Environment Conservation Journal 18 (1&2) 87-93, 2017
ISSN 0972-3099 (Print) 2278-5124 (Online)
Abstracted and Indexed

# Community structure of the herbaceous vegetation in some tourist spots of Doon valley (Uttarakhand), India

**Sonali Mamgain[1], Asha Dobhal[2], Pramod Kumar [3] and S.P. Joshi✉ [4]**

**Received: 28.01.2017** **Revised: 11.03.2017** **Accepted: 22.04.2017**

## Abstract

**The present study was carried out in three tourist spots *viz.*, Maldevta, Lachhiwala and Sahastradhara of Doon Valley. Each study site was sub-divided in three subsites namely Control Site (CS), Moderately Disturbed Site (MDS) and Highly Disturbed Site (HDS). The tourist activities has declined the native species diversity and promoted the introduction of exotic species. It was observed that moderately disturbed sites and highly disturbed sites were dominated by species like *Boerhaavia diffusa, Parthenium hysterophorous, Ageratum conyzoides, and Portula capilosa.* In control sites, the dominance of native species like *Artemesia nilagirica, Eulaliopsis binata, Eragro stistenella, Cynodon dactylon* was observed. Tropical America and Tropical South American plants have contributed to 45% and 2% of the total invasive diversity respectively. Asteraceae with 13 species is the most dominant family of the site.**

***Keywords: Exotic, Community, Tourist Spots, IVI, Disturbed Sites, Touristic activity, Dominance***

## Introduction

The structure and composition of a plant community reflects the nature of the basic trophic structure and forms habitat for many organisms. Several abiotic and biotic factors influence the vegetation of an area. Quantitative information on the vegetation structure and composition is crucial for conservation of bio-diversity in an area. The promotion of tourism in an area around the nature creates lot of pressure both on soil and vegetation of the area.In tourist spots soil and vegetation properties and the ecosystem properties are influenced by tourist pressure. This pressure reduces the amount of litter and organic matter in the upper layer of the soil. This ultimately results in unstable soil with various site effects like high compaction, reduce infiltration and increase bulk density and soil erosion. The native plants find this situation unfavourable and emigrate the disturbed areas leaving an open area for opportunistic species.The study site chosen for the present study are facing variety of biotic pressure in the form of tourism, collection of fuel and fodder, cattle grazing, mining. In recent past, after the inception of Uttarakhand in 2000, Doon Valley is expanding exponentially. Moreover, there is sharp increase in tourist influx in Sahastradhara, Lachhiwala and relatively new tourist area Maldevta. The tourism has continuously affected the dynamics and phytodiversity of the picnic spots.

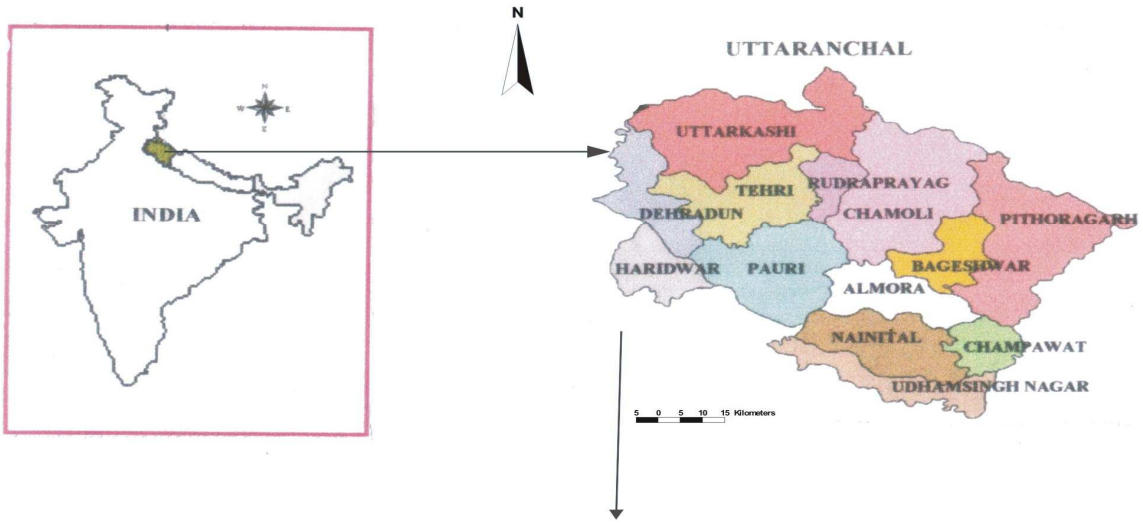
**Author's Address**
[1]Ecology Research Laboratory, Deptt. of Botany, D.A.V. (P.G.) College, Dehradun (Uttarakhand), INDIA
[2]Department of Botany, Govt. (P.G.) College, Tehri
[3]Department of Botany, H.N.B. Garhwal University Campus, Badshahithaul, Tehri.
[4]M.P.G. College, Mussoorie, Dehradun (Uttarakhand), India.
**E-mail: shambhujoshi77@gmail.com**

## Material and Methods

The present study has been carried in three picnic spots *viz.* Sahastradhara, Lacchiwala and Maldevta falling in Mussoorie Forest Division and Dehradun Forest Division. All these three spots are located along the tributaries of the Song river.. The study area is broadly divided into three study sites. Each study site represents one famous tourist spot of Doon Valley. In all the three sites, three representative sub-sites have been selected for the present study during the years 2015. In all the nine sub-sites were thoroughly explored for the present study during rainy season (Fig. 1).

The study site-1 is the new emerging tourist spot of Doon Valley known as Maldevta. It is located about 18 kms towards North-East of Dehradun and its elevation ranges from 650 m. 1,050 m. amsl. It lies between $30^0$ **2**1'N Latitude and $78^0$ 7.5'E Longitude. The area includes mountain terrain of both Himalayan and Shiwalik ranges. The study site is bound by mountains in three sides and the

fourth side opens through Bandal river, a tributary of Song river. This area is becoming popular amongst the nature lovers of Doon Valley. It is considered safe picnic spot for the students of different public school located within the city. A large number of temporary settlements including resorts, shops have emerged due to the ever increasing demands.



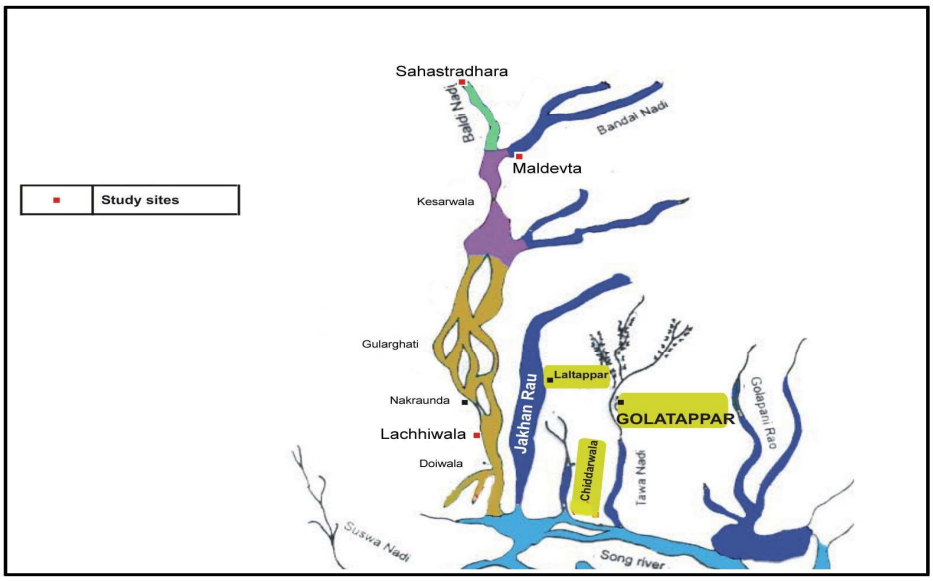




**Fig. 1 : Location Map of the Study Area**

The study site-2 lies between 30°13′ N Latitude and 78°12′ E Longitude. The area is covered by dense sal forest. It is a popular picnic spot known as Lacchiwala, located at Haridwar-Rishikesh road, 22 kms from Dehradun. It is surrounded by green forest and considered as best outing destination and a family spot near Dehradun. Lacchiwala provides a calm and fun loving environment for visitors. Apart from nature views, visitors like to enjoy a fun bath in manmade water pools in Suswa river. It is famous amongst trekkers and bird-watchers due to its solitude environment. It is often crowded at week-ends and holidays. During summer, huge tourist influx is observed in this site (Table 1).

**Table 1 : Tourist Influx (April to June) in Lachhiwala and Sahastradhara**

| Year | Lachhiwala | Sahastradhara |
|---|---|---|
| 2013 | 2,40,214 | 3,35,958 |
| 2014 | 2,60,327 | 5,03,048 |
| 2015 | 2,19,302 | 3,80,846 |
| 2016 | 1,95,960 | 4,70,960 |

**Source : Forest Department, Dehradun Forest Division, Dehradun (Uttarakhand)**

Study site-3 is the most popular spot known as Sahstradhara. It is located on the banks of Baldi river in Doon Valley at the foothills of Garhwal Himalaya. Sahastradhara literally means "a thousand fold springs". It is located at a distance of 11 kms towards North-East of Dehradun between 1000 m.-1200m. amsl. Baldi river forms a micro-watershed of the main Song river. The topography of the area is like a miniature of Doon Valley surrounded by hills on three sides and broad riverbed opens on the fourth side. This place make an ideal picnic spot and is of immense attraction to tourist both Indian and foreigners. The landscape is amazingly attractive where water seems to flow consistently and leaving an incrustation of like along the banks. At the origin of the springs, particles have formed a projecting ledge and a sort of cave in areas where from the spring falls. This study site is famous for sulphur spring that attracts visitors to cure skin infections. During summer season, the area is full of tourists and the number is increasing year after year. As a botanist, it is important to mention that Sahastradhara is a 'type locality' of three plant species namely *Sophora mollis, Itea nutans* and *Pittosporam eriocarpum.* But unfortunately, due to heavy tourist influx year after year, these three species are almost at the stage of dwindling. A comparative account of important characteristics of all the study sites is given in Table 2.

**Table 2 : Characteristics of Various study sites**

| Parameters | Study Site-1 (Maldevta) | Study Site-2 (Lacchiwala) | Study Site-3 (Sahastradhara) |
|---|---|---|---|
| Location from Dehradun | North-East | South-East | North-East |
| Latitude | 30°21′ N | 30°11′ N | 30°23′ N |
| Longitude | 78°7.5′ E | 78°7.5′ E | 78°7.5′ E |
| Forest Division | Mussoorie Forest Division | Dehradun Forest Division | Mussoorie Forest Division |
| River Water Availability | Perennial | Perennial | Perennial |
| Soil pH | 7.5 | 7.6 | 7.6 |
| Dominant Taxa | *Shorea robusta, Acacia catechu, Lantana camara* | *Shorea robusta, Parthenium hysterophorous, Lantana camara, Boerhaavia diffusa* | *Shorea robusta, Opuntia stricta, Chromolena odorata, Ageratum conyzoides* |
| Biotic Pressure | Tourism, Mining, Grazing, | Tourism | Tourism, Mining, Grazing |

The present study area was thoroughly surveyed for its topography, microclimate and biotic stress conditions. Phytosociological studies of the selected sites were conducted during rainy season for herbaceous vegetation only in the year 2015. The vegetation was analysed by means of random sampling to give most representative composition of study site vegetation. The vegetation survey was carried out by nested quadrat method. Twenty quadrats of 1x1 $m^2$ size were laid for the herbaceous vegetation in each season. Seedlings were included as herbs. Vegetation composition was evaluated by analysing the frequency, density, abundance and importance value index (IVI) according to Mishra (1968) and Curtis and McIntosh (1951) as given below:

$$\text{Frequency} = \frac{\text{Total no. of quadrats in which the species occurred}}{\text{Total no. of quadrats studied}} \times 100$$

$$\text{Density} = \frac{\text{Total no. of individuals of a species}}{\text{Total no. of quadrats studied}}$$

$$\text{Abundance} = \frac{\text{Total no. of individuals of a species}}{\text{Total no. of quadrats in which the species occurred}}$$

**(Density was expressed as individuals $m^{-2}$ and the frequency was calculated as percentage)**

Frequency indicates the number of sampling units in which a given species occur and thus expresses the dispersion of various species (Raunkiaer, 1934). The density represents the numerical strength of species in the community. The later, if taken with frequency reflects the pattern of distribution of species (Oosting, 1956). The ratio of abundance to frequency (A/F) was used to represent the distribution pattern (Whitford, 1949) of the species i.e. the two dimensional spatial organisation or dispersion of population in the community (Pielou, 1960 and Greig-Smith, 1964). The ratio of abundance to frequency if less than 0.025 indicates regular distribution while between 0.025-0.050 random and more than 0.050 indicates contiguous distribution (Cottam and Curtis, 1956).

**Importance Value Index (IVI)**

Based on the quantitative characters like frequency, density and dominance (Basal area or cover) the overall dominance of a species on the entire community is measured by analyzing the synthetic character called Importance Value Index (IVI). Phillips (1959) reported that IVI expresses the abundance and ecological success of any species. The value of IVI was computed by summation of the value of the relative frequency, relative density and relative dominance (Curtis and McIntosh, 1950, 1951; Mishra, 1968). The IVI values were tabulated in the descending order. It helped in permitting the development of an abstract called as 'Community type'. Formulae used for the calculation of IVI are as follows:

$$\text{Relative Frequency } (\%) = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \text{ x } 100$$

$$\text{Relative Density } (\%) = \frac{\text{Number of individuals of a species}}{\text{Number of individuals of all species}} \text{ x } 100$$

$$\text{Relative Dominance } (\%) = \frac{\text{Basal area of a species}}{\text{Basal area of all species}} \text{ x } 100$$

**Importance Value Index (IVI) = Rel. Freq. + Rel. Den. + Rel. Dom**

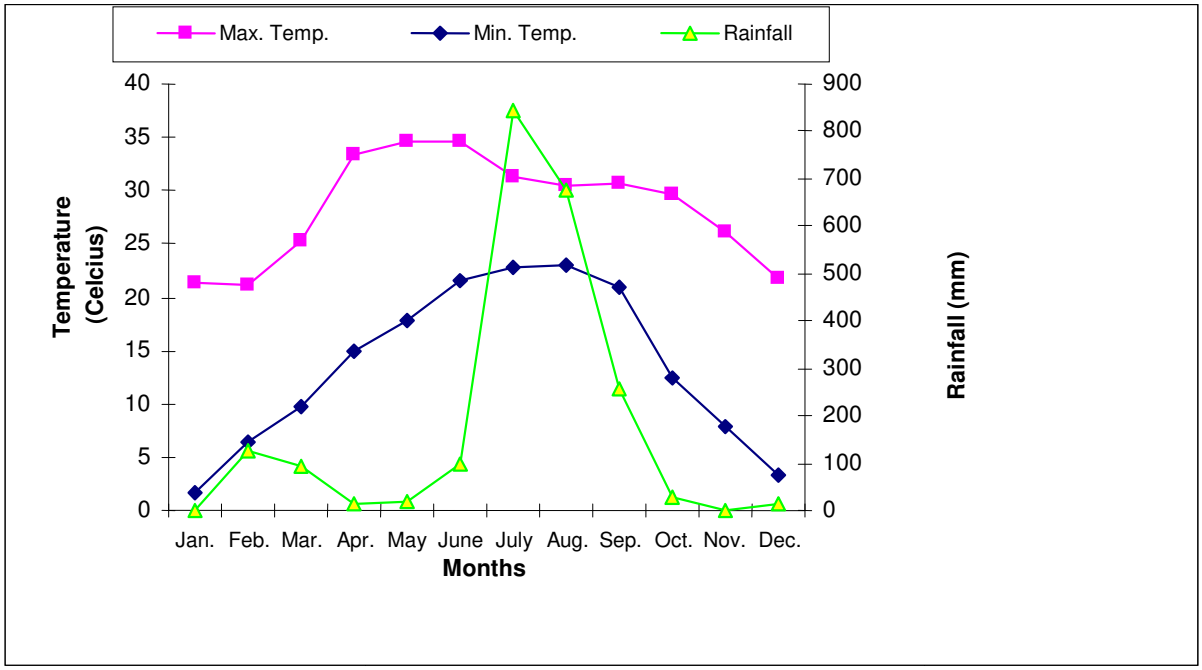



**Fig.2 :Ombrothermic diagram for temperature ($^0$C) and rainfall (mm) during the study period (2015).**

Basal cover is considered as the portion of ground surface occupied by a species (Greig–Smith, 1983). Basal area measurement was calculated by using following formula:

Total Basal Cover (TBC) = Mean basal area of a species x density of that species

Mean Basal Area (MBA) = 3.14 $r^2$ (sq. cm.)

or

$$MBA = \frac{C^2}{4 \times 3.14}$$ (Since, r = C/2 x 3.14)

where C = average circumference of one individual of that species and MBA is expressed as $cm^{-2}herb^{-1}$ (Mishra, 1968).

## Results and Discussion

Seventy four herb species were recorded in all 180 samples of 9 sub-sites of three study sites during the rainy season in the year 2015. In study site-1 control site was dominated by *Artemesia nilagirica* (IVI, 38.51) with *Cynodon dactylon* (IVI, 26.77), *Eragrostis tenella* (IVI, 25.67) and *Rumex hestatus* (IVI, 28.36) as do-dominants. The MDS of this site was dominated by invasive species *Parthenium hysterophorous* (IVI, 26.40) closely followed by three other exotic species *viz.Portulaca pilosa* (IVI, 15.04), *Alternanthera sessilis* (IVI, 14.96) and *Cassia tora* (IVI, 13,21). The HDS however was again dominated by native species *Cynodon dactylon* (IVI, 32.80) (Table 3).

**Table 3 : IVI of Herb Species of Various Sites in Rainy Season**

| Botanical Name | Maldevta | | | Lachhiwala | | | Sahastradhara | | |
|---|---|---|---|---|---|---|---|---|---|
| | CS | MDS | HDS | CS | MDS | HDS | CS | MDS | HDS |
| *Achyranthus aspera* | – | 5.46 | 8.05 | 5.46 | – | 5.46 | | | |
| *Adenostemmala evenia* | – | – | – | – | – | – | 2.69 | 2.34 | – |
| *Aervasan guinolanta* | – | 5.73 | | 5.73 | – | | | | |
| *Ageratum conyzoides* | 8.54 | 3.82 | 13.85 | 3.82 | 10.42 | 3.82 | 15.86 | 23.34 | 92.34 |
| *Alternanthera sessilis* | 6.66 | 14.96 | 17.78 | 14.96 | 19.21 | 14.96 | | | |
| *Alysicarpon vaginalis* | 3.23 | – | | | – | | | | |
| *Anisomeles indica* | – | 5.49 | | 5.49 | – | 5.49 | | | |
| *Artemisia nilagrica* | 38.51 | – | | | – | | | | |
| *Artemisia scoparia* | 4.63 | – | | | – | | | | |
| *Bidens biternata* | – | 3.10 | 5.07 | 3.10 | 4.11 | 3.10 | | | |
| *Boenninghausenia albiflora* | | – | – | | | | 6.37 | 2.34 | – |
| *Boerhaavia diffusa* | 4.43 | 10.71 | 13.09 | 10.71 | 26.34 | 32.59 | – | – | 6.28 |
| *Carex nubigena* | | | | | | | – | – | 23.31 |
| *Cassia tora* | 11.85 | 13.21 | 11.03 | 13.21 | 16.25 | 13.21 | – | 6.22 | 6.26 |
| *Chromolenao dorata* | 6.09 | – | | | 15.26 | | 16.92 | 19.28 | 39.41 |
| *Colotropis procera* | – | 5.75 | | 5.75 | – | | | | |
| *Commelina benghalensis* | – | 6.68 | 9.20 | 6.68 | 9.26 | | | | |
| *Corchorus aestuans* | 7.93 | 6.79 | 8.89 | 6.79 | 10.24 | | | | |
| *Cyanotis cristata* | 6.14 | – | | | – | | | | |
| *Cynodon dactylon* | 26.77 | 13.83 | 32.80 | 13.83 | 18.68 | 3.83 | 21.36 | 12.39 | – |
| *Cyperus distens* | | | | | | | – | – | 16.21 |
| *Cyperus kyllingia* | – | 4.50 | | 4.50 | 6.41 | | – | – | – |
| *Cyperus rotundus* | 15.05 | – | | | – | | – | – | – |
| *Desmodium gangeticum* | – | 8.23 | | 8.23 | 10.24 | 8.23 | | | |
| *Desmodium heterocarpon* | | | | | | | 3.24 | 2.34 | – |
| *Desmodium triflorum* | 5.84 | 5.11 | | 5.11 | – | 5.11 | 2.69 | 2.34 | – |
| *Echinops echinatus* | | | | | | | – | 6.22 | 3.42 |
| *Eleusine compressa* | – | – | | | | | 21.29 | 16.29 | – |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Eleusine indica* | | | | | | | – | 6.22 | – |
| *Eragro stistenella* | 25.67 | 9.29 | 9.05 | 9.29 | 4.32 | | | | |
| *Erigeron karvinskianus* | | | | | | | 13.21 | 11.02 | 12.42 |
| *Eulaliop sisbinata* | – | – | | | | | 66.21 | 38.42 | – |
| *Euphorbia hirta* | 2.20 | 6.48 | 10.41 | 6.40 | 10.42 | 6.40 | – | – | – |
| *Evolvulus alsinoides* | | | | | | | 2.69 | 2.34 | – |
| *Evolvulus nummularis* | | | | | | | – | 2.34 | 3.42 |
| *Fragaria indica* | – | – | | | | | 3.24 | 1.86 | – |
| *Inula cappa* | | | | | | | 3.24 | – | – |
| *Ipomoea eriocarpa* | – | – | | | 2.42 | | – | 5.38 | 6.32 |
| *Justicia simplex* | 3.40 | – | | | – | | | | |
| *Lantana camara*(seedlings) | – | 2.00 | | 2.00 | 3.21 | 2.00 | | | |
| *Launae anudicaulis* | – | 3.87 | 7.25 | 3.87 | – | | | | |
| *Lepidagathis cuspidata* | | | | | | | 11.32 | 11.36 | 10.24 |
| *Leucas lanata* | – | – | – | | | | – | 3.22 | 8.26 |
| *Lindernia crustacia* | 4.88 | 2.86 | | 2.86 | – | 2.86 | | | |
| *Malvastrum coromandalianum* | 6.20 | 7.36 | 12.15 | 7.36 | 12.34 | 30.12 | – | – | – |
| *Mazusru gosus* | 3.72 | 4.23 | | 4.23 | 6.21 | 4.23 | | | |
| *Micro meriabiflora* | – | – | – | | | | 13.22 | 7.41 | – |
| *Nepeta hindostana* | – | 11.14 | 10.68 | – | – | 11.14 | 3.24 | 2.34 | – |
| *Oplimenus burmanii* | 9.85 | – | | | – | | | | |
| *Oplismenus compositus* | 14.85 | 3.00 | 11.01 | 13.00 | – | 8.00 | 51.28 | 41.25 | – |
| *Opuntia dillenii* | 11.68 | – | | 11.68 | – | 11.68 | | | |
| *Oxalis corniculata* | – | 4.32 | | 4.32 | 6.38 | 4.32 | – | 7.46 | 10.41 |
| *Parthenium hysterophorus* | 11.85 | 26.40 | 15.38 | 16.40 | 21.26 | 31.40 | 18.94 | 27.96 | 66.39 |
| *Paspalidum flavidum* | 2.97 | 3.43 | 10.04 | – | – | | | | |
| *Phyllanthus urinaria* | 15.86 | 8.31 | 10.16 | 8.31 | 2.36 | 8.31 | – | – | – |
| *Physalis minima* | – | 2.79 | 5.06 | 6.22 | – | | | | |
| *Plectranthus mollis* | | | | | | | – | – | 13.26 |
| *Polygonum plebejum* | – | 8.95 | 5.92 | 8.95 | – | 8.95 | | | |
| *Portula capilosa* | – | 15.04 | 14.35 | 15.04 | 18.24 | 15.04 | 2.69 | 1.86 | – |
| *Reinwardtia indica* | – | – | | | | | – | – | – |
| *Rumex hestatus* | 28.36 | – | | | – | | 3.24 | 6.22 | 9.24 |
| *Salvia plebeia* | – | – | | | | | 1.86 | 1.86 | – |
| *Setaria glauca* | 6.39 | 7.45 | 9.87 | – | 9.36 | 7.45 | | | |
| *Sida cordata* | – | 3.69 | 5.92 | 3.69 | 6.24 | 3.69 | | 2.34 | 2.62 |
| *Sida rhombifolia* | 10.97 | 12.23 | 15.33 | – | 12.45 | 12.23 | – | | – |
| *Silene alba* | | | | | | | 2.69 | – | – |
| *Solanum xanthocarpum* | – | 6.23 | 6.32 | 6.23 | 8.29 | 6.23 | | | |
| *Spilanthes paniculata* | | | | 7.45 | | | 6.22 | 12.36 | 12.46 |
| *Stachys sericea* | – | – | – | | | | 6.22 | 6.22 | 10.24 |
| *Syndrel lavialis* | | | | 12.23 | | | – | 7.46 | 16.71 |
| *Tridax procumbans* | – | 10.11 | 8.32 | 10.11 | 12.36 | 10.11 | – | – | – |
| *Trium fettarhomboidae* | 4.37 | 3.88 | 6.35 | 3.88 | 4.36 | | | | |
| *Xanthium strumarium* | 1.73 | 8.54 | 6.39 | 8.54 | 15.36 | 8.54 | – | – | – |
| *Zorina globosa* | – | 3.41 | | 3.41 | – | | | | |

In study site-2, all the sub-sites were dominated by exotic species *Parthenium hysterophorous* (IVI, 16.40) in CS and *Boerhaavia diffusa* (IVI, 26.34 AND 32.59) respectively for MDS and HDS. In study site-3, a grass species *Eulaliopsis binata* (IVI, 66.21) dominated the CS, while *Oplismenus compositus* was its associate. In MDS, the condition reversed and *Oplismenus compositus* dominated (IVI, 41.25). In HDS, the exotic species *Parthenium hysterophorous* (IVI, 66.39) dominated the community.The nature of plant community at a place in determined by the species that grow at develop in such environment. Difference in the species composition from site to site is mostly due to micro-environment change (Mishra *et al.*, 1997). The impact of tourism on vegetation includes many aspects but overall impact is always negative. It can change floristic composition, community structure, ecosystem function. Tourist affects large areas and these affects are intense and lasting. Many workers have tried to summarize these impacts (Liddle, 1997; Leung and Marion, 2000; Buckley, 2004(b); Barros *et al.* (2013) and Prescott and Stewart, 2014).Tourism activities result in change in species richness. The species that are vulnerable to trampling are lost and in turn the opportunistic plant species colonize the disturb sites. Mc Dougall and Wright (2004) have also reported decline in native species richness due to trampling of fragile vegetation.In tourist spots soil and vegetation properties and the ecosystem properties are influenced by tourist pressure. This pressure reduces the amount of litter and organic matter in the upper layer of the soil. This ultimately results in unstable soil with various site effects like high compaction, reduce infiltration and increase bulk density and soil erosion. The native plants find this situation unfavourable and emigrate the disturbed areas leaving an open area for opportunistic species.

## Conclusion

Tourism has negative impact on the native flora. It not only accelerates soil erosion but also introduces opportunistic invasive species in the area that gradually replaces the native flora and changes the community structure.In disturbed sites of the present study, it was observed that the dominant and co-dominant species belong to exotic category and have been able to replace the native community structure.

## Acknowledgment

The senior author is thankful to the Head, Department of Botany, D.A.V. (P.G.) College for providing the necessary facilities. Authors are thankful to the Director, Systematic Branch, Botany, FRI for allowing to consult the DD Herbarium.

## References

Buckley, R. 2004b. *Environmental Impacts of Eco-tourism.* CABI Publishing, New York.

Liddle, M., 1997. *Rcreation Ecology*. Chapman & Hall, London.

Leung, Y. nand Marion, J.L. 2000. Recreation impacts and management in wilderness : A state of knowledge review. In : D.N. Cole, S.F. McCool, W.T. Borrie and J. O'Loghlin (eds.) ***Wilderness Science in a Time of Change Conference*****,** Vol. 5, Wilderness Ecosystem, Threats and Management, pp. 23-48, US Department of Agriculture, Missoula.

Biswas, S.R., J.K. Choudhry, A. Nishat, M.M. Rahman, 2007. Do Invasive Plants threaten the Sunderbana Mangroove Forest of Bangladesh? ***Forest Ecology and Management*****,** 245 : 1-9.

Cottam. G. and Curtis, J. T. 1956. The use of distance measures in phytosociology sampling. ***Ecology,* 37**: 451-460.

Curtis, J. J. and McIntosh, R. P. 1950. The interrelations of certain analytic and synthetic phytosociological characters. **E*cology,*31:** 434-455.

Curtis, J. J. and McIntosh, R.P. 1951. An upland forest continum in the prairie forest border region of Wisconsin. ***Ecology,32:*** 476-496.

Greig-Smith, P. 1964. *Quantitative Plant Ecology*. (2nd ed.) Butterworth Inc., Washington D.C., pp. 245.

Greig-Smith, P. 1983. *Quantitative Plant Ecology*. University of California Press, Berkeley, Calif.

Mishra, R. 1968. *Ecology work book.* Oxford and IBH Publishing Co. New Delhi.

Oosting, H.S. 1956. *An introduction to plant ecology,* 2nd ed. W.M. Freeman and Co., San Francisco, London, 440 pp.

Pielou, E.C. 1960. A single mechanism to account for regular, random and aggregated populations. ***J. Ecol.*,48**: 575-584.

Philips E. A. 1959. Methods Of Vegetation Study, A Holt Dryden Book. Henry Hott and Co. Inc., 107.

Whitford, P. B., 1949. Distribution of Woodland plants in relation to succession and clonal growth. ***Ecology*,30:** 199-208.