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Floral diversity and limnological studies in and around Dholbaha dam (Punjab Shivalik, India)

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ABSTRACT

A detailed study on the floral diversity and limnological parameters were carried out at Dholbaha dam, Punjab, India during 2002-04. The study area has a moist deciduous forest surrounding it. A total of 82 plant species, including 15 algaes, 6 pteridophytes, 1 gymnosperm and 60 angiosperms (13 trees, 8 shrubs, 4 climbers, 1 parasite, 9 herbs, 10 grasses and 15 aquatic & wetland vegetation) were recorded during the study period.

Key words: Floral diversity, limnological parameters, Dholbaha dam, Punjab Shivalik, India

INTRODUCTION

The vast stretches of high mountains of Himalaya in the north provide a complex terrain of the Himalayan region, which change frequently, provide endless microclimatic conditions suitable to the species to grow and evolve. The Himalaya has more than five micro-endemic centers, Shivalik ranges are one such micro-endemic center. These ranges are among the youngest hills in the world and are active as well as fragile. The Shivaliks have been identified as one of the eight most degraded rain-fed agro ecosystems of the country. There are acute shortages of drinking water, fodder and fuel wood, caused by deforestation, decreased vegetative cover and soil erosion. Rain fed agriculture is the prevalent production system in Shivaliks. The Punjab Shivalik, because of their peculiar geological formations and exposure to greater biometrical treatment due to their proximity to plains, represent the most fragile ecosystem of Himalayan mountainous range (Sud *et al.*, 2000).

Biodiversity, comprising the variability of genes, species and ecosystems, is essential for maintaining the basic process on which, life depends and is a key to sustainable development. It not only provides food, medicine and products of commercial and non-commercial use, but also maintains life by providing environmental services like, air, water quality, soil fertility, pest and disease control and waste disposal, etc. However, human activities, which have adversely affected the environment, are leading to loss of the planet biodiversity. Shivalik hills of Punjab have rich biodiversity and are the major natural green belt of the state. The state is well known for agricultural produce and industries, but the degradational activity coupled with the destruction of forests in the process of development activities has altered the natural landscape of the region to a great extent. It is facing threat for its very existence again from mankind in the name of development. Because of these increased anthropogenic activities as a result of population and agricultural explosion and change in land use practices, the natural landscape has been modified which has resulted in fragmentation of forests with poor species composition. Hence, the resulting landscape mosaic is a mixture of natural and human managed patches that vary in size, shape and arrangement.

The Punjab State is also rich in wetlands, about 147.39 km^2 and 8.39 km^2 area is under manmade and natural wetland, which is about 0.31% of the Punjab area. These manmade

dams have played a major role in defining the ecology of rural areas providing natural drainage, acting as ground water rechargers and providing habitat to the local flora and fauna. The drainage channels in the Shivalik range originate on the sloping land in the upper reaches of the watersheds and develop into gullies. A series of such gullies or channels may combine further down to take the form of gorges or ravines. Such ravines merge into seasonal streams towards the lower reaches of a watershed. The main water resources in the area are springs, nallahs, wells, tube-wells and rivers. As many as 17 small dams have been constructed as water harvesting structures in the Punjab Shivalik and the study site, Dholbaha dam is among one of them.

Perusal of literature reveals that no consolidated account is available on the floral diversity and limnological studies of Dholbaha Dam, though Bamber (1916) published work on plants of Punjab, Parker (1956) on forest flora for the Punjab, Sharma and Bir (1978) on flora of Patiala, Sharma (1990) on Punjab plants, Mittal *et al.* (2000) on sustainable resource management in Shivaliks, Alfred and Nandi (2002) on freshwater ecosystems of India, Sud *et al.* (2000) on surface water resources development in Kandi area-Punjab, Annonymous (2003) provided detailed study of Biodiversity in the Shivalik Ecosystem of Punjab and Sharma and Joshi (2007) studied diversity of Odonata (Insecta) from Dholbaha dam. Therefore, the present study makes a modest attempt to explore the existing floral diversity from Dholbaha dam.

MATERIALS AND METHOD

Study Area

Dholbaha dam is a man made wetland in village Dholbaha of district Hoshiarpur (Punjab: India), which is a part of Shivalik hills (9448.97 Km^2) of Punjab state and lies between latitude 30°34'10.82" and 32°33'02.96" North and longitude 74°50'30.30" and 76°52'51.26" East. Dholbaha Dam is constructed as under water harvesting structure in the year 1987, for controlling the water, which used to cause heavy loss to the nearby villages. Dholbaha dam is earth filled dam and area under water is 132 ha. The total catchment area of the Dholbaha dam is 56.14 Km^2 and it is 32 Km from Hoshiarpur town. The Dholbaha dam exists throughout the year although the water level may vary, thus it forms a congenial habitat for large number of aquatic insects and fishes. The prevailing climatic condition in Dholbaha dam is typically sub-tropical and north Indian monsoon type with distinct summer and winter months. The temperature varies between 14°-47°C in summer, where as between 0°-32°C during winter. The south-west monsoon arrives during June and remains till October. The average annual rainfall varies between 400-600 mm. The forest type around Dholbaha dam is moist deciduous. For carrying out the present studies the total reservoir and surroundings were divided into four sectors based on distribution and the types of vegetation and topography. The total reservoir and surroundings were divided into four sectors in accordance with distribution and the types of vegetation and topography. In each sector five spots were selected according to the maximum availability of floral species for the present study.

Abiotic Factors

Limnological parameters for water analysis were studied once in a month to obtain the variations in water quality in different seasons by using Standard Methods for Examination of Water and Wastewater (Anonymous, 1976). Following limnological parameters were studied.

Physical Parameters

Colour: The colour of the water sample may be observed usually through naked eyes after taking the sample in a glass test tube.

Turbidity: Turbidity refers to the relative clarity of water. The turbidity of water can be measured by secchi disc method which is based on the visibility of an object in water, is an approximation.

Water temperature: Water temperature was measured with the help of thermometer (0-50°C).

Chemical Parameters

pH: Water pH was calculated with the help of indicator pH paper of 5-12 range.

Dissolved Oxygen (DO): The levels of DO in natural water depends on the physical, chemical and biochemical activities in the water body. In the present study dissolved oxygen was estimated through modified Winkler or Iodometric method (Das, 1989). Water samples were taken from the bank of the reservoir and from a moderate depth with the help of a 250 ml BOD bottle. The bottle was first totally submerged to the approximate depth of 10 cm from the surface. Then the stopper was removed. After the bottle totally filled with water, a glass coverslide was horizontally kept in the mouth of the bottle tightly and it was taken out of water. Immediately after removing the coverslide with gentle hand, 2 ml of $MnSO_4$ reagent and 2 ml of NaOH + NaCl were added just below the surface. Then the bottle was stoppered and mixed vigorously by inversion. The precipitate was allowed to settle. After final settling of precipitate, 2ml of conc. H_2SO_4 was added with a pipette and the bottle was shaked until the precipitate got dissolved. 100 ml of the water sample was transferred to a 250 ml conical flask with the help of a volumetric pipette. It was titrated rapidly with 0.005 N standardized sodium thiosulphate solution filled in a 50 ml burette, until iodine colour of the sample was reduced to pale yellow or straw colour. Two drops of stabilized starch mixture was added to get uniform blue colour and the titration was continued rapidly but continuously until the blue colour first disappeared. The titration was discountinued at the end point. Any return of blue colour was ignored. The volume (ml.) of titrant used was recorded up to 2 decimal places. The dissolve oxygen of the water sample was calculated using following formula:

Dissolve oxygen (O_2) mg/lit. = ml. of Sodium thiosulphate consumed x 4

***Free CO_2 (Carbon-dioxide)*:** The amount of free CO_2 in the water sample was determined by Titrimetric method using phenolphthalein as an indicator. 50 ml of the water sample was taken in a Nesslers tube jar (200 x3^2 mm) and 2 drops of phenolphthalein solution was added. (N/44) NaOH was added by a burette and stirred gently. Titration was continued until permanent pink colour appeared. The amount of free CO_2 is expressed in part per million (ppm). It was calculated by multiplying the number of ml of (N/44) NaOH used in titration by 20.

Mathematically it is expressed by the following formula:

Free CO_2 (mg/lit.) = No. of ml. of (N/44) NaOH required for titration x 20

Biotic Factors

Analysis of vegetation

Detailed survey of the study site was carried out in order to find out the composition of the vegetation. Monthly collections of floral species were made regularly from the randomly selected spots. Herbarium of collected vegetation samples prepared and unidentified collection of vegetation samples were authentically identified with the help of experts and literature available in libraries of Forest Research Institute, Botanical Survey of India, Dehra Dun and Punjab State Council of Science and Technology, Chandigarh.

RESULTS AND DISCUSSION

Abiotic Factors

Climatically, the study area (Dholbaha Dam) is typically sub-tropical with hot summers and cold winters. There are also considerable differences in weather from season to season as well as from year to year. The whole year is divided into three seasons: winter (November to February), summer (March to June) and rainy (July to October).

Physical parameters

***Colour*:** The colour of water sample varied from light brown to dark brown

during the study period 2002-2004. During the first year of study (2002-03), the colour of water sample varied from light brown (December-May) to dark brown (June-November). During the second year of study (2003-04) colour varied from light brown (January-May) to dark brown (June-December).

***Turbidiy*:** During the first year of study (2002-03), the turbidity of reservoir water varied from minimum 31 cm (June) to maximum 38 cm (September & January). During the second year of the study (2003-04), the turbidity of reservoir water varied from minimum 32 cm (June) to 37 cm (January).

Water temperature: The water temperature of the reservoir has been measured at noon (12:00 pm). During the first year of study (2002-03), the water temperature varied from 10^0C (January) to 27.6^0C (August). During the second year of study (2003-04), the water temperature varied from 9.0^0C (January) to 27.3^0C (August). The curve of water temperature of the reservoir reached its peak during August, while the minimum temperature recorded during January.

Chemical parameters:

***pH*:** The pH of the reservoir water during the first year of study (2002-03) varied from minimum 7.4 (January) to maximum 9.2 (June). During the second year of study (2003-04) the pH varied from minimum 7.2 (January) to maximum 9.2 (July). From the data, it is observed that during study period (2002-04) the reservoir water remains alkaline, however in January the water tends to become somewhat neutral.

Dissolved oxygen: The quantity of dissolved oxygen in reservoir water during the first year of study (2002-03) varied from minimum 8.8 mg/lit (January) to maximum 12.1 mg/lit (July). During the second year of study (2003-04), the quantity of dissolved oxygen varied from minimum 9.2 mg/lit (January) to maximum 11.9 mg/lit (August). The curve of dissolved oxygen of reservoir water reaches its peak during July and August, while it goes down during December and January.

***Free carbon-dioxide*:** The quantity of free CO_2 in reservoir water during the first year of study (2002-03) varied from minimum 2.9 mg/lit (May) to 4.1 mg/lit (January). During the second year of study (2003-04), the quantity of free CO_2 varied from minimum 2.8 mg/lit to maximum 4.0 mg/lit (March). The amount of free CO_2 in the reservoir water varies and remains somewhat same except May month when a sharp down fall occurs. The data analysed on all these six limnological parameters recorded monthly during 2002-2004 are given in Table 1, 2.

Biotic Factors

Analysis of vegetation

The forest type around Dholbaha Dam is moist deciduous. The study site and surrounding area is rich in flora. Floristic composition is the major anatomical characters of the plant community. Thus, a detailed survey of the vegetation was carried out in and around the study site during the study period 2002-04. A total of 82 plant species, including 15 Algae, 6 Pteridophytes, 1 Gymnosperm and 60 angiosperms (13 trees, 8 shrubs, 4 climbers, 1 parasite, 9 herbs, 10 grasses and 15 aquatic & wetland vegetation) were recorded from all the four sectors of study sites. Table-3 shows the sector-wise details of the plant community.

SECTOR-I: A total of 69 species of plants were recorded during the study period, which

included 15 species of algae, 5 species of pteridophytes, 1 species of gymnosperm, 48 species of angiosperms (10 species of trees, 7 species of shrubs, 3 species of climbers, 1 species of parasite, 7 species of herbs, 9 species of grasses and 11 species of aquatic and wetland vegetation). This sector in terms of algae was mainly dominated by *Spirogyra grossii* Schemidle, *S. maxima* (Hassall) followed by *Diatoma elongatum* Ag. and *Ulothrix variabilis* (Kutz). In terms of pteridohytes the dominant species was *Dryopteris cochleata* (Buch.-Ham.) followed by *Adiantum incisum* Forssk. and *Equisetum debile* Roxb. In terms of forest the dominant species was *Pinus roxubrghii* Sarg and *Acacia nilotica* (Linn.) followed by *Dalbergia sissoo* Roxb., *Ficus palmata* Forssk. and *Morus alba* Linn. In terms of shrubs the dominant species was *Adhatoda zeylanica* Medik., *Lantana camera* Linn. and *Ipomoea carnea* Jacq. followed by *Withania somnifera* (Linn.). The ground vegetation was dominated by *Euphorbia hirta* Linn. and *Xanthium indicum* Koen. followed by *Cannabis sativa* Linn. and *Solanum nigram* Linn., *Phragmites karka* (Retz.), *Saccharum bengalense* Retz. and *Themeda anathera* (Neesex-Steud). The aquatic and wetland vegetation of this site was dominated by *Cyperus rotundus* Linn., *Hydrilla verticillata* (Linn.), *Typha angustata* Bory & Chaub., *Polygonum barbatum* Linn and *Potamogeton pectinatus* Linn.

SECTOR-II: A total of 53 species of plants were recorded during the study period, which included 15 species of algae, 4 species of pteridophytes, 34 species of angiosperms (5 species of trees, 7 species of shrubs, 2 species of climbers, 1 species of parasite, 6 species of herbs, 5 species of grasses and 8 species of aquatic and wetland vegetation). This sector in terms of algae was mainly dominated by *Spirogyra hyalina* Cleve, *S. rivularis* (Hassall) followed by *Ulothrix variabilis* (Kutz) and *Zygnema cruciatum* (Vaucher). In terms of pteridohytes the dominant species was *Dryopteris cochleata* (Buch.-Ham.) followed by *Equisetum debile* Roxb. In terms of forest the dominant species was *Acacia nilotica* (Linn.), *Bombax ceiba* Linn. followed by *Dalbergia sissoo* Roxb., and *Morus alba* Linn. In terms of shrubs the dominant species was *Ipomoea carnea* Jacq., *Lantana camera* Linn., *Adhatoda zeylanica* Medik. and followed by *Withania somnifera* (Linn.). The ground vegetation was dominated by *Xanthium indicum* Koen. And *Euphorbia hirta* Linn. followed by *Cannabis sativa* Linn. and *Solanum nigram* Linn., *Saccharum bengalense* Retz. and *Phragmites karka* (Retz.). The aquatic and wetland vegetation of this site was dominated by *Hydrilla verticillata* (Linn.), *Cyperus rotundus* Linn., *Polygonum barbatum* Linn. and *Typha angustata* Bory & Chaub.

SECTOR-III: A total of 53 species of plants were recorded during the study period, which included 15 species of algae, 5 species of pteridophytes, 33 species of angiosperms (7 species of trees, 5 species of shrubs, 1 species of climbers, 1 species of parasite, 5 species of herbs, 7 species of grasses and 7 species of aquatic and wetland vegetation). This sector in terms of algae was mainly dominated by *Spirogyra gibberosa* Jao, *S. maxima* (Hassall) followed by *Diatoma elongatum* Ag. and *Closterium moniliferum* (Bory.). In terms of pteridohytes the dominant species was *Dryopteris cochleata* (Buch.-Ham.) followed by *Adiantum incisum* Forssk. and *Marsilea minuta* Linn. In terms of forest the dominant species was *Dalbergia sissoo* Roxb. followed by *Acacia nilotica* (Linn.), *Ficus palmata* Forssk. and *Morus alba* Linn. In terms of shrubs the dominant species was *Lantana camera* Linn., *Adhatoda zeylanica* Medik. and *Ipomoea carnea* Jacq. followed by *Ziziphus nummularia* (Burm.). The ground vegetation was dominated by *Euphorbia hirta* Linn. and *Xanthium indicum* Koen. followed by *Cannabis sativa* Linn. and *Solanum nigram* Linn., *Saccharum bengalense* Retz., *Phragmites karka* (Retz.) and *Themeda anathera* (Neesex-Steud). The aquatic and wetland vegetation of this site was dominated by *Hydrilla verticillata* (Linn.), *Typha angustata* Bory & Chaub., *Wolffia globosa* (Roxb.) and *Rotala rotundifolia* (Roxb.).

SECTOR-IV: A total of 60 species of plants were recorded during the study period, which included 15 species of algae, 5 species of pteridophytes, 1 species of gymnosperm, 39 species of angiosperms (7 species of trees, 5 species of shrubs, 3 species of climbers, 1 species of parasite, 7 species of herbs, 7 species of grasses and 9 species of aquatic and wetland vegetation). This sector in terms of algae was mainly dominated by *Spirogyra hyalina* Cleve, *S. spreeiana* Robenh. followed by *Ulothrix variabilis* (Kutz) and *Diatoma elongatum* Ag.. In terms of pteridohytes the dominant species was *Adiantum incisum* Forssk. followed by *Dryopteris cochleata* (Buch.-Ham.) and *Equisetum debile* Roxb. In terms of forest the dominant species was *Acacia nilotica* (Linn.) and *Pinus roxubrghii* Sarg followed by *Dalbergia sissoo* Roxb., *Morus alba* Linn and *Ficus palmata* Forssk.. In terms of shrubs the dominant species was *Lantana camera* Linn. and *Adhatoda zeylanica* Medik. followed by *Agave angustifolia* Haw. The ground vegetation was dominated by *Euphorbia hirta* Linn. and *Cannabis sativa* Linn. followed by *Solanum nigram* Linn., *Saccharum bengalense* Retz., *Phragmites karka* (Retz.) and *Vetiveria zizanioides* (Linn.). The aquatic and wetland vegetation of this site was dominated by *Typha angustata* Bory & Chaub., *Cyperus rotundus* Linn., *Hydrilla verticillata* (Linn.), *Polygonum barbatum* Linn and *Eichhornia crassipes* (Mart.).

The presence of light brown or dark brown colour in water sample of Dholbaha dam indicates the presence of algae, weeds, humus, peat, iron, copper, manganese metals etc., and is free from industrial pollution. As the turbidiy of reservoir water during the study period (2002-04) varied between 31 cm to 38 cm is better for survival of water life. The water temperature of the reservoir varied from 9^0C to 27.6^0C during the study period, is better for survival of fauna and flora. As the pH of reservoir water is alkaline, it is a shine of healthy water body. As the dissolved oxygen of reservoir water varied from 8.8 mg/lit to 12.1 mg/lit, that considered study site healthy. The temperature also affects the dissolved oxygen, as oxygen is more soluble in cold than in warm water. During study period (2002-04), free CO_2 varied from 2.8 mg/lit to 4.1 mg/lit, that considered study site healthy. Temperature is the most important abiotic factor, which acts on insects directly in a variety of ways. The movement of body, respiration, circulation, digestion, development of their eggs, larvae *etc*. depend upon the external temperature. Temperatures below 25^0C slowed the activity whereas an optimal temperature above 30^0C increased activity (Jacobs, 1955). Mittal *et al*. (2000) reported that the Punjab shivalik falls in the sub- moist to humid and less hot region, with a temperature varies from a minimum 2^0C in winters to a maximum of about 42^0C in summers and the average annual rainfall varies between 400 mm to 600 mm. Bamber (1916), Parker (1956), Sharma and Bir (1978) and Sharma (1990) worked on flora of Punjab and Annonymous (2003) provided detailed study of Biodiversity in the Shivalik Ecosystem of Punjab. Therefore, the present study made an attempt to explore floral diversity and limnological perameters of Dholbaha Dam, which will help to provide the base for future studies of wetlands and waterbodies. The limnological study of the Dholbaha Dam indicates that the study area is free from pollution and rich in floral diversity.

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Table 1. Limnological Parameters of Dholbaha Dam during 2002-03

Months	Water colour	Turbidity (cm.)	Water temp. (˚C)	pH	DO (mg/lit)	Free CO_2 (mg/lit)
Oct.	Dark brown	34.5	23.0	8.2	10.8	3.4
Nov.	Dark brown	35.0	20.0	8.5	10.4	3.8
Dec.	Light brown	36.0	12.0	8.0	9.6	3.9
Jan.	Light brown	38.0	10.0	7.4	8.8	4.1
Feb.	Light brown	36.0	12.0	7.8	9.5	4.0
March	Light brown	35.0	17.4	8.6	11.2	3.8
April	Light brown	32.0	23.0	8.2	10.9	3.2
May	Light brown	34.0	26.0	8.8	11.4	2.9
June	Dark brown	31.0	27.0	9.2	11.8	3.4
July	Dark brown	35.0	26.5	9.1	12.1	3.6
Aug.	Dark brown	36.0	27.6	8.7	11.5	3.9
Sept.	Dark brown	38.0	24.0	8.5	11.1	3.8

Table 2. Limnological Parameters of Dholbaha Dam during 2003-04

Months	Water colour	Turbidity (cm.)	Water temp. (˚C)	pH	DO (mg/lit)	Free CO_2 (mg/lit)
Oct.	Dark brown	35.0	22.0	8.0	10.6	3.5
Nov.	Dark brown	36.0	19.0	8.3	10.2	3.6
Dec.	Dark brown	35.0	11.0	7.8	9.7	3.8
Jan.	Light brown	37.0	9.0	7.2	9.2	3.9
Feb.	Light brown	36.0	11.8	7.6	9.4	3.8
March	Light brown	34.5	16.6	8.4	10.9	4.0
April	Light brown	33.0	22.5	8.0	10.8	3.6
May	Light brown	35.0	25.0	8.5	11.2	2.8
June	Dark brown	32.0	26.4	9.0	11.6	3.2
July	Dark brown	34.0	26.8	9.2	11.4	3.4
Aug.	Dark brown	36.0	27.3	8.7	11.9	3.8
Sept.	Dark brown	35.0	23.8	8.4	11.2	3.5

Table 3. Floristic composition of four sectors in and around Dholbaha dam during 2002-04

Sl. No.	Plant species	Sector I	Sector II	Sector III	Sector IV
(A)	**ALGAE**				
1.	*Closterium moniliferum* (Bory.)	+	+	+	+
2.	*Diatoma elongatum* Ag.	+	+	+	+
3.	*Mougeotia caelestis* Transeau	+	+	+	+
4.	*M. ovalis* (Hassall)	+	+	+	+
5.	*Spirogyra gibberosa* Jao	+	+	+	+
6.	*S. grossii* Schmidle	+	+	+	+
7.	*S. hyalina* Cleve	+	+	+	+
8.	*S. lagerheimii* Wittrock	+	+	+	+

9.	*S. minutifossa* Jao	+	+	+	+
10.	*S. maxima* (Hassall)	+	+	+	+
11.	*S. rivularis* (Hassall)	+	+	+	+
12.	*S. spreeiana* Robenh.	+	+	+	+
13.	*Ulothrix variabilis* (Kutz.)	+	+	+	+
14.	*Zygnema cruciatum* (Vaucher)	+	+	+	+
15.	*Z. vaucherii* Ag.	+	+	+	+
(B)	**PTERIDOPHYTES**				
16.	*Adiantum incisum* Forssk.	+	-	+	+
17.	*Cheilanthes bicolor* (Roxb.)	-	+	-	+
18.	*Christella dentate* (Forssk.)	+	+	+	-
19.	*Dryopteris cochleata* (Buch.-Ham.)	+	+	+	+
20.	*Equisetum debile* Roxb.	+	+	+	+
21.	*Marsilea minuta* Linn.	+	-	+	+
(C)	**GYMNOSPERM**				
22.	*Pinus roxburghii* Sarg.	+	-	-	+
(D)	**ANGIOSPERMS**				
(i)	**Trees**				
23.	*Acacia catechu* (Linn.)	-	+	-	+
24.	*A. modesta* Wall.	+	-	-	-
25.	*A. nilotica* (Linn.)	-	-	+	-
26.	*Azadirachita indica* Juss.	+	-	+	+
27.	*Bombax ceiba* Linn.	+	+	+	+
28.	*Citrus aurantifolia* (Christon)	+	-	-	-
29.	*Dalbergia sissoo* Roxb.	+	+	+	+
30.	*Euphorbia royleana* Boiss	+	-	-	-
31.	*Ficus palmata* Forssk	+	-	+	+
32.	*Morus alba* Linn.	+	+	+	+
33.	*Phoenix sylvestris* (Linn.)	-	+	-	-
34.	*Prosopis juliflora* (Swartz)	+	-	-	+
35.	*Toona ciliata* M. Roem.	+	-	+	-
(ii)	**Shrubs**				
36.	*Agave angustifolia* Haw.	+	+	+	+
37.	*Adhatoda zeylanica* Medik.	+	+	+	+
38.	*Dodonaea angustifolia* Linn.	+	+	-	+
39.	*Ipomoea carnea* Jacq.	+	+	+	-
40.	*Lantana camera* Linn.	+	+	+	+
41.	*Withania somnifera* (Linn.)	+	+	-	-
42.	*Ziziphus mauritiana* Lam.	-	+	-	-
43.	*Z. nummularia* (Burm.)	+	-	+	+
(iii)	**Climbers**				
44.	*Asparagus curillus* Buch-Ham.	+	+	-	+
45.	*Cayratia trifolia* (Linn.)	+	-	-	-
46.	*Mimosa himalayana* Gamble	-	-	-	+
47.	*Vallaris solanacea* (Roth.)	+	+	+	+
(iv)	**Parasite**				
48.	*Cuscuta reflexa* Roxb.	+	+	+	+
(v)	**Herbs**				
49.	*Ageratum conyzoides* Linn.	+	-	-	+

50.	*Bidens pilosa* Linn.	+	+	-	+
51.	*Cannabis sativa* Linn.	+	+	+	+
52.	*Cassia occidentalis* Linn.	-	-	+	-
53.	*Euphorbia hirta* Linn.	+	+	+	+
54.	*Eupatorium adenophorium* Spreng	-	-	-	+
55.	*Solanum nigrum* Linn.	+	+	+	+
56.	*S. virginianum* Linn.	+	+	-	+
57.	*Xanthium indicum* Koen.	+	+	+	-
(vi)	**Grasses**				
58.	*Apluda mutica* Linn.	+	-	-	+
59.	*Dendrocalamus strictus* (Roxb.)	+	+	+	+
60.	*Dichanthium annulatum* (Forssk.)	+	-	+	-
61.	*Parthenium hysterophorus* Linn.	+	+	+	+
62.	*Phragmites karka* (Retz)	+	+	+	+
63.	*Saccharum bengalense* Retz.	+	+	+	+
64.	*S. spontaneum* Linn.	+	+	+	+
65.	*S. ravennae* (Linn.)	+	-	-	-
66.	*Themeda anathera* (Neesex Steud.)	+	-	+	-
67.	*Vetiveria zizanioides* (Linn.)	-	-	-	+
(vii)	**Aquatic & Wetland vegetation**				
68.	*Asclepias curassavica* Linn.	+	-	+	+
69.	*Cyperus rotundus* Linn.	+	+	-	+
70.	*Eichhornia crassipes* (Mart.)	+	-	-	+
71.	*Hydrilla verticillata* (Linn.)	+	+	+	+
72.	*Lemna perpusilla* Torr.	-	-	-	+
73.	*Najas indica* (Willd.)	+	-	+	-
74.	*Paspalum paspalodes* (Michx.)	+	+	+	+
75.	*Polygonum barbatum* Linn.	+	+	-	+
76.	*P. glabrum* Willd.	+	-	-	-
77.	*Potamogeton pectinatus* Linn.	+	-	-	-
78.	*Rotala rotundifolia* (Roxb.)	-	-	+	-
79.	*Ranunculus muricatus* Linn.	-	+	-	-
80.	*Typha angustata* Bory & Chaub.	+	+	+	+
81.	*Vallisneria spiralis* Linn.	-	+	-	-
82.	*Wolffia globosa* (Roxb.)	+	+	+	+
	Total	**69**	**53**	**53**	**60**

+ = Species present; - = Species absent