VEGETATION STRUCTURE AND SPECIES DIVERSITY OF THE HERBACEOUS LAYER IN DIFFERENT PHYTOSOCIOLOGICAL HABITATS OF DAUDZAI, PESHAWAR.

Tahseen Ullah, Zahir Muhammad, Rehman Ullah, Ghulam Jelani, Mujeeb Ur Rahman, Abdul Majeed, Hazrat Ali and Khushbu Zaman

1. Department of Botany, University of Peshawar, Peshawar, KP, Pakistan.
2. Department of Botany, Govt. Degree College Pabbi, Nowshera, KP, Pakistan.

Abstract

A phytosociological survey was carried out in the herbaceous layer of Daudzai, Peshawar during 2018-2019. A total of 12 herbaceous communities (six communities in each season) were established in six different phytosociological habitats of the area. A total of 156 herb species belonging to 42 families were recorded in spring communities while a total of 151 herb species belonging to 50 families were recorded in summer communities. TIVs for each species and TFIVs for each family were calculated for the whole communities in a season. The quantitative biological spectrum showed that therophytes and microphylls were dominated in the area. Different diversity indices (Simpson's index, Shannon's index, Species richness, maturity and evenness) were calculated for all the communities. Sorenson's similarity index showed that edaphic characteristics of the area were responsible for the similarity and dissimilarity among various herbaceous communities. Over grazing and habitat loss in the area also greatly affect the vegetation structures of the area.

Keys: Spring herbaceous vegetation Daudzai, Peshawar.

Introduction

The present research area, Daudzai is located in district Peshawar. Daudzai occupies the north east portion of district Peshawar. The area is extended from 34° 02 to 34° 11' north latitude and 71° 27" to 71° 42" east longitude. The area is green and diverse due to the plenty of water supply through river Kabul and its tributaries. Vegetational studies are mainly concerned with the classification, characteristics, relationship and distribution of plant communities and attempts to describe the species diversity in plant communities (Iqbal *et al*., 2018). Vegetation is the physiognomic unit whose structure can be clearly differentiated from other such unit (Hussain and Illahi, 1991). The study of plant communities is the best way to learn about habit, habitat, niche, and vegetation structure (Amjad *et al.,* 2013). The description of the relationship between the existing plant communities with habitat conditions and the classification of the plant communities of an area is called phytosociology (Odum, 1971). The vegetation of an area is the reflection of its climate, soil, biodiversity and anthropogenic activities and natural resources (Ilyas *et al.,* 2015). Vegetation is an ecological quantification of plant resources (Ali *et al*., 2019). The presence and the establishment of the communities reveal the plant type and surrounding condition under which they developed (Hussain *et al.,* 2019). The vegetation structure, species composition, diversity, species richness and maturity values were the important ecological characteristics that were highly influenced by the environmental variables and anthropogenic activities (Akhlaq *et al.,* 2018; Shaheen *et al.,* 2011). Vegetation is the expression of the environment in a specific habitat at a specific time and hence needs to be properly studied in a relation. The health of any ecosystem is dependent on plant biodiversity and thus the vegetation classification is a prerequisite for ecosystem management and biodiversity conservation (Zoq-ul-Arfeen *et al.,* 2015). It is useful to collect such data to describe the population dynamics of each species and how they relate to other species in the same community as well as various interactions among the plants in an ecosystem (Khan *et al.,* 2012). Abiotic variations are well known characteristic both in space and time which effect plant communities and population. The plant communities

highlight changes in response to various factors not only related to its zone of origin but also to its ecology. The most simply interpretable sign of biological variation is species richness which is highlight by different environmental characters (Ilyas *et al*., 2015).

Material and Methods

Six stands were selected in the research area based on the habitat conditions and species composition. Quadrat method was used to analyse the herbaceous vegetation. $1m^2$ quadrat was used. Plants were identified with the help of available literature (Nasir & Ali, 1970-1989, Ali & Nasir, 1989-1991, Ali & Qaisar, 1993-2018). Density, Relative Density, Cover, Relative Cover, Frequency and Relative frequency was calculated by adopting the method used by Zeb *et al*., 2016 and Badshah *et al.,* 2013. Similarity index was calculated following Sorensen's index (Sorensen, 1948). Species diversity was calculated following Simpson's index of diversity (Simpson, 1949). Species richness and maturity index of the community was calculated following Menhinick, 1964 and Pichi-Sermolli (1948) methods. Soil was collected from each site at a depth of 15 cm. After that 500 gram soil were placed in polythene bags and labelled. At first the soil moisture contents were find out from each sample. And after that the physiochemical properties were assessed in the soil science laboratory of Agriculture Research Institute Tarnab, Peshawar. Soil texture were measured with hydrometer (Koehler *et al.* 1984), pH was measured with the help of pH meter, for the measurement of lime contents acid neutralization method was used (Thomas 1982), for the measurement of soil organic matter standardized solution of $FeSO_4$ and $K_2Cr_2O_7$ were used (Nelson *et al.*, 1996), N, P, K were determined by the method described by (Soltanpour, 1991).

Vegetation structure of the herbaceous plant communities of Daudzai, Peshawar.

Spring herbaceous communities

1. *Euphorbia-Cirsium-Cynodon* (ECC) community

This community was established in the fallow lands. Fallow lands include the places which are not cultivated i.e. barren land, roadsides, field edges etc. The dominant species of this community were *Euphorbia helioscopia* with the IV value (31.41) followed by *Cirsium arvense* (28.11 IV) and *Cynodon dactylon* had the IV value of 23.89. Other co-dominant member of this community are *Melilotus indica, Ranunculus muricatus* and *Anagallis arvensis* which contributed the IV of 19.91, 13.07 and 12.81 respectively. *Coronopus didymus, Cannabis sativa, Stelleria media, Poa annua* and *Polypogon monspeliensis* were the next dominant members of this community with IV value of 9.38, 9.02, 8.31, 8.25 and 8.01 respectively. The remaining members of this community contributed less than the IV of 8. The remaining 58 members shared the TIV of 127.77 (Appendix:1). FIV results of this communities showed that Poaceae had highest FIV of (82.15) followed by Asteraceae (FIV 45.06) and Euphorbiaceae (FIV 31.97) (Appendix:3). Quantitative leaf size spectrum showed that nanophylls (IV 164.63) were dominated followed by microphylls (IV 114.73). While quantitative life form spectrum showed that therophytes (IV 265.3) were dominating followed by hemicryptophytes (IV 30.77) (Appendix:5).

2. *Taraxacum- Euphorbia- Hordium* (TEH) community.

This community was established in the protected area of Daudzai in spring. The dominant members of this community were *Taraxacum officinale* which contributed the IV of 38.77, *Euphorbia helioscopia* (IV 35.73) and *Hordium murinum* (IV 15.57). after these next important members of this community were *Phalaris minor, Stelleria media* and *Chenopodium murale* with the IV of 14.18, 9.62 and 9.04. the remaining 54 members have less IV than 9 and they have a TIV of 177.07 (Appendix:1). A total of 22 families were recorded in this community among which Poaceae (FIV 70.84), Asteraceae (FIV 65.63) and Euphorbiaceae (FIV 37.61) were the leading families (Appendix:3). The quantitative leaf size spectrum of TEH shows that microphylls (IV 166.4) were dominant followed by nanophylls (IV 129.64). And the quantitative life form spectrum showed that therophytes (IV 285.74) were dominant followed by hemicryptophytes (IV 9.06) (Appendix:5).

3. *Veronica-Polypogon- Ranunculus* (VPR) community

This community was established in the riparian zone of the river Kabul and its tributaries in spring. *Veronica beccabunga* (IV 27.44), *Polypogon monspeliensis* (IV 20.13) and *Ranunculus sceleratus* (IV 19.97) were the dominant members of this community. The co-dominant species of this community were *Potentilla supina* (16.29), *Eclipta prostrata* (12.59), *Malcolmia cabulica (*11.81*), Medicago minima* (11.62) and *Juncus articulates* (11.20). The remaining 45 members have less than 11 IV. They have a TIV of 168.91 (Appendix:1). Species of this community were distributed in 21 families. The leading families were Poaceae (FIV 48), Asteraceae (FIV 46.98) and Plantaginaceae (FIV 43.97) (Appendix:3). VPR community quantitative leaf size spectrum showed that nanophylls (IV 133.32) were dominant followed by microphylls (IV 131.76). The quantitative life form spectrum showed that therophytes (IV 230.6) were dominant followed by chemaephytes (IV 33.97) (Appendix:5).

4. *Pimpinella-Cirsium-Ampelopteris* (PCA) community.

This herbaceous community was established on the stream beds of Daudzai. Stream beds includes all the irrigation canal system. In this community *Pimpinella diversifolia* (IV= 22.55), *Cirsium arvense* (IV= 19.83) and *Ampelopteris prolifera* (IV= 19.26) were the dominant species. The co-dominant species of this community includes *Carex acutiformis* (15.56 IV), *Persicaria glabra* (14.33 IV), *Euphorbia helioscopia* (11.94 IV), *Equisetum arvense* (11.74 IV) and *Alternanthera philoxeroides* (9.05 IV). The remaining 70 members IV have less than 9. There TIV was 175.69 (Appendix:1). A total of 33 families were recorded in this plant community in which Poaceae (FIV 39.25), Asteraceae (FIV 37.38) and Apiaceae (FIV 30.6) were the first three dominant families (Appendix:3). Quantitative leaf size spectrum showed that microphylls (IV 193.02) were dominant in PCA community followed by nanophylls (IV 82.12). While quantitative life form spectrum showed that therophytes (IV 159.39) were dominant followed by chemaephytes (IV 71.18) (Appendix:5).

5. *Impereta-Launea-Cynodon* (ILC) community

This community was established in the eyots present in the river Kabul at Daudzai in spring. *Impereta cylindrica* was the most dominant and frequent member of this community having an IV of 81.71. *Launea procumbens* (IV 23.65) and *Cynodon dactylon* (IV 23.26) were the second and third dominant member of this community. Other important members of this community were *Lotus corniculatus* (IV 19.96), *Medicago lupulina* (IV 14.89), *Centaurium pulchellum* (IV 14.61), *Trigonella monantha* (IV 11.36) and *Zeuxine strateumatica* (IV 10.40). The remaining 30 species have 100.13 TIV (Appendix:1). Heavy grazing was noticed in this community. 19 families were recorded in which Poaceae (FIV 125.7), Papilionaceae (FIV 56.55) and Asteraceae (FIV 38.18) were the dominant families (Appendix:3). Quantitative leaf size spectrum showed that microphylls (IV 150.64) were dominated followed by nanophylls (IV 137.63). Quantitative life form spectrum showed that therophytes (IV 123.82) were dominant followed by chemaephytes (IV 83.56) and hemicryptophytes (IV 76.33) (Appendix:5).

6. *Bolboschoenus-Veronica-Carex* (BVC) community

This community exists in the wetlands at Daudzai. The most prominent and frequent species of this community was *Bolboschoenus affinis* with the highest IV of 80. *Veronica anagallis-aquatica* and *Carex acutiformis* were the second and third dominant species of this plant community with an IV of 25.18 and 22.65 respectively. Other co-dominant members of this plant community were *Alternanthera philoxeroides* (19.57), *Polypogon monspeliensis* (19.07), *Alopecurus myosuroides* (16.95), *Persicaria glabra* (10.99) and *Centaurium pulchellum* (10.12). the remaining 23 species have collectively 95.45 TIV (Appendix:1). Other species of this plant community have less than 10 IV. A total of 15 families were recorded in which Cyperaceae (FIV 102.7), Poaceae (FIV 63.88) and Polygonaceae (FIV 27.55) were the dominant families (Appendix:3). Quantitative leaf size spectrum showed that microphylls (IV 247.8) were dominating followed by nanophylls (IV 37.17). While the quantitative life form spectrum showed that therophytes (IV 149.27) were dominant followed by geophytes (IV 85.06) (Appendix:5).

Summer herbaceous communities

1. *Parthenium- Cynodon- Brachiaria* (PCB) community.

This community were present in the fallow lands of daudzai during summer. The dominant species of this community were *Parthenium hysterophorus* which have an IV of 29.54, the second dominant member is *Cynodon dactylon* having IV of 29.36 and the third dominant member is *Brachiaria reptans* with the IV value of 15.50. Other co-dominant species are *Achyranthus aspera*, *Cyperus rotundus* (IV 14.20 each), *Digitaria sanguinalis* (IV 13.77), and *Trianthema portulacastrum* (13.063). The remaining 66 species have less than IV 13. The TIV of these remaining species are 170.34 (Appendix:2). A total of 26 families we recorded in the area. Poaceae (FIV 109.85) was the leading family followed by Asteraceae (FIV 52.13) and Amaranthaceae (FIV 28.55) (Appendix:4). Quantitative leaf size spectra showed that microphylls were dominant in this community having the IV of 230.85 followed by nanophylls with the IV of 43.58. The quantitative life form spectrum showed that therophytes were dominant in this community having the IV of 218.79 followed by hemicryptophytes with the IV of 43.14 (Appendix:6).

2. *Desmostachya- Achyranthus- Cynodon* (DAC) community

In the protected areas (graveyards) of Daudzai during summer the most dominant species was *Desmostachya bippinata* which contributed an IV of 65.85 among the herbaceous layer during summer. The second dominant species is *Achyranthus aspera* (29.35) and the third dominant species is *Cynodon dactylon* (26.25). Other important species of this community includes *Eragrostis papposa* (25.83), *Parthenium hysterophorus* (16.52), *Kochia indica* (13.11), *Chenopodium album* and (12.34) *Atriplex stocksii* (10.15). The remaining 33 species have TIV of 100.56 (Appendix:2). The recorded species of this community belongs to 14 families. Poaceae (FIV 151.03), Asteraceae (FIV 43.27) and Amaranthaceae (FIV 38.62) were the dominant families (Appendix:4). Quantitative leaf size spectrum results showed that DAC community were dominated by microphylls (IV: 226.66) followed by nanophylls (IV: 60.12). While quantitative life form spectrum showed that therophytes were dominating (IV: 145.58) followed by chemophytes (IV: 125.21) (Appendix:6).

3. *Saccharum- Paspalum- Cyperus* (SPC) community

This community were established on the riparian zone of river Kabul and its tributaries in daudzai during summer. The dominant members of this community are *Saccharum spontaneum* (IV 41.85), *Paspalum paspalodes* (IV 41.59) and *Cyperus difformis* (IV 26.70). These dominant species were followed by *Typha domingensis* (IV 22.28), *Pycreus flavescens* (IV 20.72), *Fimbristylis dichotoma* (IV 15.29) and *Ammannia baccifera* (IV 14.95). the remaining 29 species have less than 14 IV. They contributed 116.59 TIV (Appendix:2). A total of 14 families were recorded in which Poaceae (FIV 118.4), Cyperaceae (FIV 90.49) and Typhaceae (FIV 22.28) were the leading families (Appendix:4). Quantitative leaf size spectrum showed that SPC community was dominated by microphylls (IV 207.83) followed by nanophylls (IV 51.43). The quantitative life form spectrum showed that geophytes (IV 124.73) were dominating in the area because most of the species present in this community were typical hydrophytes and most of the hydrophytes were geophyte followed by chemophytes (IV 66.02) (Appendix:6).

4. *Alternanthera-Apluda-Ampelopteris* (AAA) community

This community was established throughout on the stream beds at daudzai irrigation canal system during summer season. *Alternanthera sessilis* contributed the highest IV of 26.08 in this plant community. The second and third member of this community were *Apluda mutica* (IV 23.12) and *Ampelopteris prolifera* (IV 20.91) respectively. Other important members of this community are *Paspalum paspalodes* (IV 19.43), *Aster subulatus* (IV 14.59), *Impereta cylindrica* (IV 14.59), *Digitaria sanguinalis* (IV 11.95), *Persicaria glabra* (IV 11.82) and *Cynodon dactylon* (IV 11.44). The remaining 66 members of this community have less than 11 IV. There TIV were 148.06 (Appendix:2). A total of 31 families were recorded in which Poaceae (FIV 119.81), Amaranthaceae (FIV 37.12) and Asteraceae (FIV 31.26) were dominant (Appendix:4). The quantitative leaf size spectrum showed that microphylls (IV 214.09) were dominating in AAA community followed by

nanophylls (IV 58.97). While quantitative life form spectrum showed that therophytes (IV 98.73) was dominating followed by hemicryptophytes (IV 97.94) (Appendix:6).

5. *Impereta- Launea-Cynodon* (ILC) community

This community was established in the eyots present in the middle of river Kabul at Daudzai. *Imereta cylindrica* was the most frequent and dominant species which have an IV of 48.89. the second important member of this community is *Launea procumbens* (IV 27.21) and the third member is *Cynodon dactylon* which contributed an IV of 26.75. The co-dominant species in this community are *Fimbristylis dichotoma* (IV 24.20), *Saccharum spontaneum* (IV 21.26), *Setaria pumila* (IV 19.70) and *Desmostachya bippinata* (IV 15.44). rest of the members have less than 15 IV. These members have the TIV 116.51 the number of these species are 26 (Appendix:2). High grazing was practiced over there. 12 families were recorded in which Poaceae (FIV 168.2), Asteraceae (FIV 43.31) and Cyperaceae (FIV 30.31) were the leading families (Appendix:4). ILC community quantitative leaf size spectra showed that microphylls (IV 219.51) were dominating in the area followed by nanophylls (IV 53.93). Quantitative life spectrum showed that therophytes (IV 101.87) followed by chemaephytes (IV 96.25) (Appendix:6).

6. *Typha-Phragmites- Paspalum* (TPP) community

This community was present in the wet land of daudzai. *Typha domingensis* was the most common and dominant species contributed an IV of 44.17. *Phragmites australis* and *Paspalum paspalodes* having IV 25.45 and IV 22.22 respectively. The co-dominant species of this community are *Spirodela polyrhiza* (IV 21.17), *Echinochloa crus-galli* (IV 16.31), *Alternanthera sessilis* (12.92) and *Pycreus flavesens* (8.48). The remaining 52 species have the TIV of 150.66 (Appendix:2). A total of 25 families were recorded in which Poaceae (FIV 85.88), Typhaceae (FIV 44.17) and Cyperaceae (FIV 38.97) were the dominant families (Appendix:4). Quantitative Leaf size spectrum of this community showed that microphylls (IV 150.03) were dominating followed by megaphylls (IV 46.11). Quantitative life form spectrum of TPP community showed that therophytes (IV 110.5) were dominant followed by geophytes (IV 107.95) (Appendix:6).

TIV

TIV was calculated for each species which was recorded in the quadrat sampling method of the area. TIV results showed that a total of 156 herbaceous species were recorded in the spring herbaceous communities. Among which *Impereta cylindrica* (TIV 88.1), *Bolboschoenus affinis* (TIV 80), *Cynodon dactylon* (TIV 73.4), *Cirsium arvense* (TIV 59.5) *Polypogon monspeliensis* (TIV 58.8), *Euphorbia helioscopia* (TIV 51.1), *Taraxacum officinale* (TIV 45.04), *Veronica anagallis-aquatica* (TIV 40.32), *Carex acutiformis* (TIV 38.22) and *Melilotus indica* (TIV 37.12) were top ten dominant species of the area (Appendix:1) While the TIV results of summer herbaceous communities showed that 151 herbs were recorded in the area. Among which *Cynodon dactylon* (TIV 105.81), *Paspalum paspalodes* (TIV 85.4), *Desmostachya bippinata* (TIV 85.40), *Typha domingensis* (TIV 80.12), *Impereta cylindrica* (TIV 78.68), *Saccharum spontaneum* (TIV 67.16), *Parthenium hysterophorus* (TIV 56.42), *Setaria pumila* (TIV 48.66), *Achyranthus aspera* (TIV 46.80) and *Fimbristylis dichotoma* (TIV 43.34) were top ten dominant species of the area (Appendix:2).

TFIV

The results showed that a total of 42 families were recorded in spring herbaceous communities the prominent families in spring herbaceous communities were Poaceae (TFIV 429.8), Asteraceae (TFIV 237.8), Papilionaceae (TFIV 132.6), Cyperaceae (TFIV 121.1), Plantaginaceae (TFIV 93.7), Euphorbiaceae (TFIV 84.9), Ranunculaceae (TFIV 77.4), Polygonaceae (TFIV 73.2), Brassicaceae (TFIV 64.6) and Caryophyllaceae (TFIV 52.6) (Appendix:3). While in summer herbaceous communities a total of 50 families were recorded in which the dominant families were Poaceae (TFIV 753.1), Asteraceae (TFIV 201.2), Cyperaceae (TFIV 182.7), Amaranthaceae (TFIV 124.5), Typhaceae (TFIV 80.1), Chenopodiaceae (TFIV 50.7), Euphorbiaceae (TFIV 32.7), Solanaceae (TFIV 30.5), Lythraceae (TFIV 26.5) and Araceae (TFIV 26.1) (Appendix:4).

Soil analysis

Based on different soil particles, sand particles were present in the highest percentage in Riparian zone and Eyots that's is 66% and 64% respectively. Silt particles were present in high percentage in stream beds and wetlands that was 62% each. The clay particles were in high percentage in fallow lands that was 12%. Soil texture results showed that fallow land, protected area, stream bed and wetland have silty loamy texture while eyots and riparian zone have sandy loamy texture. Stream bed is more acidic with pH 8 and the most basic was fallow land, riparian zone and wetlands with the pH 8.2. Electric conductivity (EC) have the highest value in protected area 0.18 and lowest in eyots that is 0.15. Total soluble salt (TSS) is highest in protected area that is 0.058 and the lowest value is in eyots that is 0.048. $CaCO_3$ is highest in riparian zone that is 8.75 and lowest in stream bed that is 6.75. Organic matter (OM) is present in great amount in protected area that is 0.86 and present in lowest in wetlands that is 0.65. Nitrogen (N) is present in highest amount in protected area that is 0.043 and lowest in wetlands that is 0.032. Phosphorus (P) is present in high amount in stream bed and lowest in fallow land that is 5.4. Potassium (K) is present in high amount in stream bed that is 140 and lowest in wetlands that is 80. The soil moisture content of different soil collected from six different sites showed that highest moisture contents were recorded in wetlands while lowest soil moisture contents were recorded in protected areas (8.69%) and in eyots (9.01%)

Table:1. Soil analysis of different sites

Site name	Clay	Silt	Sand	Soil texture	pH	EC	TSS	$CaCo_3$	OM	N	P	K	SMC
Fallow land	12	60	28	Silty loam	8.2	0.16	0.051	7.50	0.79	0.039	5.4	100	16.95
Protected area	10	58	32	Silty loam	8.1	0.18	0.058	8.75	0.86	0.043	6.8	110	8.69
Riparian zone	4	30	66	Sandy loam	8.2	0.17	0.054	8.75	0.69	0.034	12.1	90	30.29
Stream beds	8	62	30	Silty loam	8.0	0.16	0.051	6.75	0.79	0.039	12.5	140	34.49
Eyots	2	34	64	Sandy loam	8.1	0.15	0.048	7.0	0.86	0.043	11.1	96	9.01
Wetlands	6	62	32	Silty loam	8.2	0.16	0.051	8.50	0.65	0.032	10.8	80	55.33

Diversity indices

Different diversity indices were calculated for all herbaceous communities. The results showed that the Simpson's diversity index value (D) is seen lower in PCA (3.89%) and VPR (3.95%) established in stream beds and riparian zone during spring respectively, which shows the higher diversity while higher Simpson's diversity index (D) value was seen in ILC (16.09%) community established in eyots during spring which indicates the low diversity of the ILC community. While the results of Simpson's diversity index calculated for summer herbaceous communities showed that PCB (0.04) and AAA (0.04) were the most diverse communities established in fallow land and stream beds while least diverse community was DAC (0.10) established in protected areas. Shannon diversity index (H) also showed the same results (Table no.2).

The species richness (SR) values indicated that high species richness was recorded in TEH (0.019) and ECC (0.02) established in protected areas and fallow lands respectively while, low species richness was recorded in riparian zone community, VPR that was (0.10). while the species richness values of summer herbaceous communities showed that AAA community established in the stream bed have high species richness, having (SR) value of 1.85 while low species richness was recorded in ILC (1.15) established in eyots (Table no.2).

The evenness (E) values of spring herbaceous communities showed that VPR community at riparian zone showed the most even abundance of all species present in the community and its value is 0.874 while the lower value was recorded in ILC (0.712) established in eyots. While The evenness (E) values of summer herbaceous communities showed that high evenness value (0.478) were recorded in

TPP community established in wetlands while low evenness value (0.415) was recorded in DAC community established in protected areas (Table no.2).

The maturity index (Mi) values shows that the most mature community was ILC established in eyots with the Mi value of 27.5 and the lower Mi values were recorded for PCA 20.12, which is established in stream beds which is most least mature spring herbaceous community. The maturity index (Mi) values showed that the most mature community was SPC community with Mi value of 36.11 established in the riparian zone while the less mature community was AAA with the low Mi value of 17.33 established in the stream beds (Table:2).

Table:2. Diversity indices of herbaceous communities

S.no	Sites	Season	community	TSN	D%	H	SR	E	Mi
1	Fallow lands	Spring	ECC	68	0.06	3.33	1.63	0.79	22.8
		Summer	PCB	73	0.04	3.57	1.73	0.48	18.8
2	Protected areas	Spring	THE	60	0.06	3.33	1.46	0.81	24.5
		Summer	DAC	41	0.11	2.79	1.42	0.42	22.9
3	Riparian zone	Spring	VPR	53	0.04	3.47	2.32	0.87	26.4
		Summer	SPC	36	0.08	2.92	1.42	0.45	36.1
4	Stream beds	Spring	PCA	77	0.04	3.64	1.86	0.84	20.1
		Summer	AAA	75	0.05	3.52	1.85	0.48	17.3
5	Eyots	Spring	ILC	38	0.16	2.59	1.4	0.71	27.5
		Summer	ILC	33	0.09	2.82	1.15	0.42	32
6	Wetlands	Spring	BVC	31	0.14	2.63	1.23	0.77	25
		Summer	TPP	59	0.06	3.39	1.71	0.48	17.9

Sorenson's similarity index values of herbaceous communities.

In the present study six herbaceous communities were establish in spring and six in summer at six different phytosociological habitats. In spring the highest similarity was recorded between ECC and TEH plant communities, the similarity index value was (0.69) which explain that ECC and TEH shows the highest similarity. These communities were established in fallow lands and protected areas respectively. The lowest value of similarity index (0.22) was shown by PCA and ILC herbaceous communities established at stream beds and eyots. Rest of the similarity index values were shown in Table:3. Six different herbaceous communities were established in summer at six sites. The similarity index values show the highest similarity between PCB and DAC with the similarity index value of 0.53. These two communities were established in the fallow land and protected areas of the study area respectively. The highest differences were shown by ILC and TPP herbaceous communities established in eyots and wetlands with the similarity index value of 0.17. Rest of the similarity index values between various herbaceous communities were shown in Table:3.

Table:3. Sorenson's similarity index table of herbaceous communities

Spring						Summer					
ECC	X					PCB	X				
THE	0.7	X				DAC	0.53	X			
VPR	0.28	0.23	X			SPC	0.17	0.23	X		
PCA	0.54	0.43	0.23	X		AAA	0.48	0.38	0.35	X	
ILC	0.41	0.37	0.37	0.22	X	ILC	0.32	0.41	0.45	0.37	X
BVC	0.38	0.29	0.24	0.42	0.29	TPP	0.3	0.18	0.41	0.5	0.32

Discussion

Structure of the herbaceous communities

In the present research area during spring the dominant species of the communities in the herbaceous layer in different phytosociological habitats were *Euphorbia helioscopia, Cirsium arvensis, Cynodon dactylon, Taraxacum officinale, Hordium murinum, Veronica beccabunga, Polypogon monspeliensis , Ranunculus sceleratus Pimpinella diversifolia, Ampelopteris prolifera, Impereta cylindrica, Launea procumbens, Bolboschoenus affinis, Veronica anagallis-equatica* and *Carex acutiformis.* Ali *et al*. (2019), Zereen *et al*. (2018), Waheed *et al*. (2009), Jabeen and Ahmad (2009) established communities in the same type of habitats they also reported that *Euphorbia helioscopia* and *Cynodon dactylon* were the dominant members of that communities. Ahmad and Yasmin (2011) surveyed the vegetation along Hanna lake, Baluchistan and they reported *Taraxacum officinale* as the dominant member of the community. Shah *et al*. (2014) reported *Hordium murinum* from their research area as a dominant species. Stancic (2010) carried a phytosociological study in the Krapina River valley at Northwest Croatia and they also reported *Veronica beccabunga* as a dominant species from the same habitat. Jabeen and Ahmad (2009) also reported *Polypogon monspeliensis* as a dominant member of the community. Similar results were published by Nawaz *et al*. (2012) and Zoq-ul-Arfeen *et al*. (2015) in which *Impereta cylindrica* and *Cynodon dactylon* were placed in the dominant species from the same habitat. Ilyas *et al*. (2015), Kamrani *et al*. (2010) and Ziada *et al*. (2008) also placed *Veronica anagallis-equatica* and *Bolboschoenus affinis* as dominant species in the community which exists in the wetland which favoured the present results.

While during summer the dominant species in the herbaceous layer in different phytosociological habitats were *Parthenium hysterophorus, Cynodon dactylon, Brachiaria reptans, Desmostachya bippinata, Achyranthus aspera, Saccharum spontaneum, Paspalum paspalodes, Cyperus difformis, Alternanthera sessilis, Apluda mutica, Ampelopteris prolifera, Imperata cylindrica, Launea procumbens, Typha domingensis* and *Phragmites australis.* Bano *et al*. (2018), Ahmad *et al*. (2016), Jabeen and Ahmad (2009) also reported *Parthenium hysterophorus* and *Cynodon dactylon* as the dominant members of the community. Urooj *et al.* (2016), Ahmad *et al*. (2014), Shah and Rozina (2013) and Quershi *et al*. (2008), also placed *Desmostachya bippinata* and *Cynodon dactylon* as the dominant members from the same type of habitats which supports our work. Zereen and Sardar (2015) reported the dominancy of *Saccharum spontaneum* which is congruent to our report. Ali *et al.* (2018) also reported *Apluda mutica* as a dominant species from the stream beds at Chail Swat. *Imperata cylindrica* and *Cynodon dactylon* were also represented as dominant species from the same phytosociological habitat by Zoq-ul-arfeen *et al.* (2015) and Fatima *et al.* (2018) and they also placed *Launea procumbens* as co-dominant species. Zia *et al.* (2018) studied the vegetation of Soon valley wetlands and they also reported *Typha domingensis* as the dominant species. Ziada *et al*. (2008) also reported *Phragmites australis* as the dominant species in the wetlands of their research area. Ilyas *et al*. (2015) reported *Paspalum paspalodes* as the dominant member from the same habitat which further supports the present study.

Diversity indices

Simpson's diversity index shows that the spring herbaceous communities were relatively highly diverse as compared to summer herbaceous community. This was because of the high richness values of the spring communities. In spring the number of species in each community was high. The conditions were almost favourable for most of the plants species in spring as compared to summer. Khan *et al.* (2013) also recorded high species diversity in spring communities as compared to summer communities at Takht-e-Nasrati, both the present area and Takht-e-Nasrati were plains which strongly support the present results. PCA spring herbaceous community established in stream beds was the most diverse community. Suitable moisture contents were recorded in stream beds. Shaheen *et al.* (2015) and Ahmad *et al.* (2016) also reported that moisture contents greatly affect the diversity of an

area which was in favour of the present study. Eyots and wetlands herbaceous communities shows that there spring communities viz. ILC and BVC respectively were less diverse than summer herbaceous communities namely ILC and TPP communities. In the case of ILC community in eyots during spring most of the species was highly palatable so that's why they were present rarely and thus the community was less diverse because of heavy grazing pressure. Shaheen *et al.* (2017), Rahman *et al.* (2016) and Bano *et al.* (2018) also recorded that grazing had an adverse effect on the species diversity. Wetlands have comparatively high-water level in spring and because of severe winter in wetlands most of the typical hydrophytic species were absent in spring and that's why they do not provide full herbaceous cover in spring. In summer the temperature is high in the area and the water level in wetlands was become lower and then these habitats become more suitable for many typical hydrophytes. Thus, the herbaceous community in summer provide full cover and was more diverse in wetlands. In eyots the conditions were xeric and second high grazing were over there so that's why eyots were less diverse. The present Simpson's diversity values were in comparable range with that of Shaheen *et al.* (2017) which strongly supports the present study.

Shannon's diversity indices almost show similar results as shown by Simpson's diversity index for herbs, shrub and tree communities. The range of the Shannon's diversity indices values were between 1.12 and 3.64. The present values were in same range as obtained by Akhlaq *et al*. (2018) Hussain and Perveen (2015) and Habib *et al.* (2011) which strongly supports the present work. The present values were in same range that was obtained by Shaheen *et al.* (2011) who study the herbaceous pastures of Kashmir, which strongly supports the present study.

According to species richness results among spring herbaceous communities, VPR established in riparian zone and PCA established in stream beds had high species richness and it were the highest value in all herbaceous communities both in spring and summer. While in summer herbaceous community's, PCB and AAA were having high species richness as these communities were established in fallow land and stream beds. This was because of the suitable high soil moisture contents in these two sites. Akhlaq *et al.* (2018), Ahmad *et al.* (2016) and Shaheen *et al.* (2015) also reported that species richness and diversity was greatly affected by the soil moisture content which strongly supports the present work. Spring community namely VPR have high species richness than SPC established in summer at riparian zone this was because of the dominant species *Saccharum spontaneum* (IV 41.85) and *Paspalum paspalodes* (IV 41.59) which cover most of the area of riparian zone in summer. Species richness values in eyots and wetlands herbaceous communities were increased in summer. The present species richness values were in same range with that of the Habib *et al.* (2011) and Shaheen *et al.* (2017) which strongly supports the present study.

The evenness values showed that in spring herbaceous communities the species were more evenly abundant then in summer communities. This was because of the very high densities of one or two species in each summer community as compared to other members of the community. Spring herbaceous communities TEH, VPR and PCA have high evenness values. While summer herbaceous community PCB evenness was greatly affected by the invasion of *Parthenium hysterophorus.* DAC and ILC community's evenness value was the most least value among all herbaceous communities. DAC evenness was decreased by the high density of *Desmostachya bipinnata* while high density of *Impereta cylindrica* decreased the evenness values of ILC community. *Typha* and *Phragmites* affected the evenness of TPP. So that's why the evenness values were less in summer communities as the evenness depends upon the density of each member of the community. Overall the herbaceous communities evenness values were in same range with that of the Bhatti *et al.* (2014) and Ismail and Elawad (2015) they also studied the herbaceous communities. The present evenness values were in comparable range with that of the values which was obtained by Hussain and Perveen (2015), Habib *et al.* (2011) and Shah *et al.* (2014) which strongly supports our work.

SPC and ILC were the most mature herbaceous communities established in summer at riparian zone and eyots respectively. While AAA and TPP summer herbaceous communities were the most least mature communities established in stream beds and wetlands. All communities present in the research area shows low maturity index values which shows the disturb nature of all phytosociological habitats of the area. Shaheen *et al.* (2011, 2015) also obtained the comparable

values of maturity index and they also stated that all the surveyed sites were disturbed which strongly supports the present study. Shaheen *et al.* (2017), Hussain and Perveen (2015), Sher *et al.* (2013) and Shah and Rozina (2013) also obtained the same range of maturity values.

Similarity index

Fallow lands and protected areas were similar in many soil properties like the percentage of soil particles (soil texture), soil moisture contents, phosphorus percentage and pH (Table:12). In this case the most powerful abiotic factors which were responsible for the vegetation similarity between these two spring communities, ECC and TEH were soil texture, soil moisture content and low phosphorus percentage. The summer community's similarity index showed that PCB and DAC communities established in fallow lands and protected areas were the most similar communities during summer. The factors behind the close similarity of these communities were there similar edaphic properties such as soil texture, soil moisture content and low phosphorus percentage (Table:12). Ismail and Elawad (2015), Iqbal *et al.* (2018) and Ilyas (2018) also reported that edaphic factors like soil texture, soil moisture, pH and organic matter were the key factors due to which the communities showed similarity. The highest dissimilarity in vegetation structure was recorded between the two spring community's viz. PCA and ILC established in stream beds and eyots. This was supported by the variation in habitats of these communities. The main abiotic factors which were answerable for this dissimilarity were soil texture, pH, K and soil moisture content; these edaphic parameters were relatively different in these two sites. The highest differences were showed by ILC and TPP communities established in Eyots and wetlands. N, organic matter, $CaCO_3$, soil texture and Soil moisture contents were very different in these two sites which influence the vegetation over there. Iqbal *et al.* (2018) also showed that dissimilarity between the communities was recorded due to the variation in soil condition, pH and organic matter which supports the present study.

Conclusion

This study concludes that herbaceous vegetation of the area was diverse, during spring a total of 156 species were recorded while during summer a total of 151 species were recorded. 6 communities were established in each season in all the six different available habitats. Diversity indices for each community were calculated. These communities show variation among it, which is totally influenced by the edaphic characteristics of the area. TIV, FIV, TFIV, quantitative biological spectrums were also calculated. Moreover, the herbaceous vegetation of the area is affected by overgrazing, invasive species and by habitat loss.

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It was the part of M.Phill thesis which is submitted by the key author to the University of Peshawar and the university is regulated by Higher Education Commission (HEC) of Pakistan

fig. 1 Quantitaive biological spectrum of spring herbacous communities

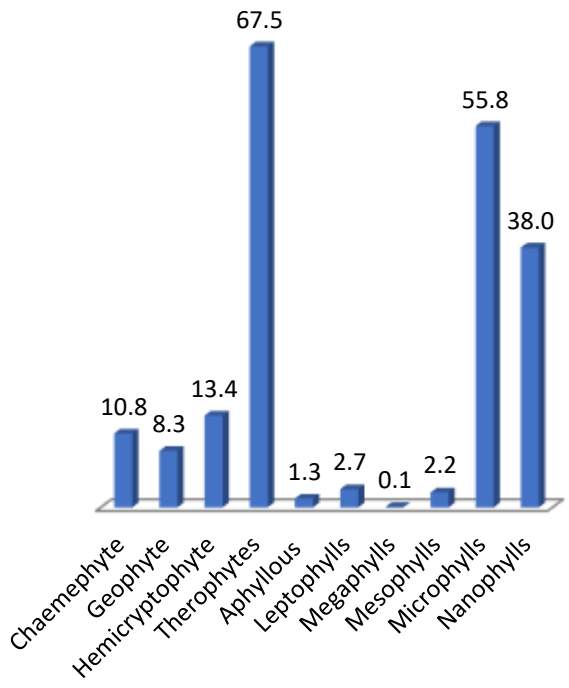


fig. 2 Quantitaive biological spectrum of summer herbacous communities

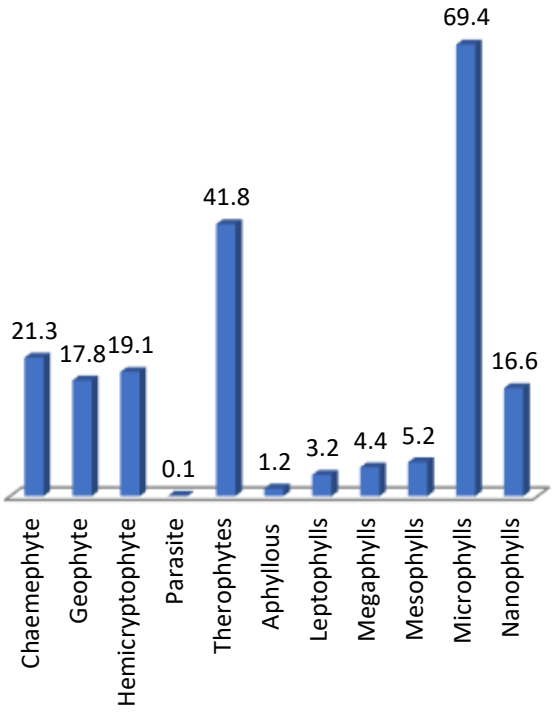
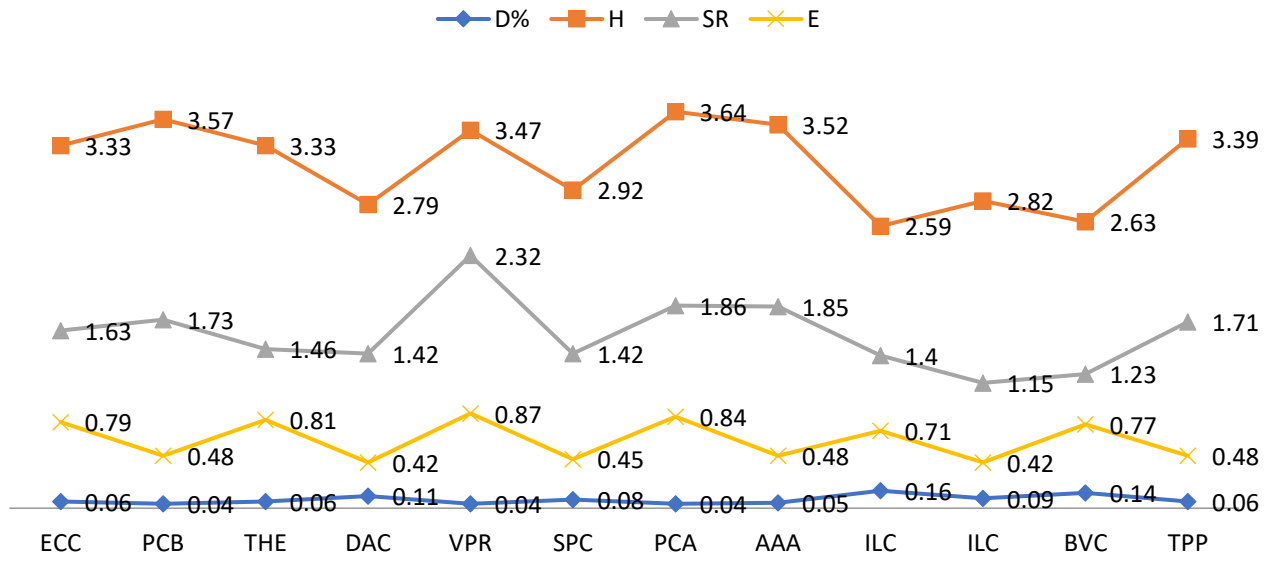
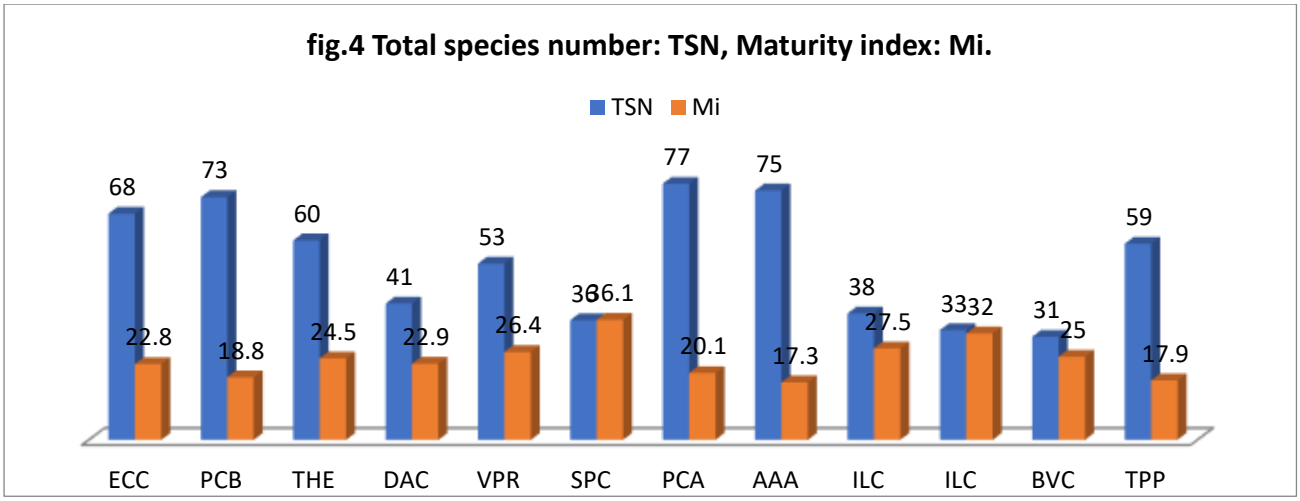
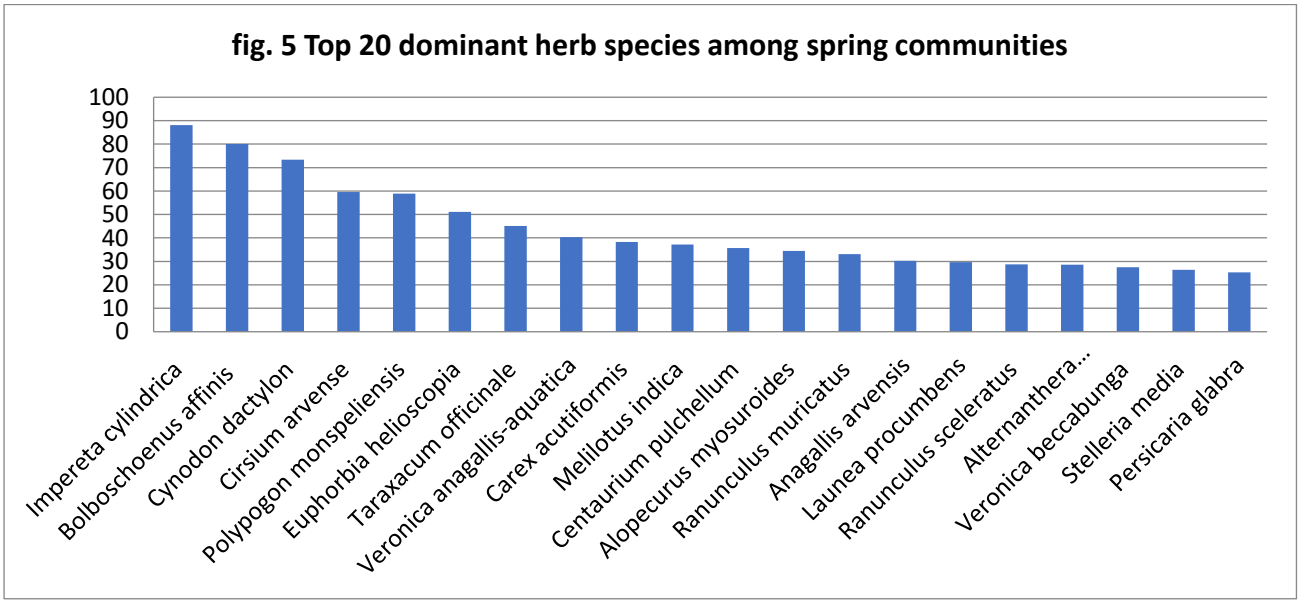
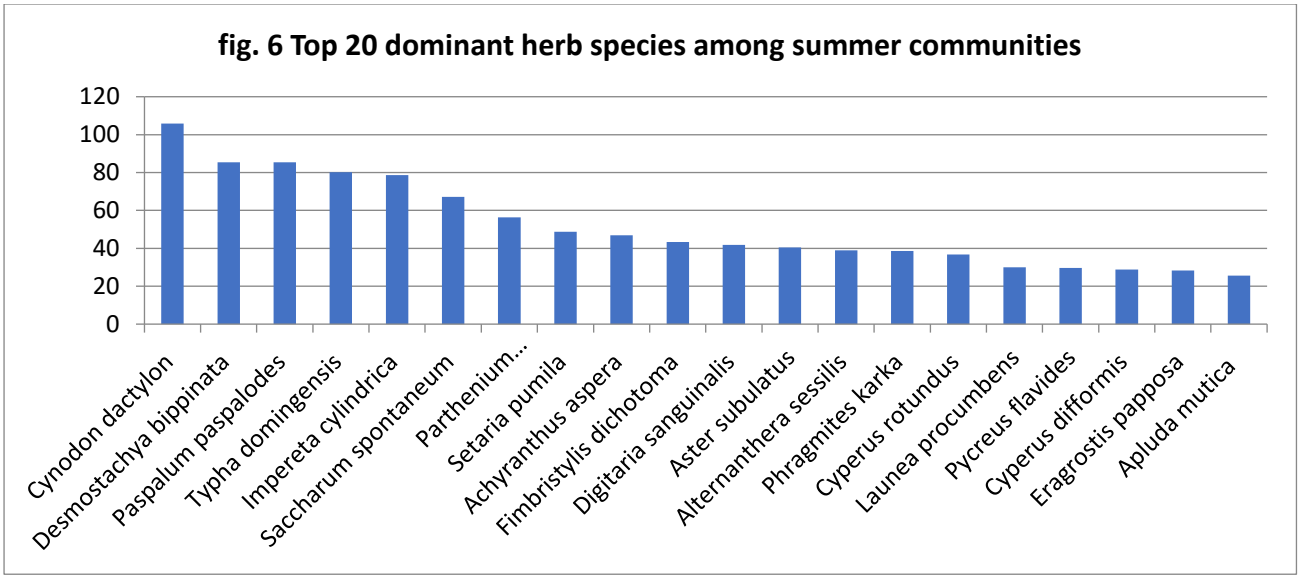


fig. 3 Simpson's index: D, Shannon's index: H, Species richness: SR, Evenness: E.









Appendix:1. Total importance value (TIV) of each spring herbaceous plant species.

S.No	Species name	Fallow lands	Protected areas	Riparian zone	Stream beds	Eyots	Wet lands	TIV

		ECC	THE	VPR	PCA	ILC	BVC	
1	*Adiantum capillus-veneris*	0	0	0	6.1	0	0	6.1
2	*Agrostis viridis*	0	0	1.64	7.69	0	7.28	16.61
3	*Alopecurus myosuroides*	5.58	6.31	0	5.63	0	16.95	34.48
4	*Alternanthera philoxeroides*	0	0	0	9.05	0	19.58	28.63
5	*Ammi visnaga*	0.33	0	0	0.86	0	0	1.19
6	*Ampelopteris prolifera*	0	0	0	19.26	0	0	19.26
7	*Anagallis arvensis*	12.81	8.89	0	5.51	1.57	1.42	30.2
8	*Anchusa arvensis*	0	0	0	0.92	1.57	6.8	9.29
9	*Anthemis arvensis*	0	0.58	0	0	0	0	0.58
10	*Apium graveolens*	0	0	0	1.29	0	0	1.29
11	*Arenaria serpyllifolia*	4.99	1.27	1.64	0	6.74	0	14.64
12	*Artemisia scoparia*	0	0	1.26	0	0	0	1.26
13	*Artemisia vulgaris*	0	0.64	0	0	0	0	0.64
14	*Astragalus orbiculatus*	0	2.95	0	0	0	0	2.95
15	*Astragalus scorpiurus*	0	0	2.71	0	0	0	2.71
16	*Astragalus subumbellatus*	0	1.76	0	0	1.44	0	3.2
17	*Avena fatua*	7.28	4.18	0	0	0	3.96	15.42
18	*Bolboschoenus affinis* [2]	0	0	0	0	0	80	80
19	*Brachypodium distachyon*	0	0	1.45	0	4.72	0	6.17
20	*Brassica compestris*	0	0.58	0	0	0	0	0.58
21	*Bromus catharticus*	3.51	7.77	0	1.52	0	0	12.80
22	*Bromus pectinatus*	0.72	6.33	1.26	0	0	0	8.31
23	*Calendula arvensis*	0	1.64	0	0	0	0	1.64
24	*Campanula benthamii*	0	0	1.26	0	0	0	1.26
25	*Campanula pallida var. pallida*	0	0	4.55	0	0	0	4.55
26	*Canna indica*	0	0	0	1.02	0	0	1.02
27	*Cannabis sativa*	9.02	2.56	0	3.91	0	0	15.49
28	*Capsella bursa-perstoris*	0.75	0	0	0	0	0	0.75
29	*Cardaria chalepensis*	0	5.28	0	0	0	0	5.28
30	*Carex acutiformis* [9]	0	0	0	15.57	0	22.65	38.22
31	*Cenchrus ciliaris*	0	0	1.26	0	0	0	1.26
32	*Centaurea iberica*	0	0	0	0.43	0	0	0.43
33	*Centaurium pulchellum*	2.71	0.7	6.58	0.92	14.62	10.12	35.65
34	*Cerastium glomeratum*	2.36	0.76	0	0.42	0	0	3.54
35	*Chenopodium album*	7.85	6.72	0	2.88	0	1.42	18.87
36	*Chenopodium ambrosoides.*	2.11	0	0	2.05	0	0	4.16
37	*Chenopodium foliosum*	2.15	0	0	0	0	0	2.15
38	*Chenopodium glaucum*	0.39	0	0	0	3.19	3.16	6.74
39	*Chenopodium murale*	4.7	9.04	0	0	0	3.01	16.75
40	*Cirsium arvense* [4]	28.12	8.54	0	19.84	0	3.01	59.51
41	*Conium maculatum*	0.91	3.74	0	2.05	0	0	6.7
42	*Convolvulus arvensis*	4.84	4.19	0	2.12	0	0	11.15
43	*Coronopus didymus*	9.39	7.37	0	2.83	0	0	19.59
44	*Cynodon dactylon* [3]	23.9	7.93	10.16	4.98	23.27	3.16	73.4
45	*Datura innoxia*	0	0	0	1.88	0	0	1.88
46	*Dichanthium annulatum*	0	0	0	0	1.57	0	1.57
47	*Dryopteris filx-mas*	0	0	0	1.29	0	0	1.29
48	*Eclipta prostrate*	0	0	12.6	1.89	0	0	14.49
49	*Emex australis*	2.6	0.7	0	0	0	0	3.3
50	*Epipactus veratrifolia*	0	0	0	2.5	0	0	2.5
51	*Equisetum arvense*	0	0	9.57	11.75	1.85	0	23.17
52	*Erodium malacoides*	0	3.15	1.26	0	1.57	0	5.98
53	*Eulophia hormusjii*	0	0	0	0	5.89	0	5.89
54	*Euphorbia falcate*	0.55	0	0	0	0	0	0.55
55	*Euphorbia helioscopia* [6]	0	35.73	0	11.95	3.42	0	51.1
56	*Euphorbia peplus*	0	1.88	0	0	0	0	1.88
57	*Filago hurawarica*	0	0	8.03	0	0	0	8.03
58	*Fimbristylis dichotoma*	0	0	2.9	0	0	0	2.9
59	*Forsskaolea tenacissima*	0	0	3.1	0	0	0	3.1
60	*Fumaria indica*	1.94	1.27	0	1.57	0	0	4.78
61	*Gallium aparine*	0	1.22	0	1.77	0	0	2.99
62	*Gamochaeta pensylvanica*	0.33	0	0	0	1.44	0	1.77

63	*Gaura parviflora*	0	0	0	2.08	0	0	2.08
64	*Hemarthria compressa*	3.26	1.51	0	0	4.72	4.43	13.92
65	*Herniaria hirsute*	0	0	3.29	0	0	0	3.29
66	*Hordium murinum*	0.33	15.57	0	0	0	0	15.9
67	*Iflago spicata*	0	0	0	0	1.57	0	1.57
68	*Impereta cylindrica* [1]	0.39	3.85	1.64	0.54	81.72	0	88.14
69	*Ipomoea purpurea*	0	0	0	0.43	0	0	0.43
70	*Juncus articulatus*	0	0	11.21	0	0	0	11.21
71	*Juncus bufonius*	0	0	8.37	0	0	0	8.37
72	*Kickxia ramosissima*	0	0	5.81	0	0	0	5.81
73	*Lactuca dissecta*	0	4.72	2.52	0	0	0	7.24
74	*Lactuca serriola*	0.39	1.77	0	0.54	0	0	2.7
75	*Lamarckia aurea*	0.33	0	3.97	0	0	0	4.3
76	*Lathyrus aphaca*	0.65	0.58	0	0.49	0	0	1.72
77	*Launea procumbens*	0.33	1.33	4.39	0	23.66	0	29.71
78	*Lepidium pinnatifidum*	0.94	0	0	1.63	0	0	2.57
79	*Lotus corniculatus.*	0	0	0	0	19.96	0	19.96
80	*Malcolmia africana*	0	0	0	0	5.44	0	5.44
81	*Malcolmia cabulica*	0	0	11.81	0	0	0	11.81
82	*Malva parviflora*	0.33	0	0	0	0	0	0.33
83	*Marsilea quadrifolia*	0	0	0	0	0	4.43	4.43
84	*Mazus pumilus*	1.55	0	1.45	0.43	0	0	3.43
85	*Medicago lupulina*	1.53	2.27	4.36	0	14.89	0	23.05
86	*Medicago minima.*	0	0	11.62	0	0	0	11.62
87	*Medicago polymorpha*	3.35	2.68	0	0	5.57	0	11.6
88	*Melilotus indica* [10]	19.92	7.27	1.26	3.78	3.15	1.74	37.12
89	*Mentha longifolia*	0	0	0	2.57	0	0	2.57
90	*Micromeria biflora*	0	0	4.16	0	0	0	4.16
91	*Misopates orontium*	0	0	1.64	0	0	0	1.64
92	*Nasurtium officinale*	0	0	2.03	1.96	0	0	3.99
93	*Neslia apiculata*	0.36	0	0	0	0	0	0.36
94	*Nicotiana plumbaginifolia*	0	0	0	0.43	0	0	0.43
95	*Notoceras bicorne*	0	0	0	0.43	0	0	0.43
96	*Oenanthe javanica*	0	0	0	0.43	0	0	0.43
97	*Oxalis corniculate*	3.62	3.02	1.45	3.09	1.71	0	12.89
98	*Oxalis pes-caprae*	1.42	1.88	0	1.25	0	0	4.55
99	*Parietaria lusitanica*	0	0	4.55	0	0	0	4.55
100	*Paspalum paspalodes*	0	0	0	2.14	0	0	2.14
101	*Pentanema vestitum*	0	0	4.55	0	0	0	4.55
102	*Persicaria glabra*	0	0	0	14.33	0	11	25.33
103	*Persicaria hydropiper*	0	0	0	5.72	0	0	5.72
104	*Persicaria maculosa*	0	0	0	1.25	0	4.84	6.09
105	*Phalaris minor*	5.44	14.18	1.26	4.36	0	0	25.24
106	*Pimpinella diversifolia*	0	0	0	22.55	0	0	22.55
107	*Plantago amplexicaulis*	0	0.64	0	0	0	0	0.64
108	*Plantago lanceolata.*	0	0	0	1.19	0	0	1.19
109	*Plantago major*	0	0	0	2.38	0	0	2.38
110	*Poa annua*	8.25	0.7	3.77	3.09	0	3.01	18.82
111	*Polygonum aviculare*	0.36	0	1.26	0	0	0	1.62
112	*Polygonum plebjum*	2.92	0	0	0	1.57	0	4.49
113	*Polypogon monspeliensis* [5]	8.01	0	20.14	8.23	3.42	19.08	58.88
114	*Potentilla supine*	0	0	19.97	0	0	0	19.97
115	*Pseudognaphalium affine*	0	0	8.22	0	0	0	8.22
116	*Pteris vittata.*	0	0	0	1.72	0	0	1.72
117	*Ranunculus arvensis*	0.36	0	0	0	1.57	0	1.93
118	*Ranunculus bulbosus*	0.33	0	0	2.02	0	1.58	3.93
119	*Ranunculus muricatus*	13.08	0.76	0	6.77	3.15	9.33	33.09
120	*Ranunculus sceleratus*	0	0	16.3	6.07	0	6.42	28.79
121	*Raphanus raphanistrum*	2.08	0	0	0	0	0	2.08
122	*Reichardia tingitana*	0	0	2.9	0	0	0	2.9
123	*Rostraria cristata*	5.03	2.51	1.45	0	4.72	6.01	19.72
124	*Rumex crispus*	0	0	0	2.11	0	3.16	5.27
125	*Rumex dentatus*	4.23	0	0	4.44	0	8.55	17.22

126	*Rumex vesicarius*	0	0	4.16	0	0	0	4.16
127	*Salvia plebeian*	0.33	0	9.1	0.43	8.22	3.16	21.24
128	*Scandax pectin veneris*	1.3	0.82	0	0.54	0	0	2.66
129	*Senecio vulgaris*	0	0	1.26	0	1.44	0	2.7
130	*Silene conoidea*	0	0	0	0	2.6	0	2.6
131	*Silybum marianum*	6.42	0.7	0	0	0	0	7.12
132	*Sisymbrium irio*	0.78	8.22	0	2.82	0	0	11.82
133	*Solanum nigrum*	0	1.27	0	0	0	0	1.27
134	*Solanum surattense*	0.39	0	0	0	1.3	0	1.69
135	*Sonchus asper*	1.53	0	0	0	0	0	1.53
136	*Sonchus maritimus*	0	0	0	1.65	0	0	1.65
137	*Sonchus oleraceus*	6.42	7.57	0	3.72	0	1.58	19.29
138	*Sonchus wightianus*	0	0	0	2.86	0	0	2.86
139	*Spergula arvensis*	0.85	0.64	0	0	0	0	1.49
140	*Spirodela polyrhiza*	0	0	0	0	0	3.32	3.32
141	*Stelleria media*	8.32	9.63	0	8.46	0	0	26.41
142	*Taraxacum officinale* [7]	1.53	38.78	0	1.72	3.01	0	45.04
143	*Thymelaea passerine*	1.55	2.81	0	0	4.72	0	9.08
144	*Torilis leptophylla*	2.05	7.99	0	2.88	0	0	12.92
145	*Trigonella monantha*	0	1.16	0	0	11.36	0	12.52
146	*Urospermum picroides*	0	0	1.26	0	7.06	0	8.32
147	*Urtica pilulifera*	1	0	0	0	0	0	1
148	*Verbascum Thapsus*	0	1.4	0	0.43	0	0	1.83
149	*Veronica anagallis-aquatica*[8]	0.36	0	9.08	5.69	0	25.19	40.32
150	*Veronica beccabunga*	0	0	27.44	0	0	0	27.44
151	*Veronica biloba*	4.8	0	0	0.86	0	0	5.66
152	*Vicia sativa*	2.34	1.45	0	2.23	0	0	6.02
153	*Viola betonicifolia*	0	0	0	0.43	0	0	0.43
154	*Viola stocksii*	0	0	8.72		0	0	8.72
155	*Youngia japonica*	0	0	0	4.3	0	0	4.3
156	*Zeuxine strateumatica*	0	0	2.42	0	10.4	0	12.82

Appendix:2. Total importance value (TIV) of each summer herbaceous plant species.

S.No.	Species name	Fallow lands	Protected areas	Riperian zone	Stream beds	Eyots	Wet lands	TIV
		PCB	DAC	SPC	AAA	ILC	TPP	
1	*Acrachne racemosa*	1.94	0	0	0	0	0	1.94
2	*Achyranthus aspera* [9]	14.20	29.35	0	3.24	0	0	46.80
3	*Adiantum capillus-veneris*	0	0	0	0.67	0	0	0.67
4	*Aerva javanica*	0	0	0	0	1.47	0	1.47
5	*Alternanthera philoxeroides*	0	0	0	5.97	0	5.90	11.88
6	*Alternanthera pungens*	6.36	4.96	0	0	0	0	11.32
7	*Alternanthera sessilis*	0	0	0	26.08	0	12.92	39.01
8	*Amaranthus viridis*	6.16	0.86	0	1.82	0	0	8.84
9	*Ammannia baccifera*	0	0	14.96	0	0	0	14.96
10	*Ammannia verticillate*	0	0	2.53	0	0	0	2.53
11	*Ampelopteris prolifera*	0	0	0	20.91	0	0	20.91
12	*Apluda mutica*	1.44	0	0	23.12	0	1	25.56
13	*Artemisia vulgaris*	0	2.21	0	0	0	0	2.21
14	*Aster subulatus*	7.16	7.88	2.53	14.60	1.22	7.12	40.51
15	*Ageratum houstonianum*	0	0	0	0	0	2.28	2.28
16	*Atriplex stocksii*	0	10.16	0	0	0	0	10.16
17	*Bacopa monnieri*	0	0	4.34	1.77	0	5.78	11.89
18	*Boerhavia procumbens*	0.39	3.21	0	0	0	0	3.60

19	*Bolboschoenus affinis*	0	0	0	0	0	1.25	1.25
20	*Brachiaria ramose*	1.55	0	0	1.78	1.47	0	4.79
21	*Brachiaria reptans*	15.50	1.11	0	0	1.47	0	18.08
22	*Canna indica*	0	0	0	2.37	0	0	2.37
23	*Cannabis sativa*	4.70	8.78	0s	3.55	0	0	17.03
24	*Carex acutiformis*	0	0	0	2.51	0	0	2.51
25	*Celosia argentea*	0.44	0	0	0	0	0	0.44
26	*Cenchrus ciliaris*	0.39	4.70	0	0	0	0	5.09
27	*Ceratophyllum demersum*	0	0	0	0.67	0	0	0.67
28	*Chenopodium album*	4.65	12.34	0	0	0	0	17.00
29	*Chenopodium ambrosoides*.	1.22	0	0	3.61	0	0	4.83
30	*Chenopodium glaucum*	0.00	0	0	0	0	0	0.00
31	*Chrozophora tinctorial*	5.08	0	0	0	0	0	5.08
32	*Citrullus lanatus*	0.39	0	0	0	0	0	0.39
33	*Cleome viscosa*	0.44	0	0	0	0	0	0.44
34	*Commelina benghalensis*	0.56	0	0	0	0	0	0.56
35	*Commelina paludosa*	0.00	0	0	1.40	0	0	1.40
36	*Conyza bonariensis*	2.72	9.49	0	1.16	4.29	0	17.67
37	*Conyza Canadensis*	0.39	1.11	2.37	4.17	0	0	8.04
38	*Corchorus olitorius*	2.49	0	0	0	0	0	2.49
39	*Crotalaria sessiliflora*. subsp. *Sessiliflora*	0	0	1.34	0	8.67	0	10.01
40	*Cucumis melo* . subsp. *Agrestis*	4.32	0	0	0	0	0	4.32
41	*Cuscuta reflexa*	0	0	0	0	0	1.17	1.17
42	*Cymbopogon jwarancusa*	0	1.74	0	0	0	0	1.74
43	*Cynanchum acutum* .	0	0	0	0	0	4.87	4.87
44	*Cynodon dactylon* [1]	29.37	26.26	10.99	11.44	26.75	1.00	105.81
45	*Cynoglossum lanceolatum*	1.16	0	0	0	0	0	1.16
46	*Cyperus alopecuroides*	0	0	0	2.44	0	1	3.44
47	*Cyperus difformis*	0	0	26.71	0	0	2.11	28.82
48	*Cyperus exaltatus*	0	0	0	0	0	3.88	3.88
49	*Cyperus laevigatus*	0	0	10.24	0	0	0	10.24
50	*Cyperus rotundus*	14.20	0	6.93	2.82	6.10	6.73	36.78
51	*Dactyloctenium aegyptium*	8.56	0	0	0	9.25	0	17.81
52	*Datura innoxia*	3.08	0.86	0	0	0	0	3.95
53	*Desmostachya bippinata* [3]	4.10	65.85	0	0	15.44	0	85.40
54	*Dichanthelium* spp.	0	0	0	0.55	0	3.87	4.42
55	*Dichanthium annulatum*	0	2.96	0	0.61	0	0	3.57
56	*Digera muricate*	1.39	0	0	0	0	0	1.39
57	*Digitaria sanguinalis*	13.77	3.44	3.47	11.95	9.13	0	41.76
58	*Dryopteris filx-mas*	0	0	0	1.10	0	0	1.10
59	*Echinochloa crus-galli*	4.85	0	0	6.22	0	7.55	18.62
60	*Echionchloa colona*	1.14	0	0	1.04	0	16.32	18.50
61	*Eclipta prostrate*	0.83	0	4.03	3.98	1.35	1.77	11.96
62	*Eichhornia crassipes*	0	0	0	0	0	2	2.00

63	*Eleocharis palustris*	0	0	2.37	0	0	2.53	4.90
64	*Eleusine indica*	3.74	0	0	4.41	0	0	8.15
65	*Eltsholzia sp.*	0	0	0	0	0	1.94	1.94
66	*Epilobium hirsutum*	0	0	0	0.49	0	0	0.49
67	*Equisetum arvense*	0	0	6.84	2.20	9.68	1	19.72
68	*Eragrostis minor*	0	0	0	0	1.59	0	1.59
69	*Eragrostis papposa*	0	25.83	0	0	2.45	0	28.28
70	*Euphorbia hirta*	0.94	0	0	0	0	0	0.94
71	*Euphorbia indica*	1	0	0	0	0	1.17	2.17
72	*Euphorbia prostrate*	1.44	0	0	0	0	0	1.44
73	*Euphorbia thymifolia*	2.06	1.11	0	0.55	6.98	1.42	12.12
74	*Fimbristylis dichotoma* [10]	0	0	15.30	0.55	24.21	3.29	43.34
75	*Fimbristylis littoralis*	0	0	5.37	0	0	0	5.37
76	*Fuirena pubescens*	0	0	0	0	0	4.16	4.16
77	*Gaura parviflora*	0	0	0	0.61	0	0	0.61
78	*Gonostegia pentandra*	0	0	0	7.72	0	1.34	9.06
79	*Gratiola brevifolia*	0	0	2.69	0	0	0	2.69
80	*Heliotropium curassavicum*	0.44	0.86	0	0	0	0	1.31
81	*Heliotropium striogosum*	0	0	0	0	7.10	0	7.10
82	*Hemarthria compressa*	0.56	0	2.84	2.14	0	2.67	8.21
83	*Impereta cylindrica* [5]	3.97	8.73	4.52	12.56	48.90	0	78.68
84	*Indigofera linifolia*	0	0	0	0	1.47	0	1.47
85	*Ipomoea eriocarpa*	6.17	0	0	1.04	0	1	8.21
86	*Ipomoea hederacea*	0.39	0	0	0.49	0	0	0.88
87	*Ipomoea indica*	0	0	0	1.03	0	0	1.03
88	*Ipomoea nil*	0	0	0	0.55	0	0.91	1.47
89	*Juncus articulatus*	0	0	3.72	0	0	0	3.72
90	*Kickxia spuria*	0.50	0	0	0	0	0	0.50
91	*Kochia indica.*	2.39	13.12	0	0	0	0	15.50
92	*Kyllinga brevifolia*	0	0	1.34	0	0	0	1.34
93	*Launea procumbens*	0	0.99	1.34	0.50	27.21	0	30.05
94	*Lemna minor*	0	0	0	2.44	0	0	2.44
95	*Leptochloa panicea*	1.72	0	0	1.16	0	0	2.89
96	*Lotus corniculatus.*	0	0	0	0	1.47	0	1.47
97	*Ludwigia perennis*	0	0	1.19	0	0	0	1.19
98	*Lycopus europaeus*	0	0	0	4.57	1.22	5.05	10.85
99	*Malvastrum coromandelianum*	2.55	1.99	0	0	0	0	4.53
100	*Marsilea quadrifolia*	0	0	5.87	2.07	0	7.13	15.07
101	*Melochia corchorifolia*	3.83	0	0	0	0	6.40	10.23
102	*Mentha longifolia*	0	0	0	0.61	0	0	0.61
103	*Merremia hederacea*	0.94	0	0	1.16	0	4.25	6.34
104	*Mirabilis jalapa*	0	1.11	0	0	0	0	1.11
105	*Nelumbo nucifera*	0	0	0	0	0	1.94	1.94
106	*Oxalis corniculate*	1.39	0	0	1.67	0	0	3.05

107	*Parthenium hysterophorus* [7]	29.55	16.53	1.34	5.74	2.43	0.83	56.42
108	*Paspalum paspalodes* [2]	2.22	0	41.59	19.44	0	22.22	85.4
109	*Paspalum scrobiculatum*	0	0	0	2.22	0	3.024	5.24
110	*Pentanema vestitum*	0	0	0	0.00	0	2.17	2.17
111	*Perilla frutescens*	2.38	0	0	2.38	0	0	4.76
112	*Persicaria glabra*	0	0	0	11.82	0	2.91	14.74
113	*Persicaria hydropiper*	0	0	0	2.14	0	0	2.14
114	*Persicaria maculosa*	0	0	0	4.02	0	1	5.02
115	*Phragmites karka*	0	3.21	0	8.56	1.35	25.46	38.58
116	*Phyla nodiflora*	1.50	0	3.00	1.78	7.59	4.16	18.03
117	*Phyllanthus amarus*	4.95	0	0	2.33	0	3.70	10.97
118	*Physalis divaricata*	6.37	0.86	0	1.65	1.35	2.25	12.49
119	*Pimpinella diversifolia*	0	0	0	1.95	0	0	1.95
120	*Pistia stratiotes*	0	0	0	0	0	4.68	4.68
121	*Plantago major*	0	0	0	0.49	0	0	0.49
122	*Polygonum aviculare*	0.61	0	0	0	0	0	0.61
123	*Polygonum plebjum*	2.22	0	0	0	0	0	2.22
124	*Portulaca oleraceae*	0	0	0	0.87	0	0	0.87
125	*Potamogeton nodosus*	0	0	0	0	0	0.91	0.91
126	*Pteris vittata.*	0	0	0	1.10	0	2.17	3.27
127	*Pycreus flavides*	0	0	20.72	0.49	0	8.48	29.70
128	*Saccharum filifolium*	0.82	3.34	6.40	2.99	9.37	1.77	24.69
129	*Saccharum spontaneum* [6]	0	0.00	41.86	4.04	21.26	0	67.16
130	*Sagittaria trifolia*	0	0.00	2.37	0	0	2.77	5.15
131	*Salsola imbricate*	0	1.86	0	0	0	0	1.86
132	*Samolus valerandi*	0	0	0	0	0	2.61	2.61
133	*Schoenoplectus litoralis*	0	0	1.50	0	0	3.25	4.75
134	*Schoenoplectus mucronatus*	0	0	0	0	0	2.28	2.28
135	*Senna occidentalis*	0.83	2.11	0	0	0	0	2.94
136	*Sesbania sesban*	1.17	0.99	0	1.14	0	0	3.30
137	*Setaria pumila* [8]	9.20	6.43	6.74	5.58	19.71	1	48.66
138	*Setaria viridis*	0.56	0.00	0	0	0	0	0.56
139	*Solanum nigrum*	1.94	4.52	0	1.76	0	0.91	9.13
140	*Solanum surattense*	0.94	0	0	0	2.69	0	3.63
141	*Sonchus wightianus*	0	0	0	0.49	0	0	0.49
142	*Sorghum halepense*	6.05	0.86	0	0.61	0	0	7.53
143	*Sphenoclea zeylanica*	0	0	5.68	0	0	0	5.68
144	*Spirodela polyrhiza*	0	0	0	0	0	21.44	21.44
145	*Trianthema portulacastrum*	13.06	0	0	0.61	0	0	13.68
146	*Tribulus terrestris*	1.77	2.09	0	0	0	0	3.87
147	*Typha domingensis* [4]	0	0	22.28	5.13	8.54	44.17	80.12
148	*Verbascum Thapsus*	1.77	1.11	0	0	0	0	2.88
149	*Verbena officinalis*	2.82	0	0	0.55	0	0	3.37
150	*Verbesina encelioides*	0	1.11	0	0	6.80	0	7.91
151	*Xanthium strumarium*	9.26	3.96	2.69	0	0	2.77	18.68

Appendix:3. Family importance value of spring herbaceous communities

S.N	Family name	Fallow lands	Protected areas	Riperian zone	Stream beds	Eyots	Wet lands	TFIV
		ECC	THE	VPR	PCA	ILC	BVC	
1	Adiantaceae	0	0	0	6.10	0	0	6.10
2	Amaranthaceae	0	0	0	9.05	0	19.58	28.63
3	Apiaceae	4.58	12.55	0	30.6	0	0	47.73
4	Araceae	0	0	0	0	0	3.32	3.32
5	Asteraceae [2]	45.06	65.63	46.98	37.38	38.18	4.59	237.82
6	Boraginaceae	0	0	0	0.92	1.57	6.80	9.29
7	Brassicaceae [9]	14.29	21.44	13.84	9.68	5.44	0	64.69
8	Campanulaceae	0	0	5.81	0	0	0	5.81
9	Cannabinaceae	9.02	2.56	0	3.91	0	0	15.50
10	Cannaceae	0	0	0	1.02	0	0	1.02
11	Caryophyllaceae[10]	16.51	12.93	4.93	8.89	9.35	0	52.61
12	Chenopodiaceae	17.21	15.76	0	4.93	3.19	7.59	48.68
13	Convolvulaceae	4.84	4.19	0	2.12	0	0	11.15
14	Cyperaceae [4]	0	0	2.9	15.57	0	102.66	121.13
15	Dryopteridaceae	0	0	0	1.29	0	0	1.29
16	Equisetaceae	0	0	9.57	11.75	1.85	0	23.16
17	Euphorbiaceae [6]	31.97	37.61	0	11.95	3.42	0	84.95
18	Fumariaceae	1.94	1.27	0	1.57	0	0	4.79
19	Gentianaceae	2.71	0.7	6.58	0.92	14.62	10.12	35.65
20	Geraniaceae	0	3.15	1.26	0	1.57	0	5.98
21	Juncaceae	0	0	19.58	0	0	0	19.58
22	Lamiaceae	0.33	0	13.26	3	8.22	3.16	27.97
23	Malvaceae	0.33	0	0	0	0	0	0.33
24	Marsileaceae	0	0	0	0	0	5.06	5.06
25	Onagraceae	0	0	0	2.08	0	0	2.08
26	Orchidaceae	0	0	2.42	2.50	16.29	0	21.21
27	Oxalidaceae	5.05	4.9	1.45	4.34	1.71	0	17.45
28	Papilionaceae [3]	27.79	20.12	19.95	6.50	56.55	1.74	132.65
29	Plantaginaceae [5]	5.15	9.29	43.97	10.13	0	25.19	93.73
30	Poaceae [1]	82.15	70.84	48	39.25	125.72	63.88	429.84
31	Polygonaceae [8]	10.12	0.70	5.42	27.85	1.57	27.55	73.21
32	Primulaceae	12.81	0.89	0	5.51	1.57	1.42	22.21
33	Pteridaceae	0	0	0	1.72	0	0	1.72
34	Ranunculaceae [7]	13.77	6.76	19.97	14.86	4.72	17.33	77.41
35	Rosaceae	0	0	16.30	0	0	0	16.30
36	Rubiaceae	0	1.22	0	1.77	0	0	2.99
37	Scrophulariaceae	1.55	1.4	1.45	0.86	0	0	5.27
38	Solanaceae	0.39	1.27	0	2.31	1.30	0	5.27
39	Thelypteridaceae	0	0	0	19.26	0	0	19.26
40	Thymelaeceae	1.55	2.81	0	0	4.72	0	9.08
41	Urticaceae	1.0008	0	7.64	0	0	0	8.64

42	Violaceae	0	0	8.72	0.43	0	0	9.15

Appendix:4. Family importance value of summer herbaceous communities

S.N	Family name	Fallow lands	Protected areas	Riparian zone	Stream beds	Eyots	Wet lands	TFIV
		PCB	DAC	SPC	AAA	ILC	TPP	
1	Adiantaceae	0	0	0	0.67	0	0	0.67
2	Aizoaceae	13.06	0	0	0.61	0	0	13.68
3	Alismataceae	0	0	2.37	0	0	2.77	5.15
4	Amaranthaceae 4	28.55	38.62	0	37.12	1.47	18.83	124.59
5	Apiaceae	0	0	0	1.95	0	0	1.95
6	Araceae 10	0	0	0	0	0	26.12	26.12
7	Asclepiadaceae	0	0	0	0	0	4.87	4.87
8	Asteraceae 2	52.13	43.27	14.31	31.26	43.31	16.94	201.22
9	Boraginaceae	1.61	0.86	0	0	7.10	0	9.58
10	Caesalpiniaceae	0.83	2.11	0	0	0	0	2.94
11	Cannabinaceae	4.70	8.78	0	3.55	0	0	17.03
12	Cannaceae	0	0	0	2.37	0	0	2.37
13	Capparidaceae	0.44	0	0	0	0	0	0.44
14	Ceratophyllaceae	0	0	0	0.67	0	0	0.67
15	Chenopodiaceae 6	9.64	37.48	0	3.61	0	0	50.73
16	Commelinaceae	0.56	0	0	1.40	0	0	1.96s
17	Convolvulaceae	7.49	0	0	4.47	0	6.16	18.12
18	Cucurbitaceae	4.71	0	0	0	0	0	4.71
19	Cuscutaceae	0	0	0	0	0	1.17	1.17
20	Cyperaceae 3	14.20	0	90.49	8.81	30.31	38.97	182.78
21	Dryopteridaceae	0	0	0	1.10	0	0	1.10
22	Equisetaceae	0	0	6.84	2.20	9.68	1.00	19.72
23	Euphorbiaceae 7	15.48	1.11	0	2.88	6.98	6.29	32.74
24	Juncaceae	0	0	3.72	0	0	0	3.72
25	Lamiaceae	2.38	0	0	7.57	1.22	6.99	18.16
26	Lemnaceae	0	0	0	2.44	0	0	2.44
27	Lythraceae 9	0	0	17.49	7.72	0	1.34	26.55
28	Malvaceae	6.38	1.99	0	0	0	6.40	14.77
29	Marsileaceae	0	0	5.87	2.07	0	7.13	15.07
30	Nelumbonaceae	0	0	0	0	0	1.94	1.94
31	Nyctaginaceae	0.39	4.32	0	0	0	0	4.71
32	Onagraceae	0	0	1.19	1.1	0	0	2.29
33	Oxalidaceae	1.39	0	0	1.67	0	0	3.05
34	Papilionaceae	1.17	0.99	1.34	1.14	11.4	0.00	16.04
35	Plantaginaceae	0.50	0	7.03	2.26	0	5.78	15.57
36	Poaceae 1	109.85	151.03	118.4	119.81	168.1	85.88	753.12
37	Polygonaceae	2.84	0	0	17.98	0	3.91	24.73
38	Pontederiaceae	0	0	0	0	0	2	2.00
39	Portulacaceae	0	0	0	0.87	0	0	0.87
40	Potamogetonaceae	0	0	0	0	0	0.91	0.91

41	Primulaceae	0	0	0	0	0	2.61	2.61
42	Pteridaceae	0	0	0	1.10	0	2.17	3.27
43	Scrophulariaceae	13.72	1.11	0	0	0	0	14.83
44	Solanaceae 8	13.72	6.25	0	3.41	4.04	3.17	30.59
45	Sphenocleaceae	0	0	5.68	0	0	0	5.68
46	Thelypteridaceae	0	0	0	20.91	0	0	20.91
47	Tiliaceae	2.49	0	0	0	0	0	2.49
48	Typhaceae 5	0	0	22.28	5.13	8.54	44.17	80.12
49	Verbenaceae	4.32	0	3.00	2.33	7.59	4.16	21.40
50	Zygophyllaceae	1.77	2.09	0	0	0	0	3.87

Appendix:5. Quantitative biological spectrum of the herbaceous vegetation during spring.

S/N	**Life form**	Abbr.	ECC	THE	VPR	PCA	ILC	BVC	TIV	%age
1	Chamaephytes	Ch	2.5	3.31	33.97	71.18	83.5	0	194	10.8
2	Geophytes	G	1.42	1.88	16.53	27.58	16.2	85.06	148	8.3
3	Hemicryptophytes	H	30.7	9.06	18.91	41.24	76.3	65.66	241.	13.4
4	Therophytes	Th	265	285	230.6	159.	123	149.2	1214	67.5
	Leaf size									
1	Aphyllous	Ap	0	0	9.57	11.7	1.85	0	23.1	1.3
2	Leptophylls	L	1.27	7.91	25.34	0	9.89	3.32	47.7	2.7
3	Megaphylls	Meg	0	0	0	1.02	0	0	1.02	0.1
4	Mesophylls	Mes	2.68	12.7	0	12.0	0	11.71	39.2	2.2
5	Microphylls	Mic	166	114	131.7	193	150	247.8	1004	55.8
6	Nanophylls	N	129	164	133.3	82.1	137	37.17	684	38.0

Appendix:6. Quantitative biological spectrum of the herbaceous vegetation during summer.

S/N	**Life form**	Abbr	**PCB**	**DAC**	**SPC**	**AAA**	**ILC**	**TPP**	TIV	%age
1	Chamaephytes	Ch	21.6	125	66.02	18.9	96.2	41.45	369	21.3
2	Geophytes	G	14.4	1.11	124.7	21.4	38.8	107.9	308	17.8
3	Hemicryptophytes	H	43.1	28.1	59.76	97.9	63.0	38.93	330	19.1
4	Parasites	P	0	0	0	0	0	1.17	1.17	0.1
5	Therophytes	Th	218	145	49.49	98.7	101	110.5	724	41.8
	Leaf size									
1	Aphyllous	Ap	0	0	6.84	2.2	9.68	2.17	20.8	1.2
2	Leptophylls	L	9.07	2.97	5.06	5.32	6.98	29.09	58.4	3.2
3	Megaphylls	Meg	0	0	22.28	2.37	8.46	46.11	79.2	4.4
4	Mesophylls	Mes	16.5	10.2	6.56	17.05	1.35	41.85	93.5	5.2
5	Microphylls	Mic	230	226	207.8	214	219	150	1248	69.4
6	Nanophylls	N	43.5	60.1	51.43	58.97	53.9	30.76	298	16.6

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