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Effect of clipping and grazing on various vegetational parameters of grassland communities of Gorakhpur, U.P.

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Abstract: Two grassland communities of Gorakhpur, one on the managed (periodically clipped) and protected site of Golf ground (site I) and the other moderately grazed, open natural site of University campus (site II) were selected and analysed for the comparison of various vegetational parameters. Out of the total 100 species, 65 were common to both sites, 9 species occurred exclusively at site I and 26 species at site II. The majority of species at both the sites were fortuitous. On managed site, only a few species showed high values of phytosociological indices while open natural and moderately grazed site showed more even distribution of values. Upper strata species like *Cassia absus, Cassia tora* and *Hyptis suaveolens* were rare in abundance at managed site while *Coccinia indica* and *Crotalaria ferugenia* were rare at natural site. The community at site I showed markedly higher dominance and the lower diversity and evenness values as compared to those at site II. A high species turnover of 8.8 indicates considerable differences between the managed and natural sites with respect to species richness and population size of key species.

Resumen: Dos comunidades de pastizal de Gorakhpur, una en el sitio manejado (podado periódicamente) y protegido de Golf Ground (sitio I) y la otra en el sitio abierto, natural y moderadamente ramoneado del campus de la Universidad (sitio II) fueron seleccionados y analizados para comparar varios parámetros vegetacionales. De las 100 especies registradas en total, 65 fueron comunes a ambos sitios, 9 estuvieron presentes exclusivamente en el sitio I y 26 especies en el sitio II. La mayoría de las especies en ambos sitios fueron casuales. En el sitio manejado, sólo una pocas especies mostraron valores altos en los índices fitosociológicos, mientras que el sitio abierto, natural y moderadamente ramoneado mostró una distribución más equitativa de los valores. Especies del estrato superior como *Cassia absus*, *Cassia tora* e *Hyptis suaveolens* tuvieron abundancias bajas en el sitio manejado, mientras que *Coccinia indica* y *Crotalaria ferugenia* fueron raras en el sitio natural. La comunidad en el sitio I mostró claramente una mayor dominancia y valores más bajos de diversidad y equitabilidad que la del sitio II. El alto recambio de especies (8.8) indica que hay diferencias considerables entre el sitio natural y el manejado respecto a la riqueza de especies y el tamaño poblacional de especies clave.

Resumo: Duas comunidades de pastagem em Gorakhpur, uma submetida a gestão (periodicamente cortada) e numa estação protegida no Campo de Golfe (Estação I) e outra moderadamente pastada, estação natural no campus da Universidade (estação II) foram seleccionadas e analisadas para comparação dos vários parâmetros vegetacionais. Do conjunto do total das 100 espécies, 65 eram comuns às duas estações, 9 espécies ocorreram exclusivamente na estação I e 26 espécies na estação II. A maioria das espécies nas duas estações eram fortuitas. Na estação gerida, só poucas espécies mostraram altos valores dos

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índices fitosociológicos enquanto a estação aberta e moderadamente pastada mostrou valores mais igualmente distribuídos. Espécies do estrato superior como a *Cassia absus*, *Cassia tora* e *Hyptis suaveolens* eram raramente abundantes nas estações sujeitas a gestão enquanto as *Coccinia indica* e a *Crotalaria ferugenia* eram raras na estação natural. A comunidade na estação I mostrou de forma marcada valores de uma elevada dominância e baixa diversidade e densidade quando em confronto com os valores da estação II. O valor de elevada rotação de espécies de 8,8 indica diferenças consideráveis entre a estação sujeita a gestão e a deixada em estado natural no que respeita a riqueza específica e dimensão da população das espécies chave.

Key words: Common, rare and exclusive species, diversity and dominance, grassland communities, moderate grazing vs. clipping, vegetational parameters.

Introduction

Various community aspects of grassland vegetation of different parts of India have been dealt with by a number of workers [grassland vegetation of Bombay (Bharucha & Dave 1944); Varanasi (Ambasht *et al.* 1972; Misra 1972; Singh 1967); Jodhpur (Gupta & Sharma 1973); and Kurukshetra (Singh & Yadava 1974)]. In spite of these efforts, the grassland communities of north-eastern U.P. largely remained under-explored except for a few studies on population interaction and productivity of selected species (Asthana 1975; Dwivedi 1978). There is no information available on the impact of disturbance on these communities. In general, the effect of disturbance on the richness and abundance of species within old-field communities have been assessed (Armesto & Pickett 1985; Cole 1995; Hulme 1996; Tilman & Pacala 1993). Liddle (1975) made a selective review of the ecological effects of human trampling on neutral ecosystems.

The present analysis, therefore, compares the quantitative characters of a natural grassland vegetation, open to moderate grazing and a managed and closed grassland community facing periodic clipping and moderate trampling. The effect of these disturbances on various vegetational parameters of the community have been analysed. The information on the impact of such disturbances on the structure and composition of grassland communities is important for assessing plant diversity status and has implications for management of regional grassland ecosystem.

Study site

The study site (25° 5' and 27° 9' N latitude, and 83° 4' and 84° 26' E longitude at 95 m above sea level) represents a typically monsoonic climate with average annual rainfall about 1814 mm (87% rainfall during monsoon period). Mean maximum temperature during wet summer (July to September), winter (October to February) and dry summer (March to June) season is 35.2 °C, 27.6 °C and 39.3 °C, and the mean minimum temperature is 26.2 °C, 12.1 °C and 24.2 °C respectively. The soil is an old gangetic alluvium. The texture is sandy loam and the soil reaction is nearly neutral.

Due to human settlement and agricultural practices, natural vegetation has been degraded to grassland vegetation which represents a state of arrested succession. The Golf ground (site I), a managed grassland, is periodically clipped and faces moderate trampling. The site is about 47 year old and covers over 22 acres area within close boundaries. The grassland (site II) at the campus of DDU Gorakhpur University, a natural old-field, is open to moderate grazing. It is over 40 year old and covers about 25 acre area.

Methods

The two grasslands, selected as representative grassland communities of north-eastern U.P., were analysed for the comparison of various phytosociological attributes on the basis of data recorded during the peak growing season (August-November). The requisite size of quadrat (20 x 20 cm) was determined through species-area-curve

method (Mueller-Dombois & Ellenberg 1974). A total of 100 quadrats were laid within each community. The occurrence and numerical strength of each species was noted carefully in each quadrat for assessment of frequency and density. The number of quadrats of occurrence of a species, expressed as percentage of the total number of quadrats sampled, was taken as frequency, and the number of individuals of a species in all quadrats, expressed as the fraction of the number of total quadrats sampled, as density of that species. The vegetal cover, however, was estimated through chart-quadrat method (Misra 1968). The outline of the crown cover was drawn to scale for which each quadrat (20 x 20 cm) was subdivided into 16 small squares each of 5 x 5 cm. The sum of area covered by the individuals of a species, expressed as the percent of ground area sampled, provided the percent vegetal cover for different species of the community. The relative value of these vegetational parameters were calculated to derive Importance Value Index (IVI) for each species (Mueller-Dombois & Ellenberg 1974).

The frequency diagrams for the communities at the two sites were compared with the Normal frequency diagram of Raunkiaer (1934). Phytograph, a device to show the IVI of a species along with its constituent indices - relative frequency (RF), relative density (RD) and relative vegetal cover (RVC), was also drawn to compare the overall phytosociological importance of the species common to both the communities. The stratification within each communities was based on percent number of species occupying different strata which were based on height classes and were represented in the form of histogram.

The exclusives (species restricted to a particular community), the top ten species having maximum share to the values of above indices and the most rare species having very low values of frequency (< 5%) and density (< 0.5 individuals m^{-2}) were grouped separately. The contribution of these groups to the sum values of different phytosociological indices like frequency, density and IVI was determined for each of the two communities. The χ^2-values were estimated on the basis of frequency of observed value (fo) and that of expected value (fe) as $\chi^2 = \Sigma(fo-fe)^2/fe$. The fe was taken as the average of values of any index at the two sites. The significance of difference was considered at 5% probability level.

The log number of individuals on Y-axis was plotted against the species sequence from most to least abundant ones on X-axis. It provided the dominance-diversity curves (Whittaker 1975) for the two sites. Species diversity index (H), however, was determined with the information function on the basis of abundance values as $H = - \Sigma (ni/N) \ln (ni/N)$. Where, H is the Shannon-Weiner information index of diversity, ni is the total number of individuals of ith species, N is the total number of individuals of all the species in the community and ln is the natural log (Magurran 1988). The Simpson's index (Simpson 1949) or the concentration of dominance (Cd), was derived as $Cd = \Sigma (ni/N)^2$. Where, ni and N are same as given above. Species evenness or equitability (E), was calculated following Pielou (1975) as $E = H/\log S$, where, S is the total number of species. ß-diversity ($H_ß$) was derived to compare the species turnover between the two communities (I and II) on the basis of formula $H_ß = Ha_{1.2} - 0.5 (Ha_1 – Ha_2)$, where a_1 and a_2 are the α-diversity of the two communities (Ramade 1984).

Results

In all, 100 species were encountered within the sampled quadrats at two sites (Table 1). Both the sites were rich in fortuitous species - frequency class A (i.e. species with low frequency), which constituted more than 85% of the total species content, showed a wide deviation from normal frequency diagram. The number of species under frequency class B, however, was comparable to normal value at site II but it was much lower at site I. Classes C & D were very poorly represented at both the sites. No species at either site was abundant enough to represent class E (Fig. 1A). The proportion of species at different strata varied between two sites. A greater proportion of species fell under lower height range at site I as compared to site II. However, the proportion of species belonging to upper stratum was comparatively

Table 1. Species composition of grassland communities at the managed site (I) and natural site (II).

Variables	Site I	Site II
Total number of species	74	91
Species common to both sites	65	
Species exclusive to either site	09	26

much higher at site II (Fig. 1B). The dominance-diversity curves for the two sites showed that most of the available niches at site I were occupied by relatively fewer species compared to site II. The pattern of the curve for site II was comparatively more convex and flattened (Fig. 1C).

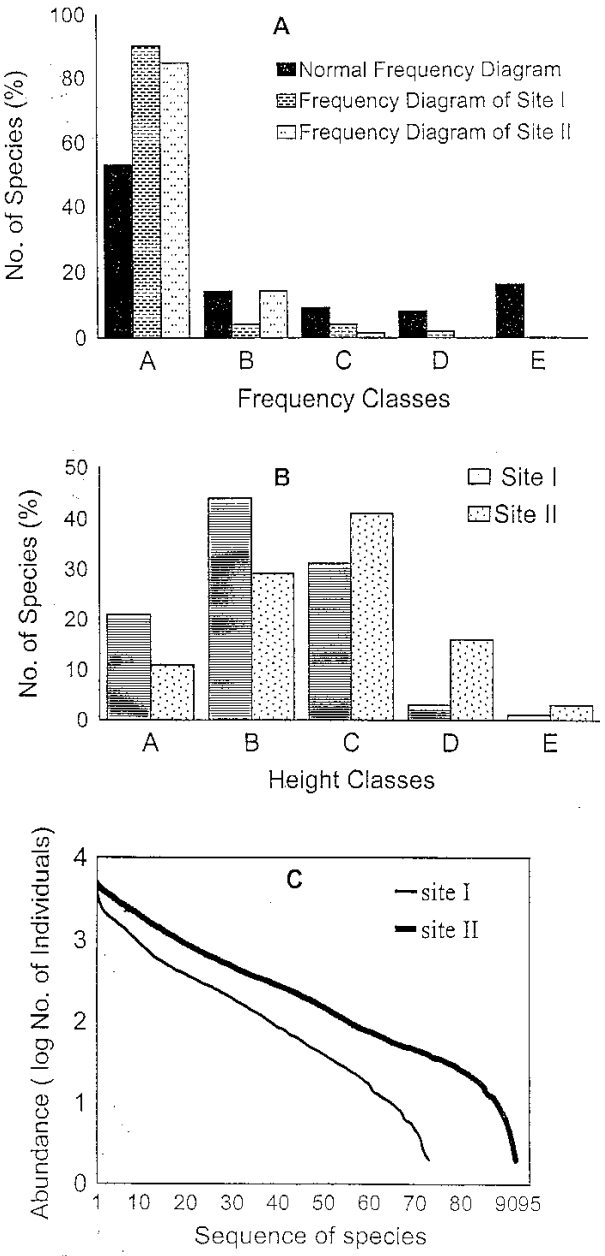

Fig. 1. (A) The comparison of frequency diagrams of sites I & site II with Raunkiaer's Normal Frequency Diagram; (B) The % number of species under different height classes (A < 5cm; B 6-10 cm; C 11-20 cm; D 21-50 cm; E >50 cm) at managed (I) and natural (II) sites, and (C) Dominance-diversity curves, exhibiting the cascade in the number of individuals of most to least abundant species at the two sites.

A scrutiny of species having higher values of frequency, density, vegetal cover and IVI shows that 25 species can be included as top ranking which assumed maximum values under different indices (Table 2). *Cynodon dactylon* had maximum importance at both the sites followed by *Rungia pectinata* at site I and *Desmodium triflorum* at site II. *Cassia tora* showed comparatively high values of different indices at site II, while *Dichanthium annulatum* did so at site I. At site I, only a few species had high values of these indices, whereas at site II, these values were more evenly distributed among other species. *Echinochloa colonum, Saccharum spontanaeum* and *Fimbristylis monostachya* showed high IVI, primarily due to their high density. The high IVI of *Setaria glauca* at site I, can be attribued to higher density and frequency values. The much greater IVI of *Alysicarpus monilifer* was primarily due to its high vegetal cover acquired through horizontal spread of leafy shoots (Table 2). As evident from the phytographs of 15 common species (Fig. 2), in general, *C. dactylon, Evolvulus nummularis, Lindernia bracheata, R. pectinata* and *D. annulatum* showed greater importance at site I but the values of IVI and the constituent indices for the latter two species were very high. On the other hand, *D. triflorum, Phyllanthus simplex* and *Corchorus aestuans* exhibited greater importance at site II primarily due to their density values. The phytographs of *S. glauca, Paspalum scorbiculatum, Boerhavia diffusa* and *Zornia gibbosa* were quite comparable at both the sites.

Table 3 compares the level of difference in the IVI and relative density of species between the two sites. IVI of *C. tora* and *F. monostachya* was significantly greater at site II ($p < 0.01$)) while that of *R. pectinata* was so at site I. Further, the relative density of *C. tora, E. colonum* and *F. monostachya* was also significantly higher ($p<0.05$) at site II and that of *R. pectinata* at site I. The values of above two indices for the species of *Aeschenomene indica, L. bracheata* and *Launea asplenifolia* showed marked differences between the two sites. Table 4 shows the total number of species, IVI, vegetal cover and the density and frequency of exclusive species at the two sites.

Table 2. The top ten species with respect to IVI, vegetal cover (VC,%), density (individuals per quadrat) and/or frequency (%) at the two sites.

Name of species	IVI		VC		Density		Frequency	
	Site I	II	I	II	I	II	I	II
Cynodon dactylon (Linn.) Pers.	59.2	30.0	14.4	6.0	14.2	4.0	54.0	42.0
Rungia pectinata (Linn.) Nees.	27.7	--	8.6	--	4.4	--	48.0	--
Desmodium triflorum (Linn.) Dc.	18.7	24.0	8.6	9.0	1.4	3.2	39.0	60.0
Cassia tora Linn.	--	22.0	--	11.0	--	3.2	--	30.0
Aneilema nudiflora R. Br.	18.0	18.0	10.6	--	1.7	3.2	30.0	32.0
Dichanthium annulatum (Forsk.) Stapf.	15.6	--	6.4	--	2.3	--	18.0	--
Sida acuminata Burm.	--	16.0	7.2	12.3	--	1.7	16.0	40.0
Lindernia bracheata Linn.	13.1	--	6.5	3.4	1.6	--	--	--
Cyperus brevifolius (Rottb.) Hassk.	--	13.0	--	--	--	--	--	34.0
Evolvulus nummularis Linn.	10.9	9.5	5.6	6.0	--	--	31.0	30.0
Echinochloa colonum (Linn.) Link.	--	12.8	--	--	--	3.6	--	--
Saccharum spontaneum Linn.	8.5	--	--	--	1.4	--	--	--
Fimbristylis monostachya (Linn.) Kuntz	--	12.0	--	--	--	2.9	--	--
Cyperus compressus Linn.	8.1	--	--	--	--	--	18.0	--
Alysicarpus monolifer Dc.	--	11.2	--	5.3	--	--	--	--
Setaria glauca (Linn.) Beauv.	7.8	--	--	--	1.7	--	--	28.0
Sida rhomboidifolia Linn.	--	--	--	3.2	--	--	--	--
Euphorbia hirta Linn.	--	--	3.2	2.9	--	--	--	--
Evolvulus alsinoides Linn.	--	--	4.1	3.1	--	--	--	--
Cyperus monocephalus Rottb.	--	--	--	--	1.4	3.8	--	32.0
Eragrostis uniloides (Retz.) Nees.	--	--	--	--	--	2.1	--	--
Eragrostis tenella (Linn.) Roem & Schult.	--	--	--	--	1.4	--	--	--
Zornia gibbosa Span.	--	--	--	--	--	2.0	--	--
Paspalum scorbiculatum Linn.	--	--	--	--	--	--	20.0	30.0
Tridax procumbens Linn.	--	--	--	--	--	--	16.0	--

Exclusives were less in number (9 : 12.21%) at site I compared to at site II (26: 28.6%). Some of the important exclusives of site I and II are given in Table 4. The total number of species and their densities were significantly much greater ($p < 0.05$) at site II.

Table 3. Species showing significant differences in Importance Value Index (IVI) and Relative density (RD) between two sites based on χ^2 –values as given in the table.

Name of species	IVI		RD	
	Site I	II	I	II
**Cassia tora*	0.4	21.8	0.02	6.16
**Fimbristylis monostachya*	0.4	11.9	0.17	5.59
**Rungia pectinata*	27.7	4.3	10.69	2.12
**Echinochloa colonum*	1.4	12.8	0.17	6.93
**Eragrostis uniloides*	0.3	8.0	0.05	4.05
Alysicarpus monolifer	2.2	11.2	0.27	3.08
Cyperus monocephalus	6.1	1.5	3.32	0.50

* The χ^2-values were significant at 5% probability level

The most rare species at the two sites, identified on the basis of their relative values of frequency and density, are presented in Table 5. *Desmodium gangeticum, Leucas aspera* and *Pouzolzia indica* were the rarest species at both the sites. The relative density of rare species accounted only for 0.03%. They had a relative frequency of around 0.3%. A comparison of contribution of different group of species at the two sites shows that the top ten species accounted for >50% of the total IVI, vegetal cover and density at both the sites. The exclusive group showed much greater contribution towards the above indices at site II as compared to site I. The contribution of rare species towards the sum values of above indices at the two sites was quite comparable. The rest of the species which had major share of species richness, showed almost similar

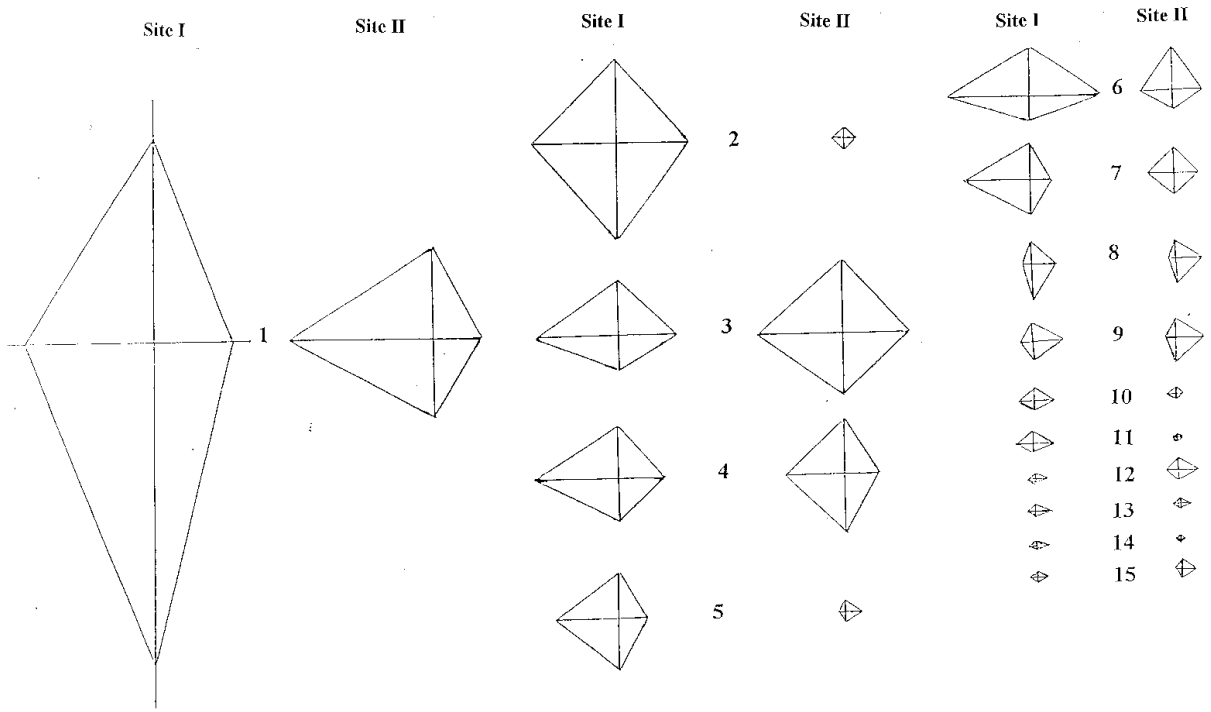

Fig. 2. Comparison of phytographs of species common to both the sites. The polygon compares the values of IVI and its constituent indices, relative frequency, relative density and relative vegetal cover of 15 species; 1. *Cynodon dactylon* 2. *Rungia pectinata* 3. *Desmodium triflorum* 4. *Aneilema nudiflora* 5. *Diachanthium annulatum* 6. *Lindernia bracheata* 7. *Evolvulus nummularis* 8. *Setaria glauca* 9. *Paspalum scorbiculatum* 10. *Eragrostis tenella* 11. *Oplismenus burmanii* 12. *Phyllanthus simplex* 13. *Boerhavia diffusa* 14. *Zornia gibbosa* 15. *Corchorus aestuans*.

contribution at both the sites (Table 6). The community at site I, however, exhibited markedly higher dominance and the lower diversity and evenness as compared to that at site II. A high species turnover of 8.8 indicates considerable differences between species richness and density of key species between two sites (Table 7).

Discussion

A total of 214 species were recorded from the grassland communities of the study sites (Tripathi 2000) which is more than 70 % of species reported in grassland vegetation of north-eastern U.P. The observation of grassland communities at the two sites exhibited maximum number of species producing seedlings and sprouts just after the first few showers of monsoon rains. Expectedly, the species richness in these communities was maximum during August-November (the sampling period). Earlier observations have indicated that the grassland community at site I, lagged behind by about a fortnight as regards to peak flowering (Tripathi 2000). Relatively higher number of species at site II can be attributed to moderate grazing. Grazing may develop mutualism between the grazers and grazed species and the animal saliva and dung may also promote the growth of some species. Herbivory may prevent competitive exclusion by suppressing the dominance and by preventing dead biomass accumulation (Gough & Grace 1998). On the other hand, the number of species in the managed or recurrently clipped community of site I is likely to be low as periodic clipping and trampling render the conditions inhospitable for most of the species of upper strata. A major share of species falling under frequency class A indicates considerable floristic heterogeneity resulting from a large number of fortuitous species. Since these grasslands were subject to frequent small-scale stochastic disturbances, a number of new entrants could grow their propagules irrespective of their vitality level to the community. At finer spatial scale, the

Table 4. Contribution to IVI, vegetal cover (VC %), density (per quadrat) and frequency (%) for communities at the two sites by exclusive species (the χ^2-values were calculated on the basis of per cent values for different indices given in parentheses).

Attributes	Site I	Site II	χ^2-value
No. of species	9 (12.2)	26 (28.6)	8.80*
IVI	10.8 (3.6)	30.2 (10.1)	2.99
% VC	3.6 (3.2)	11.9 10.0)	3.40
Density	0.5 (1.3)	4.5 (8.6)	5.30*
% Frequency	41.9 (6.4)	13.0 (13.3)	2.40

* The χ^2-values were significant at 5% probability level.

Important Exclusives:	
Andrographis paniculata (Burm.f.) Wall.	*Alysicarpus bupleurifolius* (Linn.) Dc.
Centella asiatica (Linn.) Urban.	*Anisomeles indica* ((Linn.) Ktze.
Martynia annua Linn.	*Acalypha indica* Linn.
Perotis indica (Linn.) Ktze.	*Coccinia indica* Wt. & Arn.
Convolvulus microphyllus Sieb.	*Tephrosia purpurea* (Linn.) Pers.

dense crown cover of tall erect species like *Hyptis suaveolens* and *Parthenium hysterophorous* suppressed the subordinate species at site II. Since these tall species were unpalatable and faced no clipping and little trampling, they showed local dominance. Such dominance is known to promote simplification of the community (Armesto & Pickett 1985). The degree and type of disturbance which were quite random at this site, however, resulted into a number of patches with diverse species composition and, therefore, greater species richness. On the contrary, almost uniform and periodic clipping inhibited the establishment of most of the upper strata species and promoted dominance of only a few species of prostrate habit at site I.

Table 5. Most rare species at site I, at site II and at both the sites on the basis of lowest values of relative frequency (< 0.3) and relative density (< 0.03).

Site I
Aeschynomene indica
Cassia absus
Cassia tora
Chrysanthellum indicum
Commelina benghalensis
Eclipta prostrata
Hyptis suaveolens
Physalis minima
Ruellia prostrata
Site II
Abutilon indicum
Calotropis procera
Coccinia indica
Crotalaria ferugenia
Gynandropsis gynandra
Launea asplenifolia
Nicotiana plumbaginifolia
Sida ovata
Tiliacora acuminata
Species rare at both the sites
Desmodium gangeticum
Leucas aspera
Pouzolzia indica

The resource sharing and occupancy of niche spaces are frequently expressed by dominance-diversity curves (Whittaker 1975). As evident from these curves, fewer species pre-empted most of the niches at site I as compared to site II. The conditions like moderate grazing, and the least clipping and trampling at site II allowed relatively

Table 6. Percent contribution of rare species, exclusive species, top ten species and other species to community total for IVI, vegetal cover (VC%), density (per quadrat) and frequency indices at both the sites.

Attributes →	IVI		%VC		Density		Frequency	
% contribution of	Site I	II	I	II	I	II	I	II
Rare species	1.7	1.5	2.3	1.7	0.3	0.5	2.7	2.4
Exclusive species	3.6	10.6	3.2	10.0	1.3	8.6	6.4	13.3
Top ten species	62.5	57.2	68.0	52.9	76.2	57.2	44.2	36.6
Other species	32.1	30.7	26.5	35.3	22.2	33.8	46.7	47.9
Whole community	300	300	110.6	118.5	40.8	52.0	657	978

Table 7. Values of indices of dominance (Cd), species diversity (H), evenness (E) and β-diversity (H_β) of the two grassland communities.

Parameters	Site I	Site II
H	3.1	3.8
Cd	0.15	0.05
E	0.7	0.8
H_β	8.79	

greater number of species to share community resources, thus reducing the degree of dominance at community level, as evident from the less steeper and more flattened curve (Raizada *et al.* 1998) at that site. Disturbance had positive effects on frequency and density values of some species and negative effect on others as reported earlier by some workers (Sundriyal *et al.* 1987). Further, disturbances caused by herbivores may reduce the effect of competition (Grace & Jutila 1999). *C. dactylon* was more frequent and had high dominance at site I. It escaped any disturbance caused by clipping and faced no grazing. Its ramet-based prostrate growth habit exploited the easily available horizontal spaces created by disturbance at this site and thus had greater numerical strength. *D. triflorum* has been reported to occur most frequently within low disturbance zone (Dwivedi 1978). This was further strengthened by this study. The species occurred more frequently at site II. The much higher vegetal cover and dominance of species like *Cynodon dactylon, Rungia pectinata, Evolvulus nummularis* and *Dichanthium annulatum* at site I may be related to their characteristic growth pattern showing profuse sprouting and flowering even at highly disturbed spots. They behaved as stress-tolerant category of Grime (1979). On the other hand, species like *Desmodium triflorum, Phyllanthus simplex* and *Corchorus aestuans* had much greater dominance at site II. Despite general similarity in edaphic and climatic conditions, the species of *Cassia tora, Alysicarpus, Fimbristylis, Eragrostis* and *Echinocloa* showed significantly higher IVI and relative density at sites II while *Rungia pectinata* and *Cyperus monocephalus* did so at site I. The difference in these values may be attributed to the type and level of disturbance at the two sites.

The extent of the occurrence of exclusive species may also be related to the nature of disturbance and available resources at the two sites. Several exclusive species of site II like *Acalypha indica, Tephrosia pupurea* and *Anisomeles indica* had erect habit and distinct crown, least preferred by grazing animals and also faced no clipping. On the other hand, the much fewer number of exclusives at site I was probably due to the availability of lesser niches. Upper strata species like *Cassia absus, Cassia tora* and *Hyptis suaveolens* at site I and *Coccinia indica* and *Crotalaria ferugenia* at site II were the rarest species. These species seemed to be recent immigrants. *Desmodium gangeticum* (shade-tolerant) and *Pouzolzia indica* (moisture-loving) were rare at both the sites probably due to their habitat specificity. Similarly, *Leucas aspera* was also very rare. Its population density, in this region, has fast declined during the last few years indicating its specialist nature (Tripathi 2000). In the context of IVI *Polygala chinensis* and *Dactyloctenium aegypticum* were among the rarest ones. Hubbell & Foster (1986) found that most rare species are specialists either in habitat or in regeneration niche.

The pattern of diversity change has often been related to the degree of disturbance in non-equilibrium ecosystems (McNaughton 1983; Whittaker 1975). As evident from the observations, disturbances in the form of moderate grazing increased the species diversity and evenness at site II. This pattern has also been observed by Reddy (1998). It is reported that such low level of disturbance may reduce the competitive ability of dominant species and promote inferior competitors (Pacala & Crawley 1992; Tilman & Pacala 1993). On the other-hand, a more severe disturbance in the form of periodic clipping at site I caused greater dominance and low diversity, and the species of prostrate habit dominated the site. It was further evident by high species turnover (ß-diversity) between the two sites indicating significant difference in composition and structure between the two communities. The moderate disturbance not only enhanced species diversity but also improved the composition of grassland by preventing the dominance of only a few species.

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