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PHENOLOGY AND BIODIVERSITY OF RIPARIAN PLANT SPECIES OF GANGA RIVER BANK AT BHARWARI (KAUSHAMBI), U.P., INDIA

PRABODH SRIVASTAVA[a1] AND M. P. SINGH[b]

[a]P.G. Department of Botany D.S. College, Aligarh, U.P., India
E-mail: praboodh23@yahoo.co.uk
[b]P.G. Department of Botany, T.D. P.G. College, U.P., India
E-mail: mahendrapratapsinghtdpg@gmail.com

ABSTRACT

Plant communities in riparian lands are the main elements which are interacting with both aquatic and terrestrial ecosystems. It is argued that these communities can be used as indicators of the conditions in both upland and aquatic communities. Riparian vegetation protects the stream bank from flood water and also maintains biological diversity along rivers. In present study the phenology and biodiversity of riparian plant species were worked out at two sites i.e. Abandoned land and Cultivated cropland, on the Ganga River Bank at Bharwari (Kaushambi). It was found that a total of 71 plant species were recorded from both the study sites and biodiversity of plant species was highest on undisturbed site.

KEYWORDS : Riparian zone, Biodiversity, Riparian vegetation

The areas of forested land adjacent to a body of water, stream, river, marsh or shore line which form the transition between the aquatic and the terrestrial environment are referred to as riparian zone. Riparian ecosystems are the green ribbons of lush vegetation located adjacent to rivers, creeks, lakes, springs, wetlands and coulees. In other words, the riparian zone is the interface between a land and a flowing/stagnant surface water body. Riparian areas are non-linear areas along rivers & stream that are occasionally flooded by these bodies of water, but may be dry for varying portion of the growing season (Mitsch & Gosselink, 1993). Riparian lands are complex habitat on which different kinds of plant communities develop. As such riparian ecosystems are very complex ecosystems in the world (Naiman et al. 1993). Riparian ecosystem has input via water and high connectedness with other habitats. These two features make them unique habitats. Plant communities in riparian lands are the main elements which are interacting with both aquatic and terrestrial ecosystems. Holland et al. (1990) argued that these communities can be used as indicators of the conditions in both upland and aquatic communities. Riparian plant communities also constitute the major organizer of biotic associations in rivers, both by supplying food and by forming habitat. Riparian vegetation protects the stream bank from flood water and also maintains biological diversity along rivers.

Phenology is the scientific study of seasonal change i.e. the periodic phenomenon of organisms in relation to their climate. Different species have different periods of seed germination, vegetative growth, flowering and fruiting, leaf fall, seed and fruit dispersal etc. Such data for individual species are recorded. A study of the data and time of these events is phenology. It has practical uses in grasslands and other ecosystems. Most of the phenophases are genetically determined but the activity is set in motion by changing environmental conditions of habitat such as light, heat, moisture supply etc.(Daubenmire, 1968).

Growth form usually is the character which can easily display the relationship between plant and environmental factors. The life-form of a species is usually a constant feature but there are some plants which can show different life forms under different environmental conditions and the utility of the Raunkiaer's life-form classification could be used in expressing the differences and similarities among plant communities (Dombois and Ellenberg, 1974).

In India floristics and phytosociological analysis of riparian vegetarian are not many in numbers. Some workers had listed only the weed flora of cultivated lands. Some other workers such as Chakhaiyar (1981) and Mishra (1983) have done ecological survey of crop fields of Banaras Hindu University. Singh (1998) and Srivastava & Singh (2010) have studied riparian vegetation of Pili River at Jaunpur (U.P.) and Kali River at Aligarh (U.P.) respectively.

Biodiversity can be defined as the genetic variability and diversity of life forms such as plants, animals

[1]**Corresponding author**

and microbes. Biodiversity related to plant species diversity is assumed here as an index for the survival value of the community or its relative stability status. Greater the diversity, greater is its stability under the prevailing climate.

MATERIALS AND METHODS

Two different sites (1) Abandoned land (Site-I) and (2) Cultivated cropland (Site-II) were selected for the detailed study on the right bank of River Ganga at Bharwari (Kaushambi), Uttar Pradesh. Each site has a demarcation of 100m x 100m for study. Zonation of each site has been done into 1. Wet ground 2. Dry ground and 3. Upper reaches of bank. The inhabitant plant species found on each site round the year from March to Feb. next year, on all the zones were recorded. The phenology of individual species was observed every month at study site up to one year. Vegetation analysis system given by Raunkiaer (1934) and modified by Dansereau (1957) had been followed. Inclusion of flora in different life-forms according to Raunkiaer's method (1934) show climatic condition and biotic stresses.

Following symbols are used to describe the different stages of life span during phenological studies.

Symbol	Phenological stage		
1	Germination	2	Vegetative growth
3	Flowering	4	Fruit formation
5	Seed maturation	6	Death

Diversity Index

Odum et al., (1960) have regarded diversity (d) as the number of species (S) per one thousand individuals:

d = S\1000 individuals

Where, d = diversity index

S = number of species

RESULTS AND DISCUSSION

Floristic Composition

Component species of plant community is represented by floristic composition. All of the component species were identified with their different stages of growth which were found on two sites and are listed in Table, 1.

A total no. of 71 plant species was recorded from both the sites. These plants comprised of grasses, sedges, herbs, weeds and forbs etc. of 71 species 39 species were recorded from cropland site and 53 species from abandoned site. 21 species were common to both sites. The most common species which frequently occurred at (Abandoned) site-I are *Achyranthes aspera, Ageratum conyzoides, Alternanthera sessilis, Brachiaria reptans, Cassia tora, Cassia occidentalis, Convolvulus arvensis, Crotalaria medicaginea, Cynodon dactylon, Cyperus kyllingia, Commelina benghalensis, Dactyloctenium aegyptiacum, Evolvulus alsinoides, Euphorbia microphylla, Gomphrena celosioides, Heliotropium ovalifolium, Pluchea lanceolata, Saccharum munja, Vernonia cinerea, Zizyphus nummularia*. The following species were present exclusively on (Cropland) site-II and were absent from site-I, *Argemone mexicana, Anagallis arvensis, Aneilema nudiflorum, Blumea lanceolata, Brassica campestris, Chenopodium album, Cajanus cajan, Cyanotis axillaris. Lathyrus aphaca, Melilotus indica, Medicago denticulata, Polygonum plebejum, Scoparia dulcis, Sida cordifolia*.

The grasses which were most common to both the sites are viz. *Brachiaria reptans*, *Cynodon dactylon, Desmostachya bipinnata, Eragrostis tenella, Panicum javanicum, Saccharum spontaneum, Cyperus rotundus*.

The most common species which frequently occurred at site-II during cropping period as well as fallow land period are - *Anagallis arvenisis, Argemone mexicana, Asphodelus tennuifolius, Brachiaria reptans, Cynodon dactylon, Convolvulus arvensis, Cyperus rotundus, Chenopodium album, Imperata cylindrica, Eclipta prostrata, Launea asplenifolia, Melilotus indica, Polygonum plebejum, Phyla nodiflora, Saccharum spontaneum*. Out of the total plant species recorded on both sites, *Cynodon dactylon* was considered the most dominant on site-I whereas *Saccharum spontaneum* was dominant on site-II.

When the observation started in the month of March, most of the plant species were at blooming stage while quite a few were at mature fruiting stage. Only a few were in a vegetative phase near river margin where they still managed to get the moisture. In the months of April and May most of the plants showed drying and dispersal of fruits and seeds. Surviving plant species up to the middle of the month of May were *Achyranthes aspera, Ageratum conyzoides,*

Table 1 : Characteristic features of the two study sites (I & II) from March to February

Site and size	Zones	Distance from min water level (m)	Slope angle	Slope type	Span of inundation days	Months of inundation	Most characteristic species	Vegetation type	Remarks
I 100 x 100m	Wet grounds	0-35	8-10^{o}	Moderate	75	In the first week of July and during September	*Polygonum glabrum Ranunculus scleratus Cyperus rotundus* and *Phyla nodiflora*	Wetland flora	Severe riparian erosion in rainy season
	Dry Grounds	35 - 90	6 - 8^{0}	Gentle	45	In the mid of July and during August	*Desmostachya bipinnata, Pluchea lanceolata, Cynodon dactylon, Cassia occidentalis*	Ephemeral mixed flora of ruderal weeds	Erosion during floods
	Upper reaches	90 - 120	15 - 30^{0}	Steep	nil	nil	*Saccharum spontaneum, Cynodon dactylon, Cassia occidentalis, Convolvulus arvensis*	Mixed flora of ruderal weeds	Severe erosion by gullies
II 100 x 100m	Wet grounds	0 – 30	6 – 9^{0}	Moderate	60	In the first week of July up to mid of Sep.	*Cynodon dactylon, Cyperus rotundus, Impereta cylindrica*	Wet and marshy vegetation	Fertile belt, mild riparian erosion
	Dry Grounds	30 – 85	8 – 10^{0}	Moderate	40	At the end of July and during Aug.	*Desmostachya bipinnata, Argemone Mexicana, Anagallis arvensis*	Abundance of ruderal weeds mixed with ephemerals	Less fertile belt
	Upper reaches	85 - 110	20 - 30^{0}	Steep	nil	nil	*Saccharum spontaneum, Cynodon dactylon*		Erosion by rills and gullies

Argemone mexicana, Brachiaria reptans, Calotropis procera, Cynodon dactylon, Evolvulus alsinoides, Eclipta prostrata, Desmostachya bipinnata, Launea asplenifolia, Euphorbia microphylla, Pluchea lanceolata, Xanthium strumarium. Ranunculus scleratus sometimes was found up to the last of May near water margin. After middle of June the pre monsoon and monsoon rain occurs and new plant species started emerging from ground. Some of the summer plant species which withstand the extreme hot condition showed persistence till first week of August. These species were *Argemone mexicana, Convolvulus arvensis, Xanthium strumarium.* Rainy season plant species started germinating in the first week of July and showed flowering in the month of August and fruiting in the month of September and October. Some weeds also showed the germination up to middle of winter season. However winter weeds and annuals showed luxuriant growth and flowering during January and February which lasts till March. Seed maturation of winter species started in the middle of March due to start in rising of temperature. Grasses showed less sexual reproduction in comparison to asexual reproduction by means of vegetative propagation for example, *Cynodon dactylon*, *Saccharum spontaneum. Desmostachya bipinnata* etc. showed fruit formation in less quantity.

Climatic conditions were distinct and have major role in the phenological events of plant species. Most of the herbaceous plant species showed germination by seeds. Some plants appeared from the perennating structures after first shower of monsoon. Few plants showed periodicity in germination. It was shown in weeds during winter crop. Most species showed staggered germination brought about by phenomenon of dormancy which resulted in their recurrence and supported the findings of Branchley and Warrington, (1933). In winter the presence of sufficient moisture and moderate temperature resulted in the increase in large number of weeds. But as the moisture decreased and temperature rose at the onset of summer season, the number of plant species decreased drastically. Roberts and Margret (1980) also demonstrated in a series of experiments that moisture content of soil determines the pattern of weed emergence after cultivation. Plants that emerged on the exposed area after recession of flood water had shortened vegetative phase while the reproductive phase was fairly extended.

Formation of fruits in various herbs and grasses varied due to selective grazing of palatable plant species. Due to this palatable species were not able to left alive up to the formation of fruits in large numbers.

In this study the plant species were studied with regard to life-form classes of Raunkiaer (1934). Life-forms

Table 2 :life-form And Phenology of The Constituent Species At Both The Study Sites (I & II)

Plant Species	Life forms	MONTHS												
		Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Luxuriant Flowering period
1. *Acacia nilotica* (Linn.) Del	Ph	2,3	3,4	3,4,5	4,5	1,2	1,2	1,2	2	2	2	2	2	throughout the year
2. *Achyranthes aspera* Linn.	Th	4,5	5	6	1	1,2	1,2	2,3	2,3,4	3,4	2,3,4	3,4,5	4,5	Sep. to Jan.
3. *Ageratum conyzoides* Linn.	Ch	3,4,5	4,5,6	5,6	1	1,2	1,2,3	2,3	2,3	2,3	2,3	2,3,4	3,4	throughout the year
4. *Alternanthera sessilis* (Linn.) R.Br.ex DC	Th	3,4,5	3,4,5	5,6	1	1,2	1,2,3	2,3	2,3,4	2,3,4	2,3,4	3,4,5	3,4,5	Aug. to Feb.
5. *Anagallis arvensis* Linn.	Th	4,5,6	6	-	-	-	1	1,2	2	2,3,4	2,3,4	3,4	3,4,5	Nov. to Mar.
6. *Anielema nudiflorum* R.Br.	Th	-	-	-	1	1,2	2,3	3,4	3,4,5	1,2	-	-	-	Aug. to Nov.
7. *Argemone mexicana* Linn.	Th	3,4,5	3,4,5	3,4,5,6	3,4,5,6	4,5,6	1	2	2	1,2	2,3	3,4	3,4	Feb. to June
8. *Asphodelus tennuifolius* Cav.	G	3,4	4,5,6	-	-	-	-	-	-	1	1,2	2,3	3,4	Jan. to April
9. *Blumea laciniata* (Roxb.) DC	H	3,4	5	6	-	-	-	-	2	2,3	2,3	2,3	2,3,4	Nov. to Mar.
10. *Boerhaavia diffusa* Linn.	H	3,4	3,4	4,5	5	1	1,2	2,3	2,3,6	2,3,6	2,3	2,3	2,3,4	throughout the year
11. *Brachiaria reptans* (Linn.)Gard.	Th	-	-	-	1,2	2,3,4	3,4	3,4,5	3,4,5,6	5,6	-	-	-	July to Oct.
12. *Brassica campestris* (Linn.) Prain.	Th	4,5	5,6	-	-	-	-	-	-	1,2	2,3	3,4	3,4	Dec. to Mar.
13. *Calotropis procera* (Ait) R. Br.	Ph	3,4,5	3,4,5,6	6	2	2,3	2,3	3,4	4,5	5	1	1,2,3	3,4	Jan. to April
14. *Campanula marginata* Thumb.	Th	-	-	-	1	2	2,3	3,4	3,4,5	4,5,6	-	-	-	Aug. to Nov.
15. *Canscora decussata* (Roxb.)J.A. et-J.H. Schult	Th	4,5	5,6	-	-	2	2,3	2,3	3,4	3,4	3,4,5	3,4,5,	4,5	Aug. to Feb.
16. *Cassia occidentalis* Linn.	Th	-	-	-	-	1,2	1,2,3	2,3	3,4	4,5,6	-	-	-	Aug. to Nov.
17. *Cassia tora* Linn.	Th.	-	-	-	-	1,2	1,2,3	2,3,4	4,5,6	-	-	-	-	Aug. to Oct.
18. *Chenopodium album* Linn.	Th.	4,5	5,6	6	-	-	-	-	1,2	2,3	2,3,4	2,3,4,5	3,4,5	Dec. to Mar.
19. *Chrozophora rottleri* (Geis) Juss	Th	3,4	3,4,5	3,4,5	3,4,5	3,4,5	5,6	1,2	2	2	2,3	2,3	3,4	Major part of the year
20. *Cajanas cajan* Linn.	Th	3,4,5	5,6	-	-	-	-	-	-	1,2	2	2,3	3,4	Jan. to Mar.
21. *Commelina benghalensis* Linn.	Th	-	-	-	1	2	2,3	3,4	3,4,5	3,4,5,6	4,5	5,6	-	Aug to Nov.
22. *Convolvulus arvensis* Linn.	H	4,5	5	5,6	6	1	2	2,3	2,3	2,3	2,3,4	1,2,3	3,4	Oct. to April.
23. *Crotalaria medicaginea* Lamk.	Th	3,4	4,5	5,6	1,2	2	2	2,3	3,4	3,4,5	2,3,4	2,3	2,3	throughout the year
24. *Cyanotis axillaris* (Linn.) J.A. & J.H. Schult	Th	-	-	-	1	2	2,3	3,4,5	4,5	5,6	-	-	-	Aug. to Oct.
25. *Cynodon dactylon* (Linn.) Pers.	Ch	2	2	2,3	1,2,3	1,2,3	2,3	2,3	2,3,4,5	2,3,4,5	2,4,5	2	2	Major part of the year
26. *Cyperus kyllingia* Endl.	G	4,5	5,6	-	1	2,3	2,3	2,3	3,4	3,4	3,4,5	3,4,5	4,5	July to Mar.
27. *Cyperus rotundus* Linn.	H	1,4,5	1,2	1,2	1,2	1,2,3	1,2,3	1,2,3	2,3	1,2,3,4	2,3,4	1,2	2,3,4	July to Mar.
28. *Dactyloctenium aegyptiacum* Linn.	Th	-	-	-	1	1,2	1,2,3	3,4,5	4,5	5,6	-	-	-	July to Nov.
29. *Desmostachya bipinnata*(Linn.) Stapf.	Ch	2	2	2	2	2,3	2,3	2,3,4	2,3	2,3	2,3,4	3,4	4,5	throughout the year
30. *Eclipta prostrata* Linn.	Th	3,4,5	2,3,5	2,3	1,2	2,3	3	3	2,3,4	2,3,4	3,4	3,4	3,4,5	July to mar.

31. *Eragrostis tenella* (Linn.) Roem. & Schult	Th	4,5,6	3,4,5	-	1	1,2,3	3,4	3,4	3,4,5	4,5	1,2	1,2	2,3	July to Mar.
32. *Euphorbia hirta* Linn.	Th	3,4,5	3,4,5	4,5	2	2,3	2,3	3,4	3,4	3,4,5	2,4,5	2,3,4	2,3,4	throughout the year
33. *Euphorbia microphylla* Heyne ex. Roth	Th	4,5	4,5	4	3,5	2,3,4	3,4	4	2,4	3,4	3,4,5	3,4,5	4,5	throughout the year
34. *Evolvulus alsinoides* Linn.	H	3,4	3,4,5	4,5	1,5	1,2	2	2	2,3	2,3	2,3	2,3	3,4	Oct. to May
35. *Gomphrena celosioides* Mart.	Th	3,4,5	4,5	6	-	-	-	1	1,2	2	2,3	2,3,4	3,4	Dec. to Apr.
36. *Heliotropium ovalifolium Forsk.*	Th	4,5	2,5	2	1,2	2	2,3	2,3	2,3	2,3,4	3,4	3,4,5	4,5	Aug. to Feb.
37. *Imperata cylindrica* (Linn.)Beauv.	Ch	2,3,4	4,5,6,	5,6	5,6	1,2	2,3	2,3	2,3,4	2,3,4	4,5	1,2,3	2,3	Aug. to Mar.
38. *Indigofera cordifolia* Heyne ex. Roth.	Th	3,4,5	4,5	5,6	5,6	1,2	2,3	2,3	2,3,4	3,4	2,3,4	3,4	3,4	July to Apr.
39. *Indigofera linifolia* (Linn.) Retz.	Th	2,3,4	2,4,5	3,4,5	2,3,4	3,4	3,	2,3	3,4	3,4	2,3	2,3	3,4	Major part of the year
40. *Justicia diffusa* Willd.	Th	4,5	-	-	1	2	2,3	2,3,4	3,4	3,4	3,4	3,4	3,4,5	Aug. to Feb.
41. *Jatropha gossypifolia* Linn.	Th	-	-	-	1,2,	3,4	3,4,5	3,4,5	4,5	4,5	3,5	3,5	6	July to Oct.
42. *Lathyrus aphaca* Linn.	H	3,4,5	4,5	-	-	-	-	-	-	1	1,2	2,3	3,4	Jan. to Mar.
43. *Launea asplenifolia* Hk.f.	H	3,4,5	2,3	2,3,4	2,3,4	2,3	2,3	2,3	2,3	2,3	2,3,4	2,3,4	3,4	Oct. to Feb.
44. *Leucas aspera* (Willd.) Spreng	Th	4,5	5	-	-	1,2	2,3	3	3,4	3,4	2,3,4	3,4,5	3,4,5	Aug. to Feb.
45. *Lindernia ciliata* (Colsm.) Pennell	Th	-	-	-	1	1,2	2,3	2,3,4	3,4,5	4,5	-	-	-	Aug. to Nov.
46. *Malvastrum tricuspidatum* A. Gray	Th	4,5	-	-	1,2	1,2	2,3	3	3,4	3,4	2,3,4	3,4	3,4,5	Aug. to Feb.
47. *Medicago denticulata* Willd.	Th	4,5	3,4,5	4,5	5,6	-	-	-	2	2,3	2,3,4	3,4	3,4,5	Nov. to Apr.
48. *Melilotus indica* (Linn.) All.	Th	3,4,5	3,4,5	4,5	4,6	-	-	-	2	2,3	2,3,4	3,4	3,4,5	Nov. to Apr.
49. *Nicotiana plumbaginifolia* Viv.	Th	3,4,5	3,4	3,5	3	6	2	2,3	2,3	2,3,4	2,3,4	3,4	3,4,5	Oct. to May.
50. *Oldenlandia dichotoma* Hk.f.	Th	4,5	5,6	-	1	2	2	2,3	2,3	2,3,4	2,3,4	3,4	3,4,5	Oct. to Mar.
51. *Panicum javanicum* Poir.	Th	-	-	-	-	1	2,3	3,4	3,4,5	4,5	-	-	-	Aug to Mar.
52. *Parthenium hysterophorus* Linn.	Th	2,3,4	3,4	3,4,5	4,5,6	5,6	-	-	1,2	1,2	2	2,3	2,3,4	Dec. to May.
53. *Phyla nodiflora* (Linn.) Greane	Ch	2,3,4	2,3,4	2,3,4	3,4,5	3,4,5	2,5	2,4	2,3,4	2,3,4	2,3,5	2,4,5	2,3	throughout the year
54. *Phyllanthus fraternus* Webster	Th	-	-	-	1	1,2	2,3	3,4	3,4	4,5	5,6	-	-	Aug. to Oct.
55. *Phyllanthus niruri* Linn.	Th	-	-	-	1	1,2	2,3	2,3	3,4	3,4	4,5	4,5	5,6	Aug. to Nov.
56. *Pluchea lanceolata* Linn.	Th	2,3,4	2,3,4	3,4,5	3,4,5	2,3,4	2,3	2,3,5	2,5	2,3	2	2	2,3	throughout the year
57. *Polygala chienensis* Linn.	Th	-	-	-	1	1,2	1,2	2,3	2,3	3,4	4,5	-	-	Aug. to Nov.
58. *Polygonum glabrum* Willd.	H	3,4	3,4,5	3,4,5	4,5	-	-	-	1,2	2	2,3	2,3,4	3,4	Oct. to Apr.
59. *Polygonum plebejum* R.Br.	Ch	2,3,4	3,4,5	3,4,5	2,4,5	1,2,3	2,3	2,3	2,3	2,3,4	2,3,4	2,4	2,3	Oct. to May
60. *Potentilla supina* Linn.	Th	-	-	-	1,2	1,2,3	2,3	3,4	4,5	6	-	-	-	July to Sep.
61. *Ranunculus scleratus* Linn.	Th	2,3,4	2,3,4	2,3,4,5	4,5,6	-	-	-	1,2	2	2	2,3	2,3,4	Jan. to May
62. *Rumex nigricans* Hk.f.	Th	3,4,5	2,4,5	-	-	-	-	-	2	2	2,3	2,3	3,4	Dec. to Apr.
63. *Saccharum spontaneum* Linn.	Ch	2	2	2,6	2	2	2	2	2,3	2,3,4	2,3,4	2	2	July to Nov.
64. *Saccharum munja* Roxb.	Ch	2	2	2,6	2	2	2	2	2,3	2,3,4	2,3,4	2,3,4	2	July to Dec.
65. *Scoparia dulcis* Linn.	Th	2,3,4	3,4,5	4,5	1,2	1,2	2,3	2,3,4	2,3,4	2,3,4	2,3	2,3	2,3,4	throughout the year
66. *Sida cordifolia* Linn.	Th	-	-	-	-	1,2	2,3	2,3	2,3,4	4,5	4,5,6	-	-	July to Sep.
67. *Solanum nigrum* Linn.	Th	3,4	4,5	5	2,3	2,3	2,3	3	2,3	2,3	2,3,4	3,4	3,4	July to Apr.
68. *Solanum xanthocarpum* Schrad.	Th	2,3	3,4,5	3,4,5	4,5	1,2,5	3	2,3	2,3,4	3,4	2	2	2	Aug. to Apr.
69. *Vernonia cinerea* (Linn.) Less	Th	3,4,5	3,4,5	4,5	1,2	2,3	3	3,4	3,4	2,4	2,3	3,4	3,4	throughout the year
70. *Xanthium strumarium* Linn.	Th	2,3	3,4,5	2,3,4,5	4,5	1,2,5,6	3	2,3	2,3,4	2,4	2	2	2	throughout the year
71. *Zizyphus nummularia* (Burm.f) W.& A.	Ph	-	2	-	2	-	-	-	-	-	2	-	-	Flowers & fruits absent

Symbols 1- Germination, 2- Vegetative phase, 3- Flowering, 4- Fruiting, 5- Mature Seeds, 6- Death of the plant

Ph - Phenerophytes, Ch - Chamaephytes, H - Hemicryptophytes, G - Cryptophytes or Geophytes, Th - Therophytes

of species present on the two sites are listed in Table, 2. The percentage of therophytes is maximum and of geophytes is minimum. The percentage of hemicryptophytes stands next to therophytes. Similar findings were obtained by various other workers on the river banks in India (Srivastava, 1944; Rao, 1968; Prakash, 1982; Singh, 1984 and Singh, 1998). In comparison to normal biological spectrum of Raunkiaer it can be said that the flora can be regarded as therophytic although the phyto-climate is not of therophytic type as these differences were brought about by periodic floodings and prevailing biotic stresses at study sites.

Therophytes become dominant life-form on the riparian sites only due to periodic physical and biotic stresses of which the flooding and overgrazing are the most common factors. But the exposure, silting, run-off and soil erosion also cause elimination of shrubs and facilitate dominance of therophytes. Phanerophytes were least which confirms the views of Misra and Puri (1954) who stated that intense human exploitation reduced phanerophytic flora into therophytic one.

The diversity index at both sites during the year is shown separately in the Table 3. On site I the maximum diversity index value of 51 was shown in the month of September and the minimum value of 23 was shown in the month of May.

Table 3 : Biological spectrum of both the sites (I and II) as compared with those of other places in India and Raunkiaer's normal spectrum

Place	% distribution of life forms				
	Ph	Ch	H	G	Th
World Normal Spectrum (Raunkiaer, 1934)	46	9	26	6	13
Allahabad (Srivastava, 1944)	38	9.2	3.4	7.8	41.6
Karmnasa watershed (Rao, 1968)	40	6	1	10	43
Jaunpur district	24.3	-	0.37	7.8	67.4
Rouza ghat area (Singh, 1984)	2.59	4.31	9.48	3.45	80.17
Present Study (Kaushambi)	**4.1**	**10.9**	**12.3**	**2.7**	**69.86**

Ph - Phanerophytes; Ch - Chamaephytes;
H - Hemicryptophytes; G - Geophytes;
Th - Therophytes

On site II the maximum value for diversity index 38 was shown in the month of November and minimum 16 in the month of May. During winter cropping period the highest diversity index value of 31 was noted in the month of January and lowest index value was noted in the third week of December.

Similarity index for the two sampled sites (I & II) was calculated which gives an information about the plant communities at both the sites. Respective dissimilarity index was also calculated for both the sampled sites. These values are given in Table, 4 along with biodiversity indices. The peak value for similarity index was obtained in the month of May which was 0.56 while the months of July and September show a little lower value of 0.52 & 0.51 respectively. The lowest value of similarity index was obtained in the month of November which was 0.48. Dissimilarity index was recorded at the highest value of 0.59 in the month of November and lowest value of 0.44 in May. These values always remained less than unity.

Diversity of plant species at both the sites remained minimum during May when extremely dry condition prevails. This was due to extreme unfavorable conditions presented in the month of May for the growth of herbaceous plant species. Plant species diversity index was higher during rainy and post monsoon periods on site-I and fallow land of site-II. Diversity index is very much affected by grazing patterns and status of soil moisture.

Similarity index was higher in the month of May because most of the common species were weeds and grasses which showed growth in the extreme environmental conditions also. So when most of the herbaceous species died in the month of May thereby lowering the total number of species present at the same time, the common species to both sites show larger proportion in the total species at both sites. Likewise dissimilarity index was also lowered in the month of May. Similarity index show the degree of similarity of abiotic and biotic conditions at both the sites as well as the number of species which show more ecological tolerance to various conditions. The high value of similarity index reveals highly uniform environmental conditions which prevails in the two different plant communities at different place whereas low value show distinct

Table 4 :total Number oPlant Species Per 1000 Individuals Counted (Diversity Index - DI) At Different Sampling Dates At Both The Sites (I & II) And Their Similarity (SI) And Dissimilarity (DSI) Indices

Sampling dates	SITE-I (DI) No. of Species per 1000 individuals counted (A)	SITE-II (DI) No. of Species per 1000 individuals counted (B)	No. of Species common to both sites (C) x 2	Similarity Index (SI) 2C/(A+B)	Dissimilarity Index (DSI)
21st March	39	31	17 x 2 = 34	34/70 = 0.48	0.52
22nd May	23	16	11 x 2 = 22	22/39 = 0.56	0.44
21st July	47	29	20 x 2 = 40	40/76 = 0.52	0.48
22nd Sep.	51	30	21 x 2 = 42	42/81 = 0.51	0.49
21st Nov.	48	38	18 x 2 = 36	36/86 = 0.41	0.59
22nd Jan.	40	31	17 x 2 + 34	34/71 = 0.47	0.53

heterogeneity.

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