PLANT FORMS AND SEASONALITY OF LEAVES IN HERB LAYERS OF SITES WITH VARYING LEVELS OF DEFORESTATION

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JOSHI, M., SINGH, S.P. & RAWAT, Y.S.1994. Plant forms and seasonality of leaves in herb layers of sites with varying levels of deforestation. The present study highlights the changes in species composition, life form, growth form and leaf phenology of herb layers in response to change in extent of tree cover, and associated variations in edaphic conditions between 1600- 2000*m* elevation in Central Himalaya. The flora was phanerophytic in forested site, therophytic in partly deforested site and hemigeophytic in the deforested site. Forbs were the dominant growth forms of the forested site, while in partly deforested and deforested sites grasses and sedges in combination with short forbs and tall forbs respectively predominated. The observations on leaf phenology indicated that of the total 44 herb species 68% initiated growth during the rainy season and the rest during the summer season. The periods of photosynthetic activity were longer for summer-initiated species than for the rainy season initiated species.

Key words: Deforestation - gradient - growth form - leaf deployment - life form

JOSHI, M., SINGH, S.P. & RAWAT, Y. S.1994. Bentuk tumbuhan dan musim daun pada stratum herba di tapak kawasan yang mempunyai tahap pembasmian hutan yang berbeza. Kajian semasa ini menonjolkan perubahan komposisi spesies, bentuk hidupan, bentuk tumbesaran dan fenologi daun pada stratum herba, sebagai respons terhadap perubahan dalam takat kawasan yang diliputi pokok serta perubahan-perubahan yang berkaitan pada keadaan edafik antara ketinggian 1600-2000*m* di Himalaya Tengah. Flora di tapak kawasan yang berhutan bersifat fanerofitik manakala flora di kawasan yang sebahagian hutannya telah bersifat terofitik dibasmi. Flora di tapak kawasan yang hutannya telah dibasmi bersifat hemigeofitik. Herba daun lebar merupakan bentuk tumbuhan yang dominan di tapak kawasan yang berhutan manakala tapak kawasan yang sebahagian hutannya dibasmi lebih banyak diliputi rumput. Tapak kawasan yang hutannya telah dibasmi pula lebih banyak diliputi rusiga serta herba daun lebar yang pendek dan panjang. Daripada sejumlah 44 spesies herba yang dikaji, 68% didapati mula tumbuh semasa musim hujan manakala bakinya pula mula tumbuh semasa musim panas. Penemuan ini berdasarkan pemerhatian pada fenologi daun. Tempoh aktiviti fotosintetik untuk spesies yang mula tumbuh pada musim panas lebih panjang daripada tempoh fotosintetik bagi spesies yang mula tumbuh pada musim hujan.

Introduction

The elevation belt of 1200-2400*m* in Central Himalaya roughly corresponds with the oak (mainly *Quercus leucotrichophora*)- pine (*Pinus roxburghii*) forest zone. This is also the belt where most of the human settlements occur. Because of close relationship between forests and subsistence economy (Singh & Singh 1991), these forests have been severely degraded. There is a gradient of increasing deforestation with proximity to villages in this region (Singh & Singh 1991). Such gradient provides an opportunity to examine the pattern of change in herb layer species composition, growth form and leaf phenology in response to changes in extent of tree cover, and associated variations in soil properties (*e.g.*, nutrients, moisture storage). We hypothesise that the changes in environment due to deforestation and grazing will not only have modified species and growth form composition, but also the strategies of the species with respect to seasonal patterns of leaf deployment.

While analysing plant adaptations, we kept in view that natural selection should favour plants whose form and physiology tend to maximise the net production, because such plants often have the most resources with which to reproduce and compete for additional space (Horn 1971, Orians & Solbrig 1977, Givnish 1986).

This study was undertaken with the objective to examine the changes in plant form composition and pattern of leaf deployment in herb layer species in response to changes in the levels of deforestation, and associated variations in the edaptic conditions.

Study sites

The study was conducted at Nainital, which is located from 29°7' to 29°26' N and from 79°15' to 79°38' E at an elevation of 1600-2000*m* in Central Himalaya.

Three adjacent sites with different degrees of deforestation were selected within the banj oak (*Quercus leucotrichophora*) belt *viz.*, forested (banj oak forest), partly deforested (banj oak-chir pine, *Pinus roxburghii* forest) and deforested (open grassland with a few scattered trees of the original banj oak forest) sites. The total tree basal area, sectional area of stems at breast height of the forested site (53 m^2 ha^{-1}) was comparable with that of the other similar forests of the region (Singh & Singh 1987). The total tree basal area at the partly deforested site was 30 m^2 ha^{-1}. In addition to the lower basal area, the branches of most oak trees had been cut by local people for fire wood and tree fodder.

Climate

A meteorological station is located at an elevation of 2000*m* near the study area. Of the 2488 *mm* annual rainfall, more than 75% occurs during the later part of the summer, from mid-June to mid-September. The mean monthly maximum temperature varies from 12.1°*C* (January) to 27.4°*C* (May) and the mean monthly minimum from 3.5°*C* (January) to 16.9°*C* (June). Depending on climatic variations,

the year is divisible into: (1) a dry and warm summer season (March to mid-June), (2) a wet and warm rainy season (mid-June to mid-September), and (3) a dry and cold winter season (mid-September to February). Details of the climate are given in Joshi *et al.* (1991).

The rocks present in the study area are commonly black carbonaceous and pyritous, locally oxidized to an ash-grey colour, with characteristic oxidation rings on primary planes. Light green and grey banded slates intercalated with layers of silt stone is another typical element of the lithology (Valdiya 1980).

The soil is residual and dominated by sand particles (57 to 76%). The pH is in the acidic range (5.8 to 6.3). The total N (in 0-30 *cm* depth) ranges from 0.16 to 0.28% and organic C from 2.0 to 4.3%, the highest being in forested site and lowest in deforested site. Soil moisture (16 to 25%) and water holding capacity (40 to 54%) decrease from forested site to deforested site, while bulk density (0.89 to 1.21 $g\ cm^{-3}$) shows a reverse pattern (Table 1).

Materials and methods

Since our objective was to examine the pattern of change in herb layer growth form composition and leaf phenology in response to changes in extent of tree cover and associated variations in edaphic conditions, no attention was given to designing models of spatial interspersion and segregation (such as completely randomized, randomized block and systematic design types). This approach is subject to the problem of 'simple pseudoreplication' (Hurlbert 1984). However, the lack of replication in this case (replication of plots within each community) was unavoidable, given the objective of the study. According to Hurlbert (1984) replication is often impossible or undesirable and, in a situation like this, studies involving unreplicated treatments may also be the only or best option.

After a thorough reconnaissance of the study area a total of 44 herb species were observed during 1988-1990 for phenological characters. Observations were made at 3 to 4 - day intervals during the early growing season (March to August) and at 10 to 14 - day intervals later in the growing season (September to February) when plants had matured and changes were slow. When green tissues became first visible as a result of sprouting of propagules and germination of seeds in a species, growth was considered to have initiated in that species. The onset of senescence was recognizable due to rather abrupt change in colour of leaves which precede the death of shoots.

Trees were sampled using 10 by 10 *m* quadrats, shrubs with 5 by 5 *m* quadrats and herbs with 1 by 1 *m* quadrats. The quadrats were placed randomly in each of the three sites, The various species encountered were categorized into life forms (Raunkiaer 1934), growth forms and seasonal pattern of leaf deployment following the characteristics given in Table 2 and Table 3.

Soil samples were collected in triplicate from 0-30 *cm* soil depth at the end of rainy season (last week of August). Soil texture, bulk density, water holding capacity and porosity were determined according to Misra (1968). The pH of the soil was determined by a digital pH-meter (in distilled H_2O), total nitrogen by the micro

Table 1. Soil, moisture and C/N characteristics (± 1 SE) of the study sites

Site	Total basal area ($m^2\ ha^{-1}$)	Texture (%)			Bulk density ($g\ cm^{-3}$)	Porosity (%)	Water holding capacity (%)	Soil moisture (%)	Total N (%)	Organic C (%)	C : N ratio
		Sand	Silt	Clay							
Forested site	54	57 ± 4.1	28 ± 2.0	15 ± 0.9	0.89 ± 0.03	66 ± 4.3	54 ± 3.8	25 ± 2.3	0.28 ± 0.09	4.29 ± 0.87	15.3
Partly deforested site	30	66 ± 2.6	22 ± 1.2	12 ± 0.8	1.02 ± 0.04	61 ± 2.9	46 ± 2.7	20 ± 2.5	0.19 ±0.04	2.72 ±0.46	14.3
Deforested site	-	76 ± 4.8	14 ± 0.7	10 ± 0.6	1.21 ± 0.02	54 ± 2.0	40 ± 1.8	16 ± 2.3	0.16 ± 0.03	1.99 ±0.45	12.4

Kjeldal technique (Peach & Tracey 1956); and organic carbon as given in Piper (1944).

Chi-square (χ^2) contingency table analyses was used to simultaneously examine relationships between levels of deforestation, growth form, and leaf deployment categories.

Table 2. Life form and growth form characteristics

Plant forms	Plant characteristics
Life forms	
Phanerophytes	Woody plants, having perennating buds on the twigs/branches.
Chamaephytes	Perennating buds are found above the soil surface and the buds are protected by dead leaves and snow.
Hemi-geophytes	The perennating buds are found at or near the soil surface and protected by soil and dead leaves.
Geophytes	The perennating buds are found below the surface of soil on a rhizome or tuber or bulb.
Therophytes	Annual plants which survive under unfavourable conditions in the form of seeds.
Growth forms	
Trees	Ligneous plants more than 3 *m* in height
Shrubs	Plants with woody stems, branching from the base, and less than 3 *m* in height.
Tall forbs	Herbaceous plants more than 30 *cm* in height with scattered leaves all along the erect stem.
Short forbs	Herbaceous plants equal to or less than 30 *cm* in height with leaves arranged in a short umbrella-like structure with or without arching stems.
Cushion and spreading forbs	Cushion or rossette forming and prostrate forms.
Grasses and sedges	Grass-like plants including sedges.

Table 3. Growth initiation and leaf deployment categories

Growth initiation category	Period of leaf deployment
A. Summer initiated species	(i) summer-initiated evergreen species (ii) summer-initiated species, remaining green until winter (iii) summer-initiated species, remaining green until rainy season
B. Rainy season initiated species	(i) rainy season-initiated species, remaining green until winter season. (ii) rainy season-initiated species, remaining green only during rainy season.

Results

Life forms and growth forms

In the forested site all the major groups of Raunkiaer (1934) were represented, and their proportions occurred within a limited range, from 11.8% for geophytes to 26.5% for phanerophytes (Table 4). Geophytes were absent in partly deforested site and deforested site. The two important life forms representing partly deforested and deforested sites were therophytes (34.2 and 26.7% respectively) and hemigeophytes (28.9 and 33.3% respectively) (Table 4).

Table 4. Life form spectra for the study sites (% of total species) Ph=phanerophytes; Ch=chamephytes; Hg=hemigeophytes; Ge=geophytes; Th=therophytes

Site	Ph	Ch	Hg	Ge	Th	
Forested site	26.5	23.5	17.6	11.8	20.6	Phanerophytic
Partly deforested site	18.4	18.4	28.9	0	34.2	Therophytic
Deforested site	20.0	20.0	33.3	0	26.7	Hemigeophytic
Total area	22.8	19.3	22.8	7.0	28.1	Therophytic
Raunkiaer's average spectrum	43.0	9.0	26.0	4.0	13.1	Phanerophytic

There were 34 species in the forested site, 38 in partly deforested site and 15 in deforested site (Table 5). Species categorized by growth forms in different sites are listed in Appendix 1. Fifty-seven species occurred across all three sites, 7 of which were trees, 6 shrubs, 10 tall forbs, 15 short forbs, 6 cushion and spreading forbs and 13 grasses and sedges.

Table 5. Percentage of species by growth form T=tree; SH=shrub; TF=tall forb; SF=short forb; CS=cushion and spreading forb; GS=grasses and sedges

	Number of species	T	SH	TF	SF	CS	GS
Forested site	34	11.8	14.7	23.5	32.4	8.8	8.8
Partly deforested site	38	7.9	10.5	12.2	23.7	13.2	31.6
Deforested site	15	2.0	0	26.7	20.0	6.7	26.7
Total study area	57	12.3	10.6	17.5	26.3	25.6	8.8

Among the growth forms, short forbs and tall forbs were more represented than others in the forested site and grasses and sedges and short forbs in the partly deforested site. In the deforested site, tall forbs, grasses and sedges (26.7% each) and short forbs were more or less evenly distributed (Table 5).

In each site, the species richness was markedly higher during rainy season (12 in deforested site to 31 in partly deforested site) than during winter (10-16) and summer (7-12). In the course of rainy to summer season, species in each herbaceous growth form declined, but the decline was especially high for tall forbs (from 10 to 1 species over all sites). For other growth forms the decline was similar: from 13 to 4 species in grasses and sedges, from 15 to 7 in short forbs and from 6 to 4 in cushion and spreading forbs (Table 6). Thus, species richness was least affected by seasonal change in cushion and spreading forbs.

Phenology of leaf deployment

Various categories of herbs with respect to seasonal pattern of leaf deployment are indicated in Table 7.

Sixty-eight per cent of the species initiated growth (seed germination or sprouting) during the rainy season. However, only 20% of them remained green up to the winter season, and none of them remained green up to the summer season. All the species which showed growth initiation during the summer season (32% of the total) attained maximum size during the rainy season. Within this category, 21% species remained green until the rainy season, 29% until the winter season, and 50% remained green throughout the year. In general, periods of photosynthetic activity were longer for summer-initiated species than for the rainy season initiated species.

For evergreen species, short forbs dominated in each of the sites (Table 7). The species initiating leaves during rainy season and remaining green up to the winter season were roughly evenly distributed (χ^2 - test, difference was not significant) in grasses and sedges and tall forbs, while rainy season initiated species were evenly distributed among all growth forms with the exception of cushion and spreading forbs (χ^2-test, difference was not significant). However, in relation to site, growth form distribution of these rainy season species varied considerably. Grasses and sedges, for example, which were the most important rainy season species in the partly deforested site, were conspicuously absent in the other two sites.

Phenological characteristic of growth forms

Tall forbs: Among the tall forbs, 90% (n = 9) initiated growth during the rainy season (Table 7), and 70% (n = 7) completed growth-cycle within the rainy season. Only 20% of tall forb remained green until the winter and none of them remained green until summer. The only evergreen tall forb was *Scutellaria angulosa.*

Short forbs: Of the short forbs, 53% (n = 8) initiated growth during the rainy season and all of them completed their growth cycle during the same season (Table 7). Forty-seven per cent of the short forbs initiated growth during the summer season, of which 27% were evergreen, 13% remained green until the rainy season and 7% remained green until the winter season.

Cushion and spreading forbs: Among this category, 67% (n = 4) initiated growth during the rainy season, most of which completed the growth cycle during the same

Table 6. Seasonal variation in species richness in different growth forms of herbs in the study sites

	Forested site			Partly deforested site			Deforested site			Total study area		
	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
Tall forb	1	8	3	1	5	2	1	4	2	1	10	3
Short forb	6	11	6	4	9	4	3	3	3	7	15	6
Cushion and spreading forbs	3	3	1	3	5	4	1	1	1	4	6	4
Grasses and sedges	2	3	3	3	12	6	2	4	4	4	13	7
Total herb species	12	25	13	11	31	16	7	12	10	16	44	20

Table 7. Distribution of the species of different seasonal pattern with respect to leaf deployment in different sites and growth forms (values in parenthesis are per cent of total species)
TF =tall forb; SF = short forb; CS = cushion and spreading forb;
GS = grasses and sedges

Category with respect to seasonal pattern of leaf deployment	Site												Total study area			
	Forested				Partly deforested				Deforested							
	TF	SF	CS	GS	TF	SF	CS	GS	TF	SF	CS	GS	TF	SF	CS	GS
(A) Summer-initiated species																
(i) Summer-initiated evergreen species	1 (11)	4 (40)	0	2 (67)	1 (20)	2 (22)	0	1 (8)	1 (25)	2 (67)	0	0	1 (10)	4 (27)	0	2 (15)
(ii) Summer-initiated winter green species	0	1 (10)	1 (33)	0	0	1 (11)	1 (20)	2 (17)	0	1 (33)	0	2 (50)	0	1 (7)	1 (17)	2 (15)
(iii) Summer-initiated rainy green species	0	1 (10)	1 (33)	0	0	1 (11)	1 (20)	0	0	0	0	0	0	2 (13)	1 (17)	0
(B) Rainy season-initiated species																
(iv) Rainy season initiated winter green species	2 (22)	0	0	1 (33)	1 (20)	0	1 (20)	3 (25)	1 (25)	0	0	2 (50)	2 (20)	0	1 (17)	3 (23)
(v) Rainy season species	6 (67)	4 (40)	1 (33)	0	3 (60)	5 (56)	2 (40)	6 (50)	2 (50)	0	1 (100)	0	7 (70)	8 (53)	3 (50)	6 (47)
Total number of species	9	10	3	3	5	9	5	12	4	3	1	4	10	15	6	13

season and only a few continued to bear green leaves until the winter season (Table 7). The summer- initiated species (33% of the total) were equally divided between the species which remained green until the rainy season and the species which remained green throughout the year.

Grasses and sedges: About two thirds of the grasses and sedges initiated growth during the rainy season, of which 67% (n=6) completed their growth cycle during the same season (Table 7). The rest remained green until winter season. The summer-initiated species (30% of the total) were equally divided between evergreen and those which remained green until winter. None of this category remained green until the rainy season.

Discussion

Unregulated harvest of biomass, grazing, burning, concomitant degradation of soil and changes in light and temperature regimes have brought about marked changes in the composition of the original herbaceous vegetation of the forest. From forest site through partly deforested site to deforested site, not only was the scale of disturbance increased, but the duration of disturbance was also longer (Joshi 1991). Soil-physical analyses (Table 1) show that soil texture changed markedly from forested site to deforested site. The decrease in the proportion of fine soil particles ($p < 0.01$) may be explained as an effect of eroding influence of rain water, which penetrates much faster through the open canopy. Related to that was a clear soil compaction and reduction in porosity and moisture retention capacity of soil. Modifications in soil structures and soil nutrients as described in this study are likely to occur with increasing biotic disturbance (Saxena & Singh 1980, Walker *et al.* 1981, Crawley 1983, Pandey & Singh 1991).

The life form spectrum was phanerophytic in forested site, therophytic in partly deforested site and hemigeophytic in deforested site. Saxena *et al.* (1982) also reported that phanerophytic floras were more abundant in oak forests than in the mixed forests of Kumaun Himalaya. The oak forests are characteristically more mesic (Saxena & Singh 1980), fire-free (Champion & Seth 1968) and close canopied (Saxena 1979). The therophytic nature of the flora of the partly deforested site may be attributed to heavy grazing, recurring fires, and more xeric conditions due to soil erosion and resultant loss of soil moisture storage. The open canopy, however, also permits a luxurious herbaceous growth during the rainy season. The flora of this site is comparable to that of open canopied chir-pine forest reported by Saxena *et al.* (1982). The relatively xeric habitat in an otherwise similar climate is conducive to therophytic predominance (Daubenmire 1968). The predominance of hemigeophytes in the deforested site is understandable because grasslands, in general, are rich in hemigeophytes (Braun-Blanquet 1932). Saxena *et al.* (1982) have also reported the predominance of hemigeophytes in a grassland of Kumaun Himalaya that developed subsequent to deforestation. A markedly higher proportion of therophytes in the deforested site as compared to Raunkiaer's normal spectrum of the world (27 against 13 in normal spectrum) indicates a trend toward desertification, with the loss of tree cover. Similar results

have been reported by Melkania (1988) from a mixed-Himalayan grassland. Bharucha and Dave (1944) found a grassland in Bombay area dominated by therophytes and suggested that therophytes is an indicator of anthropogenic impacts and grazing animals.

The moderate level of disturbance somewhat increased the herb species richness, but severe disturbances (deforested site) caused a drastic reduction. A pattern of species richness peaking in the middle part of gradient of disturbance is consistent with observations of Connell (1978) for tropical rain forest and coral reefs, Pandey and Singh (1991) for tropical savanna vegetation and Rikhari *et al.* (1993) for an alpine meadow.

Because of favourable conditions (wet and warm), the majority of the species occurred during rainy season, and the number of the species decreased markedly after the rainy season. Occurrence of a marked seasonality in floristic composition is a common feature of the Indian grasslands (Kumar & Joshi 1972, Singh & Yadava 1974, Singh 1991).

Of the 10 tall forbs recorded from study sites, 7 were rainy season species, and all except one occurred in the forested site. Competition for light is a selective pressure on the height where leaves are placed in the shade of undercanopy environments, especially during rainy season when herbaceous cover is greatest (Givnish 1987). Competition for light favours increased leaf height which prevents overtopping. Plants should grow taller until the likely photosynthetic advantage of being taller than an opponent is balanced by structural cost (stem for raising leaves to greater height) of decreased proportion of energy allocated to leaves (Givnish 1987). In order to minimise the structural cost to raise the leaves to a greater height, the tall forbs generally had a narrow canopy with leaves scattered over a broad vertical interval. In contrast, short forbs had a broader umbrella-like canopy with greater structural cost for raising unit of leaves to a given height. However, such plants are not especially suited to the environment of the rainy season in the forest under canopy. That may explain why short forbs were poorly represented in the forested site during rainy season, and were evenly distributed between summer and rainy seasons with respect to leaf deployment. The short forbs, by allocating a greater proportion of energy to leaves, are expected to have a greater photosynthetic gain, but only when light is not a limiting factor. Grasses and sedges in which leaves emerge right from the base and grow much in horizontal space were not well represented in the forested site. A dense overstorey discourages the growth of graminoids and encourages adaptations to low intensities, such as large leaf areas, thin cuticles, cell walls and stems, that make plants particularly susceptible to trampling damage (Cole 1987). And of the three grass species that occurred in the forested site two species retained green leaves during most of the year.

Analyses of leaf phenologies in relation to growth form revealed that short forbs were most common in the evergreen category while several growth forms were evenly represented within the rainy season annuals. The favourable conditions of the rainy season seem to provide opportunity for a wider range of growth forms to be expressed, but their distributions vary in relation to variation in forest cover.

Variation in height, manner of leaf deployment and periodicity of leafing enabled a number of species to occupy the same site, by reducing competition for vital resources (Negi *et al.* 1992). These findings indicated a close relationship between plant form and height of leaf deployment and the environment they occupied spatially and temporally.

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Appendix 1. Species composition of study sites

Growth form/species	Forested site	Partly deforested site	Deforested site
Trees			
Acer oblongum	+	-	-
Aesculus indica	+	-	-
Cupressus torulosa	-	-	+
Myrica esculenta	-	+	-
Pinus roxburghii	-	+	+
Quercus leucotrichophora	+	+	+
Rhododendron arboreum	+	-	-
Total	4	3	3
Shrubs			
Berberis asiatica	+	+	-
Daphne cannabina	+	-	-
Lantana camara	-	+	-
Myrsine africana	+	-	-
Randia tetrasperma	+	+	-
Rubus ellipticus	+	+	-
Total	5	4	0
Tall forbs			
Arisaema tortuosum	+	-	-
Bidens biternata	+	+	-
Craniotome furcata	+	+	+
Gnaphalium hypoleucum	+	+	+
Goldfusia dalhousiana	+	-	-
Hedychium spicatum	+	-	-
Paris polyphylla	+	-	-
Scutellaria angulosa	+	+	+
Siegesbeckia chinensis	-	+	-
Swertia cardata	-	-	+
Total	8	5	4
Short forbs			
Cyanotis vega	+	+	-
Dicliptera roxburghiana	+	+	+
Dipsacus mitis	+	-	-
Erigeron bonariensis	+	-	-
Galium aparine	+	-	-
Impatiens scabrida	+	+	-
Micromeria biflora	+	+	+
Nepeta leucophylla	-	+	-
Oldenlandia diffusa	+	-	-
Pedicularis pectinata	-	+	-
Polygonum nepalense	+	+	-
Reinwardtia indica	+	-	+
Roscoea procera	+	-	-
Rumex hastatus	-	+	-
Teucrium royleanum	-	+	-
Total	11	9	3

Appendix 1 - continued

Cushion and spreading forbs			
Circium argyracanthus	+	+	-
Fragaria vesca	+	-	-
Oxalis corniculata	-	+	+
Parietaria debilis	+	+	-
Polygonum capitatum	-	+	-
Trollis japonica	-	+	-
Total	3	5	1
Grasses and sedges			
Apluda mutica	-	+	-
Arthraxon lanceolatus	-	+	+
Arundinella nepalensis	+	+	+
Carex cruciata	+	+	-
Chrysopogon serrulatus	-	+	+
Cymbopogon distans	-	+	+
Cynodon dactylon	-	+	-
Cyperus compressus	-	+	-
Dicanthium annulatum	-	+	-
Fimbristylis dichotoma	-	+	-
Imperata cylindrica	-	+	-
Mondo intermedium	+	-	-
Setaria glauca	-	+	-
Total	3	12	4

(+) = present, (-) = absent .