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# Comparative study of herb layer diversity in lower Dachigam National Park, Kashmir Himalaya, India

**S. A. Shameem[1]*, P. Soni[2] and G. A. Bhat[3]**

[1]Division of Environmental Sciences, SKUAST-Kashmir, Srinagar (J and K), Forest Research Institute University, Dehradun, Uttarakhand, India.
[2]Ecology and Environment Division, Forest Research Institute Dehradun, Uttarakhand, India.
[3]Postgraduate Department of Environmental Sciences/CORD, University of Kashmir, Srinagar (J and K), India.

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**The present study was conducted at two different ecosystems that is, site I (pastureland) and site II (forest) in the lower Dachigam National Park of Kashmir, Himalaya. The pasture site is located outside the National Park and is under grazing whereas forest site is located inside the National Park and is protected. The study was done on seasonal basis and the average results revealed comparatively more or equal values of diversity (H′) for both sites (site I = 2.435 and site II = 2.395) while dominance index showed higher value at site I (average = 0.147). The richness index (average = 3.842) and equability index (average = 0.90) both showed higher value at site II. Seasonal trend of Shannon diversity (site I = 3.03, site II = 2.87), richness index (site I = 3.70, site II = 5.83) and evenness or equability index (0.94, site I and II) depicted highest value during summer season whereas lowest variation in Shannon diversity and richness index was observed in winter season at both sites. However, dominance index was recorded lowest in summer season at both sites (site I = 0.06 and site II = 0.07) hence inversely related to diversity (H′). The frequently occurred dominant species during prominent seasons based on importance value (IV) were *Cynodon dactylon*, *Salvia moorcroftiana* and *Thymus serphyllum* at site I and *Fragaria nubicola*, *Galinsoga parviflora*, *Stipa sibirica* and *Viola indica* at site II. The abundance to frequency ratio (A/F) indicated most of the species performed contagious pattern of distribution.**

**Key words:** Biodiversity, community structure, seasons, species, grazing.

## INTRODUCTION

The global biodiversity crisis has given rise to a growing concern at the prospect of a rapidly accelerating loss of species, population, domesticated varieties, medicinal herbs and natural habitats. Recent estimates suggest that more than half of the habitable surface of the planet has already been significantly altered by the human activity (Hannah and Bowles, 1995) and we are on the verge of mass extinction of the species (Wilson, 1985). Conservation biologists warn that 25% of all species could become extinct during the next 20 to 30 years. The cause for the loss of species is numerous but the most important is the loss and fragmentation of natural habitats. Biological diversity implies the variety of living organisms and includes diversity within species, between species and of ecosystems and the ecological processes of which they are a part (Gaston and Spicer, 2004). Spices diversity is considered to be one of the key parameters characterizing ecosystems and a key component of ecosystem functioning (Hutchinson, 1959; Schulze and Mooney, 1994; Larsson, 2001; Loreau et al., 2002; Scherer-Lorenzen et al., 2005). Globally, biodiversity is changing at an unprecedented rate as a complex response to several human-induced changes (Vitousek, 1994; Hooper et al., 2005). These changes in biodiversity cause concern for ethical, economical, ecological, and aesthetic reasons, but they also have a strong potential to alter ecosystem services such as the prevention of soil erosion and maintenance of hydrologic cycles, and ecosystem goods, like tourism and recreation. Beyond the ecosystem services, biodiversity influences many ecosystems properties such as productivity, decomposition rates, nutrient cycling,

***Corresponding author. E-mail: sa78@rediffmail.com.

resistance and resilience to perturbations (Loreau et al., 2001). Moreover, a high biodiversity is seen as an insurance against a decline in ecosystem services, and should therefore be preserved (Yachi and Loreau, 1999).

The structure of plant as well as animal communities in many natural ecosystems is largely influenced by the disturbances, frequently occurring in the system naturally or due to anthropogenic activities (Armesto and Pickett, 1985; Bennett and Adams, 2004; Eldered and Doak, 2006; Kwit and Platt, 2003). In many of these systems, disturbances change overall community structure (Shaforth et al., 2002; Sousa, 1979) which in turn can ultimately affect community and population dynamics. In other words, the global environmental degradation has been severely occurred and has been introduced as one of the main environmental troubles worldwide. Studying vegetation and various environmental factors (e.g. physiographic, climate, soil, etc.), the community stability and the factors correlation with the vegetation can be reached, which is crucial in terms of forest communities development and rehabilitation (Basiri, 2003). Grazing areas have become less and less productive resulting from over stocking of livestock. Conflicts over the use of land have increased due to increased demand for land by different sectors of the economy. Of particular concern are the conflicts among cultivators, livestock keepers, wildlife conservationists, individual land users and governments due to encroachment of humans into the protected areas (Hoare, 1999; Campbell et al., 2003; Western, 1976; Wells and Brandon, 1992). Forests are the primary source to rejuvenate productivity of land through recycling of nutrients, which make physico-chemical conditions of the soils favourable for plant growth (Bargali et al., 1998). Due to increasing human population, the biotic pressure on native forest is inevitable. The uncontrolled lopping and felling of trees for fuel wood, leaf fodder, burning of ground vegetation, livestock grazing and harvesting of ground vegetation for forage are some of the factors responsible for exploitation of forests (Bargali et al., 1998).

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 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. Anthropogenic disturbances in forests followed by livestock grazing in pasture lands adversely affected the composition of herbaceous vegetation, it is therefore imperative to conserve the herbaceous vegetation of the two selected sites. In this context, the present study was therefore conducted to assess the seasonal variations in phytodiversity and distribution pattern of herbaceous vegetation in the two selected sites.

## METHODOLOGY

### Study area

Dachigam National park is located between 34°.04′-34°.11′ N - latitude and 74° 54′-75° 09′ E-longitude is nearly 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 (forest located inside the official boundary of the Park).

### Vegetation analysis

To study the community composition and other phytosociological characteristics of the herbaceous vegetation at two selected sites, thorough field surveys were conducted during four prominent seasons Spring (March-May), Summer (June-August), Autumn (September-November) and Winter (December-February). 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). Specimen of plant species encountered at each site during the study period were collected and herbarium was prepared and identified at Centre of Plant Taxonomy, Botany Department University of Kashmir, 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 by eliciting the distribution pattern. This ratio has indicated regular (‹0.025), random (0.025 - 0.05) and contagious (›0.05) distribution (Curtis and Cotton, 1956). Plant diversity in the two study sites were evaluated using the following indices:

Diversity index (H') Shannon-Weaver (1949)

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

H′ is Shannon-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) (Shannon-Weaver, 1949).

Simpson Index (Simpson, 1949):

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

Evenness Index (Pielou, 1966),

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

Richness Index (Margalef, 1958)

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

## RESULTS

### Diversity indices

During the study period total number of herbaceous species reported during prominent seasons was 48 at site I (pastureland) and 41 at site II (forest) (Figure 1). 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 = 18; summer = 21). During autumn and winter season species number at both sites showed overall a declined trend (site I, autumn = 11; winter = 10) and (site II, autumn = 14; winter = 8). However, out of the total plant species encountered at both sites during different seasons results of 22 highly dominant species based on importance value (IV) are depicted in Figure 2 and elaborated below as season wise and site wise. Dominant species based on importance value (IV) during spring season at site I were *Bothriochloa pertusa* (39.51), *C. dactylon* (37.29), *S. moorcroftiana* (35.30), *Organum vulgare* (22.13), *Tulipa stellata* (21.66), *S. sibirica* (13.45) *Ranunculus* sp. (17.56) and *T. serphyllum* (15.79) whereas at site II dominant species recorded were *F. nubicola* (74.17), *G. parviflora* (34.15), *S. sibirica* (25.53), *Dropteris flixmass* (24.37) and *Poa* sp (23.86) in the same season. During summer season *T. serphyllum* (34.01), *C. dactylon* (27.66), *S. moorcroftiana* (26), *Oxalis corniculata* (22.56) and *Plantago lanceolata* (20.26) showed higher dominance at site I and *Arthraxon prinoides* (37.42), *Setaria viridis* (32.15), *F. nubicola* (31.93) *Viola indica* (21.18) and *Stipa sibirica* (19.46) depicted high dominance at site II during the same season.

*S. moorcroftiana* (140.97), *T. serphyllum* (40.60), *C. dactylon* (12.10), *P. lanceolata* (18.57) and *S. sibirica* (18.10) are the species showing high dominance at site I in autumn season. Site II was dominated by *Poa annua* (101.35), *F. nubicola* (53.34), *Impatiens grandiflora* (20.45), *Galinsago parviflora* (22.98) and *Viola indica* (32.13) during this season.

High dominance in winter season at site I was shown by *S. moorcroftiana* (IVI = 108.97), *C. dactylon* (22.27), *S. sibirica* (26.22), *Artemisia* sp. (20.31) followed by *T. serphyllum* (41.59) and *P. lanceolata* (57.56). At site II during this season high dominance was reported by *Poa angustifolia* (IVI = 55.88), *F. nubicola* (43.93), *Poa annua* (37.14), *Stellaria media* (30.18) followed by S. sibirica (30.37). Comparatively S. moorcroftina, T. serphyllum and *C. dactylon* remained as dominant species during different seasons throughout the study period at site I whereas *F. nubicola*, *G. parviflora*, *S. sibirica* and *Viola indica* were dominant. Different diversity indices recorded at both sites are presented in Figure 3. The perusal of the data revealed diversity index (H′), evenness index and richness index obtained maximum value during summer season at both sites (site I = 3.03, site II = 2.87), evenness index (0.94 each at site I and II) and richness index (site I = 3.70, site II = 5.83). However, minimum value of diversity index (H′) was recorded in winter (1.80 = site I) and autumn season (2.04 = site II). Moreover, evenness index showed lowest value during autumn season at both sites (0.73-site I and 0.85- site II). Species richness was recorded lowest at both sites during winter season (1.87-site I and 2.47-site II). Dominance index depicted inverse trend to that of Shannon diversity with lowest values reported in summer season at both sites (site I = 0.06 and site II = 0.07) and highest during autumn at both sites (0.25-site I and 0.18-site II) hence inversely related to diversity (H′). In general diversity showed an increasing trend from spring to summer and thereafter a declined trend was observed at both sites.

### Distribution pattern

The abundance to frequency ratio (A/F) indicated most of the species at both sites performed contagious pattern of distribution. A seasonal picture of both sites noted most of the species as contagious>random>regular distribution during different seasons. At site I about 26.09 (spring) to 57.15% species in winter season showed contagious distribution followed by 39.14% (summer) to 56.53% species in winter as randomly distributed (Figure 4). Seasonal trend indicated that during spring season at site II maximum (50%) species fall in random distribution followed by contagious (44.45%) and only one species (*S. media*) fall in regular distribution (5.56%). In summer season (47.62%) species showed contagious distribution followed by regular (28.58%) and random (23.81%). During autumn and winter season maximum species (72.73, 70%) showed contagious distribution followed by random (27.28%, 30%) during the same season. Regular distribution of species was absent during autumn and winter season at site II (Figure 5).

## DISCUSSION

Diversity is considered to be an outcome of evaluation of species in a bio-geographic region. It is considered to be synthetic measure of the structure, complexity and stability of a community (Hubble and Foster, 1983). It is a combination of two factors: the number of species present, referred to as species richness and the distribution of individuals among species, referred to as species evenness or equability. Species diversity therefore, refers to the variation that exists among the

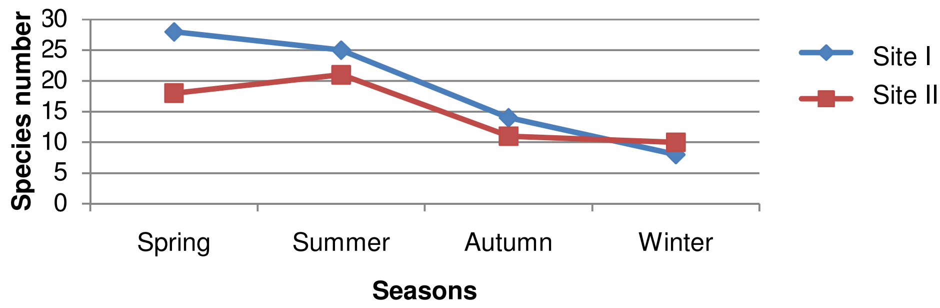


**Figure 1.** Species recorded at two sites during different seasons.

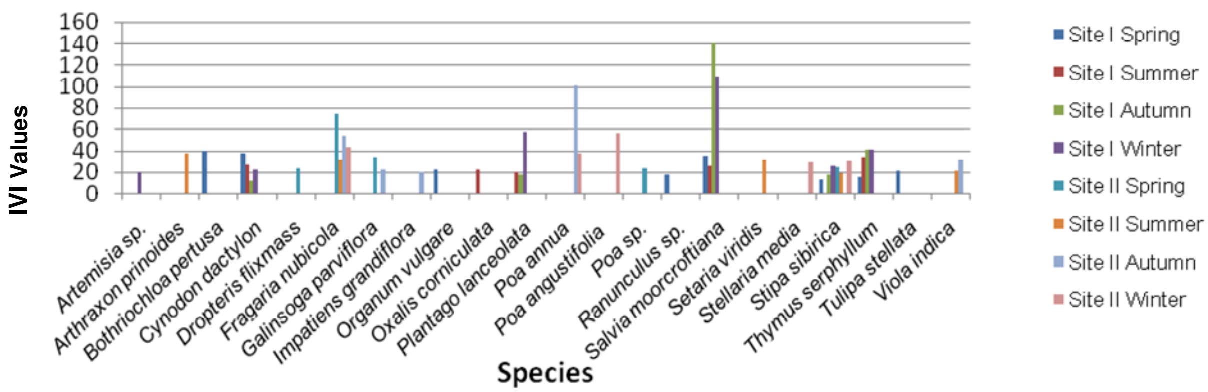


**Figure 2.** Twenty two highly dominant herbaceous plant species recorded at two sites during different seasons.

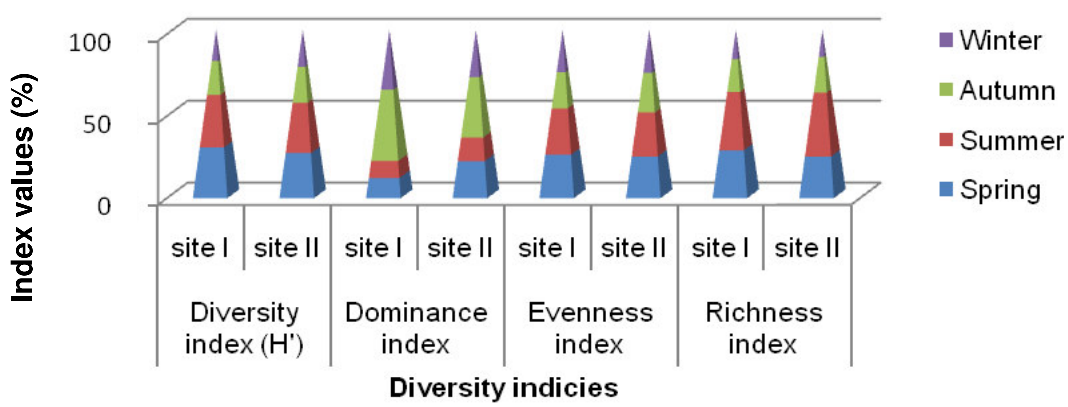


**Figure 3.** Diversity estimates of the herbaceous vegetation at site I and site II using different diversity indices.

different life forms. In the present study general structure of vegetation at both sites depicted an increasing trend in species number particularly during spring and summer seasons (site I, spring = 28; summer = 25) and (site II, spring = 18; summer = 21). The reason for their maximum occurrence during the two seasons could be due to the availability of moisture present in the form of rains and other environmental factors. Alhassan et al. (2006) during their study period reported similar factors responsible for the variation in species number and diversity. The sequence of observations mirrored to present study was also mentioned by Sharma and Upadhyay (2002). The species diversity in the present study ranged from 1.80 (winter) to 3.03 (summer) at pasture site and 2.04 (autumn) to 2.87 (summer) at forest site. An increasing trend in species diversity was observed

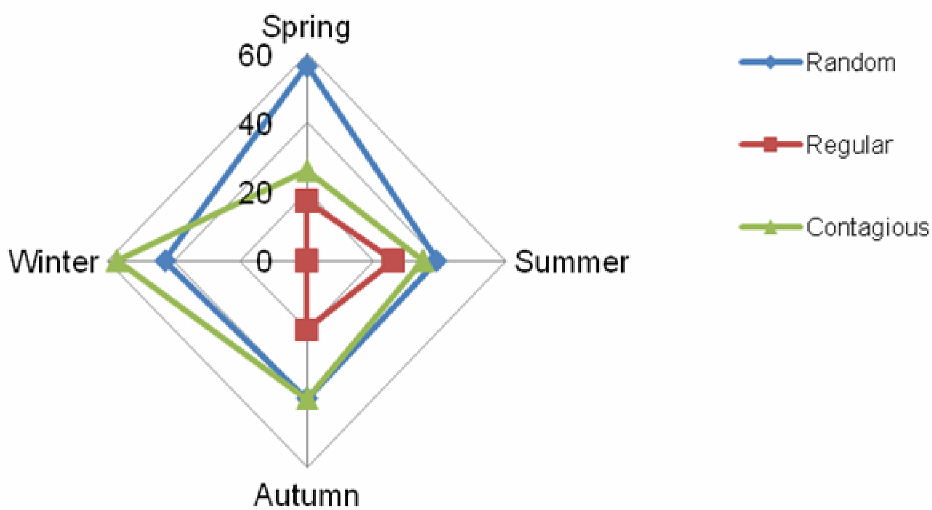


**Figure 4.** Distribution pattern (%) of herbaceous vegetation at site I during different seasons.

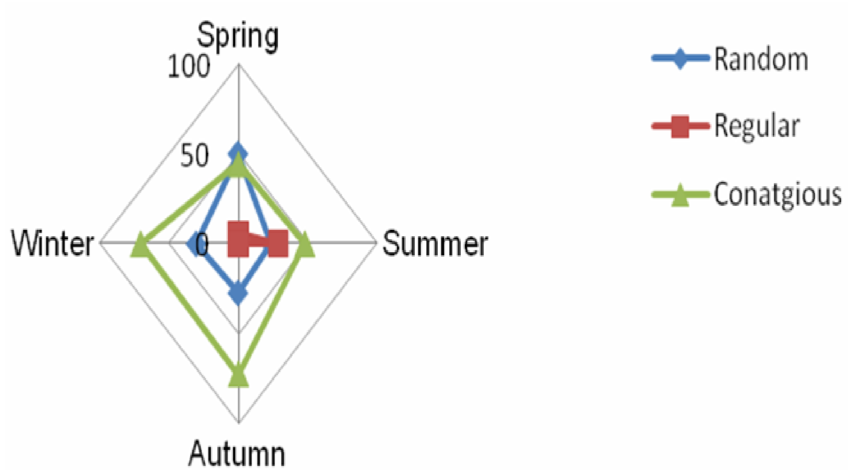


**Figure 5.** Distribution pattern (%) of herbaceous vegetation at site II during different seasons.

from spring onwards which declined with the commencement of autumn and winter seasons at both sites. This character is attributed to the fact that during spring and summer seasons, new species goes 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 may also be due to lower rate of evolution and diversification of communities (Fischer, 1960; Simpson, 1964) and severity in environment (Connel and Oris, 1964). Comparatively, results of Shannon diversity at both sites fall within the range of the study carried out by Kiss et al. (2004); Yadav and Gupta (2007). Lalfakawma et al. (2009) and Kharkwal et al. (2004) are in the same view while comparing the results of Shannon-diversity in concurrent to the present study. However, highest species diversity during summer season at site I might be due to the moderate level of grazing or anthropogenic disturbances and invasion of new species. Connell (1978) and Decocq et al. (2004) also reported species diversity highest in intermediate disturbance ecosystem than in undisturbed systems. Many other studies mentioned similar results pertaining to the present study emphasizing moderate level of grazing promoted species diversity (Rikhari et al., 1993; Singh et al., 2003). Pandey and Singh (1985) in their study on disturbed ecosystem of Kumaon Himalaya are in the same agreement that species diversity increased in disturbed ecosystem due to moderate disturbances. 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. 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. Highest trend in species diversity during summer season at site II could be due to various environmental and climatic factors. Concentration of dominance at site I ranged from 0.06 (summer) to 0.25 (autumn) at site I and 0.07 (summer) to 0.18 (autumn) at site II hence inversely related to diversity index (H'). Compatible results of inverse relationship between diversity and dominance were also reported by Kharkwal et al. (2004). The lower value of dominance at forest site showed that dominance of herb layer plants is shared by many species. The Pielou's indices at both sites were around 0.0825 (site I) and 0.90 (site II) on average, indicating low dominance and more or regular distribution of plant species at both sites. Site I during autumn/winter and site II during winter season was at lower side in species richness which could be due to dry environmental conditions and also due to slow growth rate, to a maximum during spring/ summer (site I), spring/summer and winter season at site II which could be due to favourable climatic conditions. Abdullah at al. (2009) in their study also mentioned climatic factors as a reason that influenced the distribution of species in certain habitats. High importance value (IV) 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 why certain species grow together in a particular environment is usually because they have similar requirements for existence in terms of environmental factors such as light, temperature, water and 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). In accordance to our results for site I *S. moorcroftiana* and *T. 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 the two seasons. However, their dominance at a particular site could be due to the availability of optimum conditions for their growth. Favourable observations in support of results achieved for site I was also reported by (Kukshal et al. 2009) based on seasonal changes in the IVI value of species that makes them dominant during different seasons. The growing dominance of non-palatable and other species at pasture site is probably an indication of adaption against herbivory and adverse climatic conditions. Bhandari et al. (1999) while working in pasturelands of Garhwal Himalaya reported same trend in their results as concurred in the present study. However, at site II maximum IVI was shared by *Fragaria nubicola, Galinsoga parviflora, Stipa sibirica* and *Viola indica* during most of the season. Their dominance during a particular season can be well correlated with the study conducted by (Kukshal et al. 2009). Moreover, high IVI value 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 reported always highest by few species during autumn than rest of the seasons. Other reason for their dominance during autumn and winter season could be as the rate of sprouting of root/seed stock is diminished and the species number declined owing to adverse climatic conditions. 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). The loss of natural associations may be the probable reason for supporting low number of species (Walker, 1992). It is to be mentioned 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. Whereas at site I only 2-3 species occupied more niche space than other species during a particular season.

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). The pattern of distribution depends both on physico-chemical natures of the environment as well as on the biological peculiarities of the organisms themselves. 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 whereas as regular distribution was reported almost negligible during most seasons.

The study conducted by Shadangi and Nath (2005) reported maximum species in contagious distribution. Ilorkar and Khatri (2003) investigated herb layer species in contagious distribution followed by random. 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 has been reported by Greig-Smith (1957); Kershaw (1973); Singh and Yadava (1974) hence compatibly favours the results achieved in the present study. However, observations indicated that contagious distribution in vegetation (as recorded for both sites) was due to multitude factors and the vegetative reproduction may not be the only reason (Kershaw, 1973; Saxena and

Singh, 1982).

## Conclusion

The study concluded that the improvement in vegetation cover is possible through regular monitoring of livestock grazing and human disturbance at site I and biotic interference at site II. Furthermore, new sites need to be explored for seasonal grazing of livestock as an alternate followed by protection for few years that certainly will allow the vegetation to regenerate which is constantly under threat due to various factors at site I. However, increasing biotic inference at site II within the national park need urgent attention and the human activities for fuel fodder collection, harvesting of medicinal herbs, burning of ground vegetation and livestock grazing requires sustainable control measures. It is also suggested that new sites within the national park must be allowed for future use so that constantly increasing pressure in the present selected site can be reduced which ultimately will be helpful in the enhancement of species diversity at this site. 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.

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