution in forest ecosystem was also reported by Kumar et al. (2004) and Chen et al. (2008) hence are in agreement to the present study. Contagious distribution in forest foot Hills of Garhwal Himalaya were also reported by Kumar and Bhat (2006). Dominance of contagious distribution may be due to the fact that the majority of species reproduce vegetatively in addition to their sexuality. Odum (1971) described that in natural conditions contagious distribution is most common type of distribution and is performed due to small but significant variation in environmental conditions, while random distribution is found only in very uniform environment. Contagious distribution in natural vegetation in the present study is in accordance as reported earlier by Greig-Smith (1957); Kershaw (1973) and Singh and Yadava (1974). However, observations indicated that contagious distribution in vegetation (as recorded for both sites) were due to multitude of factors and the vegetative reproduction may not be the only reason (Kershaw, 1973; Saxena and Singh, 1982).

Conclusion

From the present investigation, it can be inferred that seasons have great influence on soil characteristics and species diversity. An increase in species diversity was observed during spring and summer season which declined thereafter as autumn and winter approached resulted decrease in diversity due to dry environmental conditions, slow growth rate and other climatic factors. Variation in quantitative parameters like, species richness and species diversity is related to variations in edaphic factors, elevation, slope aspect and micro-climatic conditions between the two sites. Grazing pressure not only brought about a reduction in the plant density and vegetation cover, but also caused a significant change in plant growth pattern. By higher animal trampling the availability of mineral nutrients in the soil was significantly affected. High nutrient levels at the forest site is also due to nutrient regeneration from fallen leaves, twigs, buds, flowers, decaying roots etc. It is further recommended that species with lower IVIs need priority measures for protection and those with higher IVIs need monitoring effort in order to maintain diversity in the selected sites during different seasons. From forest site to grazed site due to changes in plant growth pattern and different root densities, the chemical characteristics of the soil were altered.

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REFERENCES

Abdulhadi R, Mirmanto E, Kartawinata KA (1987). A lowland Dipterocarp Forest in Sekundur, North Sumatra, Indonesia: Five Years After Mechanized Logging. Kostermans, A. J. G. H. (Ed.), Proceedings of Third Round Table Conference on Dipterocarps, UNESCO.

Abdullah MB, Sanusi SS, Abdul SD, Sawa FBJ (2009). An Assessment of the Herbaceous Species Vegetation of Yankari Game Reserve, Bauchi, Nigeria. Am. Eur. J. Agric. Environ. Sci., 6(1): 20-25.

Adler P, Raff D, Launeroth W (2001). The effect of grazing on the spatial heterogeneity of vegetation. Oecologia, 128: 465-479.

Alhassan AB, Chiroma AM, Kundiri AM (2006). Properties and classification of soils of Kajimaram Oasis of Northeast Nigeria. Int. J. Agric. Biol., 8: 256–261.

Allison FA (1973). Soil organic matter and its role in crop production. Amsterdam: Elsevier.

Amiri F, Ariapour A, Fadai S (2008). Effects of livestock grazing on vegetation composition and soil moisture properties in grazed and non-grazed range site. J. Biol. Sci., 8(8): 1289-1297.

Anonymous (1979). Tropical Grazing Land Ecosystems. UNESCO, UNEP FAO., Paris, France.

Ardakani MR (2004). Ecology. Tehran University Press, p. 340.

Barnes BV, Zak DR, Denton SR, Spurr SH (1998). Forest Ecology. 4th Edn., John Wiley and Sons Inc., ISBN: 13: 978-0471308225, p. 773.

Batjes NH (1996). Total carbon and nitrogen in the soils of the world, Eur. J. Soil Sci., 47: 151–163.

Bawa KS, Dayanandan S (1998). Climate change and tropical forest genetic resources. Clim. Change, 23: 449-466.

Bist S, Lodhiyal LS (2005). Various aspects of soils and tree layer vegetation analysis in reserve forests of Kumaon in central Himalaya. Ind. J. For., 28(1): 37-50.

Black CA (1968). Soil Plant Relations. J. Wiley and Sons, New York.

Blackburn W, Knight RW, Wood MK (1982). Impacts of grazing on watersheds. Texas Agric. Exp. Sta. Mp, p. 1496.

Bliss LC (1962). Rosine and lipid contents in alpine Tundra plants. Ecology, 43: 753-757.

Brady NC (1984). The nature and properties of soils. New York: Mac Millan.

Branson FA, Gifford GF, Renard KG, Hadley RF (1981). Rangeland Hydrology (2nd Edn.). Society for Range Management Kendall/Hunt Publ. Co., Dubuque, IA Range Science Series. No. 1.

Brooks PD, Williams MW, Schmidt SK (1996). Microbial activity under alpine snowpacks, Niwot Ridge, Colorada. Biogeochemistry, 32: 93-113.

Buckman HO, Brady NC (1967). The nature and properties of soils. Eurasia Publishing House (Pvt) Ltd. New Delhi.

Bunker DE, Carson WP (2005). Drought stress and tropical forest woody seedlings: Effect on community structure and composition. J. Ecol., 93: 794-806.

Chaichi MR, Saravi MM, Arvash M (2005). Effects of livestock trampling on soil physical properties and vegetation cover (case study: Lar Rangeland, Iran). Int. Agric. Biol., 7: 1-5.

Chen J, Shiyomi M, Yamamura Y (2008). Frequency distribution models for spatial patterns of vegetation abundance. Ecol. Mod., 211: 403-410.

Connel JH, Oris E (1964). The ecological regulation of species diversity. Am. Nat., 48: 399-414.

Connell JH (1978). Diversity in tropical forests and coral reefs. Science Conservations. Conserv. Biol., 6: 324-337.

Crawley MJ (1986). The structure of plant communities. In: Crawley, M.J. (ed.) Plant Ecol., pp: 1–50. Blackwell, Oxford, UK.

Curtis JT, Cotton G (1956). Plant Ecology Workbook: Laboratory Field Reference Manual. Burgess Publishing Co., Minnesota, 193 p.

Curtis JT, McIntosh RP (1950). The interrelations of certain analytic and synthetic phytosociological characters. Ecol., 31: 434-455.

Curtis JT (1959). The vegetation of Wisconsin: An ordination of plant communities. University of Wisconsin Press Madison, Wisconsin, 657 p.

Dar GH, Bhagat RC, Khan MA (2001). Biodiversity of Kashmir Himalaya. Valley Bok House, Srinagar, J & K, India.

Das SN, Maili TC, Banerjee SK (1980). Genesis of red and lateritic forest soils of west Bengal on Centenary basis, Part-I, Morphological studies. Ind. For., 106(10): 704-714.

Decocq G, Aubert M, Dupont F, Alard D, Saguez R, Wattez-Franger A, Foucault BDE, Delelis-Dusollier A, Bardat J (2004). Plant diversity in a managed temperate deciduous forest: Understorey response to two silvicultural systems. J. Appl. Ecol., 41: 1065-1079.

Dormaar JF, Willms WD (1998). Effect of forty-four years of grazing on fescue grassland soils. J. Range Manage., 51: 122-126.

El-Khouly AAL (2004). Effects of human activities on vegetation diversity in Siwa Qasis. International Conference on Water Resources and Arid Environment.

Economic and Social Commission for Asia and the Pacific (ESCAP) (1995). State of the Environment in Asia and the Pacific. Bangkok.

Evans R (1997). Soil erosion in the UK initiated by grazing animals. Appl. Geogr., 17: 127-141.

Evans R (1998). The erosional impacts of grazing animals. Prog. Phys. Geogr. Full Text Via Cross Ref., 22: 252-268.

Faizul B, Karlw DM, Murray L (1995). Livestock grazing impacts on infiltration rates in a temperate range of Pakistan. J. Range Manage., 46: 367-372.

FAO (Food and Agricultural Organisation of the United Nations) (1988). Revised legend of the soil map of the world, FAO, Rome.

FAO (1998). Livestock and the Environment. In: Meeting the Challenge, FAO, Rome.

Fischer AG (1960). Latitudinal variation in organic diversity. Evolution, 14: 64-81.

Gliessman SR (2000). Field and laboratory investigation in Agro Ecology (Eric W. Engles, ed.). Lewis Pub. New York.

Goh KM (2004). Carbon sequestration and stabilization in soils: Implications for soil productivity and climate change. Soil Sci. Plant Nutr., 50: 467–476.

Greigh-Smith P (1957). Quantitative plant ecology, 2nd edn. Butterworth, London.

Grogan P, Jonasson S (2003). Controls on annual nitrogen cycling in the understory of a subarctic birch forest. Ecology, 84: 202-218.

Hall JS, McKenna JJ, Ashton PMS, Gregoire TG (2004). Habitat characterizations underestimate the role of edaphic factors controlling the distribution of Entandrophragma. Ecology, 85: 2171-2183.

Hegazy AK (1999). The United Nations conservation on biological diversity: From adoption to implementation, In: Hegazy, A. K. (1999). Environment 2000 and beyond. UNESCO, copyright@, ICED, Cairo, Egypt, 442 p.

Hector A, Schmid B, Beierkuhnlein MC, Caldeira D (1999). Plant diversity productivity experiments in European grasslands. Science, 286: 1123-1127.

Hegland SJ, Merijn VL, Gerard BO (2001). Population structure of *Salvia pratensis* in relation to vegetation and management of Dutch dry flood plain grasslands. J. Appl. Ecol., 38(6): 1277-1289.

Heydari M, Mahdavi A (2009). Patterns of plant species diversity related to physiographic factors in Melah Gavan protected area, Iran. Asian J. Biol. Sci., 2(1): 21-28.

Hickman KR, Hartnett DC, Cochran RC, Owensby CE (2004). Grazing management effects on plant species diversity in tallgrass prairie. J. Range Manage., 57: 58-65.

Hobbs RJ, Huenneke LF (1992). Disturbance, diversity, and invasion-implications for conservation. Conserv. Biol., 6 (3): 324-337.

Huston M (1979). A general hypothesis of species diversity. Am. Nat., 113: 81-101.

Ilorkar VM, Khatri PK (2003). Phytosociological Study of Navegaon National Park, Maharashtra. Indian Forester, 129(3): 377-387.

Itoh A, Yamakura T, Ohkubo T, Kanzaki M, Palmiotto PA, LaFrankie JV, Ashton PS, Lee HS (2003). Importance of topography and soil texture in the spatial distribution of two sympatric dipterocarp trees in a Bornean rainforest. Ecol. Res., 18: 307-320.

Jackson ML (1967). Soil chemical analysis. Asia Publication House, Bombay, 498 p.

Kakinuma K, Takatsuki S (2008). Change in plant communities by grazing in north Mongolia and land assessment of herders. 21st. International Grassland Congress and 8th International Rangeland Congress in Hohhot, 28 June-6 July, China, pp. 493-493.

Kala CP (2004). Studies on the Indigenous Knowledge, Practices and Traditional Uses of Forest Products by Human Societies in Uttaranchal State of India. Almora: GB Pant Institute of Himalayan Environment and Development.

Kala CP (2005). Community composition, species diversity, and secondary succession in grazed and ungrazed alpine meadows of the West Himalaya, India. Int. J. Field Stud., 2(1).

Karki S (1999). Ecological study of riverine forest in Koshi Tappu Wildlife Reserve (KTWR) [thesis]. Kathmandu: Central Department of Botany, Tribhuvan University, 56 p.

Keoghh JL, Maples R (1972). Variation in soil test results as affected by seasonal sampling. Bulletin, Arkansas Agricultural Experiment Station. Arkansas University, Fayetteville, USA, 123: 715-783.

Kershaw KA (1973). Quantitative and Dynamic Plant Ecology. 3rd Edn, ELBS and Edward Arnold Ltd., London.

Khan AU (1994). Appraisal of Ethnoecological incentives to promote conservation of *Salvadora oleoides*. Dine the cse for creating a resource area. Biol. Conserv., 75(2): 187-190.

Kharkwal G, Rawat YS (2010). Structure and composition of vegetation in subtropical forests of Kumaun Himalaya. Afr. J. Plant Sci., 4(4): 116-121.

Kharkwal G, Rawat YS, Pangtey YS (2009). An ordination of the forest communities in Nainital catchment of Kumaun Himalaya. J. Environ. Biol., 30(5): 853-857.

Kharwal G, Mehrotra P, Rawat YS, Pangtey YPS (2004). Comparative study of herb layer diversity in pine forest stands at different altitudes of central Himalaya. Appl. Ecol. Environ. Res., 2(2): 15-24.

Khatri PK, Totey NG, Pandey PK (2004). Altitudinal variation in structural composition of vegetation in Satpura National Park. Indian Forester,130(10): 1141-1154.

Kirwan L, Luscher A, Sebastia MT, Finn JA (2007). Evenness drives consistent diversity effects in an agronomic 10 system across 28 European sites. J. Ecol., 95: 530–539.

Kiss T, Sipos G, Bodis K, Barta K (2004). Community composition, species diversity, and secondary succession in grazed and ungrazed alpine meadows of the west Himalaya, India. Int. J. Field work Stud., 2(1).

Krahulec F, Skálová H, Herben T, Hadincová V (2001). Vegetation changes following sheep grazing in abandoned mountain meadows. Appl. Veg. Sci., 4: 97–102.

Krzic M, Broersma K, Thompson DJ, Bomke AA (2000). Soil properties and species diversity of grazed crested wheatgrass and native rangelands. J. Range Manage., 53: 353-358.

Kuhnelt W (1970). Structural aspects of soil surface-dwelling biocoenosis in methods of study in soil ecology. Proc. Paris Symp., 46 p.

Kukshal S, Nautiyal BP, Anthwal A, Sharma A, Bhat AB (2009). Phytosociological investigation and life form pattern of grazing lands under pine canopy in temperate zone, Northwest Himalaya, India. Res. J. Bot., 4: 55-69.

Kumar M, Bhat V (2006). Plant Biodiversity and Conservation of Forests in Foot Hills of Garhwal Himalaya. J. Ecol. Aplication, 11(2): 43-59.

Kumar M, Sharma CM, Rajwar GS (2004). A study on the community structure and diversity of a sub-tropical forest of Garhwal Himalayas. Ind. For., 130(2): 207-214.

Lalfakawma SUK, Roy S, Vanlalhriatpuia K, Vanalalhluna PC (2009). Community Composition and Tree Population Structure in undisturbed and Disturbed Tropical Semi-Evergreen Forest Stands of North-East India. Appl. Ecol. Environ. Res., 7(4): 303-318.

Landsbery J, James CD, Maconochie J, Nicholls AO (2001). The relationship between species density and community biomass in grazed and ungrazed coastal meadows. J. Appl. Ecol., 39: 427-444.

Leck MA, Simpson RL, Parkerson VT (1989). Ecology of Soil Seed Bank. Publication Academic Press, USA.

Lubchenco JL (1978). Plant species diversity in a marine inter-tidal community: Importance of herbivore food preference and algae competitive abilities. Am. Nat., 112: 23-29.

Lyaruu HV (2010). The influence of soil characteristics on plant species diversify and distribution patterns in Western Serengeti, Tanzania. Ser. For. Bull., 5(3): 234-241.

Magurran AE (1988). Ecological diversity and measurement. Princeton University Press, Princeton, p. 354.

Mapfumo E, Chanasyk DS, Baron VS, Naeth MA (2000). Grazing impacts on selected soil parameters under short-term forage sequences. J. Range Manage., 53: 466-470.

Margalef R (1958). Perspective in ecological theory. University of Chicago Press, Chicago.

McNaughton SJ (1979). Grazing as an optimization process: Grass-ungulate relationships in the Serengeti. Am. Nat., 113: 691-703.
Metzger KL, Coughenour MB, Reich RM, Boone RB (2005). Effects of seasonal grazing on plant species diversity and vegetation structure in semi-arid ecosystem. J. Arid. Environ., 61: 147-160.
Michael P (1984). Ecological methods for field and laboratory investigations. Tata Mcgraw Hill Pub. Comp. Ltd.
Milchunas DG, Lauenroth WK, Burke IC (1998). Livestock grazing: Animal and plant biodiversity of short-grass steppe and the relationship to ecosystem function. Oikos, 83: 65-74.
Miller CE (1965). Soil reaction and liming soil fertility. New York: John Wiley and Sons Inc., 436 p.
Mishra D, Mishra TK, Banerjee SK (1997). Comparative phytosociological and soil physic-chemical aspects between managed and unmanaged lateritic land. Ann. For., 5(1): 16-25.
Mueller-Dombois D, Ellenberg E (1974). Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York.
Münzbergová Z, Herben T (2005). Seed, dispersal, microsite, habitat and recruitment limitation: Identification of terms and concepts in studies of limitations. Oecologia, 145: 1–8.
Odum EP (1971). Fundamentals of Ecology. Saunders Co., Philadelphia.
Pagliai M, Raglione M, Panini T, Maletta M, Marca ML (1995). The structure of two alluvial soils in Italy after 10 years of conventional and minimum tillage. Soil Till. Res., 34: 209-223.
Paine RT (1966). Food-web complexity and species diversity. Am. Nat., 100: 65-75.
Pandey AN, Singh JS (1985). Mechanism of ecosystem recovery: A case study from Kumaun Himalaya. Recl. Reveg. Res., 3: 271-292.
Paudel S, Sah JP (2003). Physiochemical characteristics of soil in tropical sal (*Shorea robusta* Gaertn.) forests in eastern Nepal. Him. J. Sci., 1(2): 107-110.
Phillips EA (1959). Methods of vegetation study. Henry Holt and Co., New York, 318 p.
Pielou EC (1966). Species diversity and pattern diversity in the study of ecological succession. J. Theor. Biol., 10: 370-383.
Piper CS (1966). Soil and Plant Analysis. Hans Publisher, Bombay.
Proulx M, Mazumder A (1998). Reversal of grazing impact on plant species richness in nutrient-poor versus nutrient-rich ecosystems. Ecol., 79: 2581-2592.
Rajvanshi R, Kumar V, Bachpari W, Rajgopal K, Raj SFH (1987). Herbaceous under growth in some forest habitats in Nilgiris. Ind. For., 113(9): 599-608.
Ricotta C (2003). On parametric evenness measures. J. Theor. Biol., 222: 189-197.
Rikhari HC, Negi GCS, Ram J, Singh SP (1993). Human-induced secondary succession in alpine meadow of Central Himalaya, India. Arctic Alpine Res., 25: 8-14.
Ristan TE, Horsley SB (2001). Sampling to assess species diversity of herbaceous layer vegetation in Allegheny hardwood forests. J. Torrey Bot. Soc., 128(2): 15-164.
Sanderson MA, Soder KJ, Brzezinski N, Muller LD, Skinner RH, Wachendorf M, Taube F, Goslee SC (2004). Plant species diversity influences on forage production and performance of dairy cattle on pasture. Grassland Sci. Eur., 9: 632-634.
Sarmiento G, Pinillos M, Silva da MP, Acevedo D (2004). Effects of soil water regime and grazing on vegetation diversity and production in a hyper seasonal savanna in the Apure Llanos, Venezuela. J. Trop. Ecol., 20: 209-220.
Saxena AK, Singh JS (1982). A phytosociological analysis of woody species in forest communities of a part of Kumaon Himalaya. Vegetation, 50: 3-22.
Saxena AK, Singh JS (1984). Tree population structure of certain Himalayan forest associations and implications concerning their future composition. Vegetation, 58: 61-69.
Schuler A (1998). Sustainability and biodiversity–forest historical notes on two main concerns of environmental utilization. Assessment of Biodiversity for Improved Forest Planning. Kluwer Academic Publishers, Dordrecht, pp. 353-360.
Shadangi DK, Nath V (2005). Imapct of seasons on ground flora under plantation and natural forest in Amarkantak. Ind. For., 131(2): 240-250.
Shannon CE, Wiener W (1963). The Mathematical Theory of communication. University Illinois Press, Urbana.
Sharma KP, Upadhyaya BP (2002). Phytosociology, primary production and nutrient retention in herbaceous vegetation of the forestry arboretum on the Aravalli hills at Jaipur. Trop. Ecol., pp. 325-335.
Sharma SK, Georga M, Prasad KG (1983). Forest vegetation survey and classification with special reference to South India. 1. Vegetation survey and quadrate analysis. Ind. For., 109(6): 384-394.
Sher H, Hussain F (2009). Ethnobotanical evaluation of some plant resources in Northern part of Pakistan. Afr. J. Biotechnol., 8(17): 4066-4076.
Sher H, Ahmad A, Eleyemeni M, Faiz-i-Hadi S, Sher H (2010). Imapct of nomadic grazing on medicinal plants diversity in Miandam, Swat-Pakistan (preliminary results). Int. J. Biod. Conserv., 2(6): 146-154.
Sher H, Khan ZD, Khan AU, Hussain F (2005). *In-situ* conservation of some selected medicinal plants of Upper Swat, Pakistan. J. Acta. Bot. Yunnan., 27: 27-36.
Shourkaie SG, Chaichi MR, Saravi MM, Hosseini HMS, Lotfollahi M (2007). Evaluation of grazing intensity effects on organic matter content and mineral nutrients recycling in rangeland soils (Case study: Mirza Bailue Rangelands, Golestoan Province, Iran). American-Eurasian J. Agric. Environ. Sci., 2(5): 504-510.
Shrestha A (1992). Physical and chemical properties of soil in Nepal. J. For. Inf. Nep.,3(4): 27-29.
Sigdel ER (1994). Physico-chemical properties of soil in Royal Chitwan National Park [thesis]. Kathmandu: Central Department of Botany, Tribhuvan University, 49 p.
Simpson EH (1949). Measurement of diversity. Nat., 163: 688.
Simpson GG (1964). Species diversity of North American recent mammals. Syst. Zool., 13: 57-73.
Singh JS, Yadava PS (1974). Seasonal variation in composition, plant biomass, and net primary productivity of tropical grassland at Kurukshetra, India. Ecol. Monogr., 44: 351-376.
Singh G, Kachroo P (1976). Forest Flora of Srinagar and Plants of Neighbourhood. B. Singh and M.P. Singh, Bishan Singh, Mohinderpal Singh, Dehradun, India.
Singh JS, Singh SP (1992). Forest of Himalaya, Structure, Functioning and impact of Man. Gyanodaya Prakashan, Naintal, India.
Singh JS (2006). Sustainable development of Indian Himalayan region: Linking ecological and economic concerns. Curr. Sci., 90(6): 784-788.
Singh J, Singh AK, Kanjiya SPS (2003). Medicinal plants: India's Opportunity. Pharma Bio world Jassubhai Media, India, pp. 59-66.
Singh YP, Kumar A, Rai JPN (2003). Species diversity as related to grazing pressure in alpine meadows of Nanda Devi Biosphere Reserve. Proc. Nat. Seminar on Biodiversity conservation and management, EPCO, Bhopal, pp. 147-153.
Stewart RR (1982). History and exploration of plants in Pakistan and adjoining Areas (Nasir, E. and S.I. Ali, eds.) Pan Graphics, Islamabad, Pakistan.
Suoheimo J (1995). Natural regeneration potential of mixed sal (*S. robusta*) forests in Nepal, VOL. II. FMUDP working paper no. 18. Kathmandu: National Forest Division, Department of Forests, Ministry of Forest and Soil Conservation, HMGN.
Swaine MD, Hall JB, Alexander IJ (1987). Tree population dynamics at Kade. Ghana (1968-1982). J. Trop. Ecol., 3: 331-345.
Swindel BF, Conde LF, Smith JE (1984). Species diversity: Concept, measurement and response to clear cutting and site preparation. For. Ecol. Manage., 8(1): 11-22.
Tilman D (2007). Resource competition and plant traits: A response to Craine et al. (2005). J. Ecol., 95: 231–234.
Tilman D (1997). Community invisibility, recruitment limitation and grassland biodiversity. Ecology, 78: 81-92.
Vermeer JG, Berendse F (1983). The relationship between nutrient availability, shoot biomass and species richness in grassland and wetland communities. Vegetation., 53: 121-126.
Vesk PA, Westboy M (2001). Predicting plant species response to grazing. J. Appl. Ecol., 38: 897-909.
Vesk PA, Westoby M (2000). Predicting plant species responses to grazing. J. Appl. Ecol., 38(5): 897-909.
Walker BH (1992). Biodiversity and ecological redundancy. Conserv. Biol., 6: 18-23.

Walkley AE, Black JA (1934). An examination of the Degtiga vett. method for determining soil organic matter and proposed modification of the chromic acid titration method. Soil Sci., 37: 29.

Wamelink GWW, Ter Braak C J F, van Dobben H F (2003). Changes in large scale patterns of plant biodiversity predicted from environmental economic scenarios. Landsc. Ecol., 18: 513-527.

Wang YS, Shiyomi M, Tsuiki M, Tsutsumi M, Yu XR, Yi RH (2002). Spatial heterogeneity of vegetation under different grazing intensities in the Northwest Heilongjiang Steppe of China. Agric. Ecosyst. Environ., 90: 217-229.

Watkinson AR, Ormerod SJ (2000). Grasslands, grazing and population dynamics *Vulpia ciliata*: editors introduction. J. Appl. Ecol., 37(6): 233-236.

Western D, Gichohi H (1995). Segregation effects and the impoverishment of Savanna parks: The case for ecosystem viability analysis. Afr. J. Ecol., 13: 269-281.

Wood J, Low AB, Donaldson JS, Rebelo AG (1994). Threats to Plant Species Diversity Through Urbanization and Habitat Fragmentation in the Cape Metropolitan Area, South Africa, pp: 259-274. In: Huntely, B. J (Ed.) Strelitzia 1, Botanical diversity in south Africa. Proceedings of a Conference on the Conservation and Utilization of Southern African Botanical Diversity. Cape Town, September 1993. Pretoria: National Botanical Institute.

Wright SJ (2002). Plant diversity in tropical forests: A review of mechanisms of species coexistence. Oecologia, 130:1-14.

Yadav AS, Gupta SK (2007). Effect of micro-environment and human disturbance on the diversity of herbaceous species in Sariska Tiger Project. Trop. Ecol., 48(1): 125-128.

Yasuhiro K, Hirofumi M, Kihachiro K (2004). Effects of topographic heterogeneity on tree species richness and stand dynamics in a subtropical forest in Okinawa Island, southern Japan. J. Ecol., 92(2): 230-240.

Zhou H, Tang Y, Zhao X, Zhou L (2006). Long-term grazing alters species composition and biomass of a shrub meadow on the Qinghai-Tibet Plateau. Pak. J. Bot., 38(4): 1055-1069.