International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1246-1249

Received: 16-05-2019
Accepted: 18-06-2019

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Study of forest diversity in semi-arid agro-climatic conditions of Uttar Pradesh

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Abstract
An investigation was carried out to study the vegetational parameters viz., Tree density, Mean Basal Area (MBA), Total Basal Area (TBA) and Importance Index Value (IVI) in semi-arid agro-climatic conditions of Uttar Pradesh. Three locations of Uttar Pradesh i.e. Agra (S_1), Mathura (S_2) and Hathrus (S_3) were selected purposefully for the present study. Total 13 tree species were identified irrespective of site and maximum number of species were belonging to Leguminosae family. Among all sites, *Acacia nilotica* was one of the most dominant tree species with IVI 64.25(S3), 54.51 (S_1) and 60.36 (S_2). Total basal area was also found maximum for *Acacia nilotica* in all sites. *Acacia nilotica* is a multipurpose tree species which is being uses as timber, fodder, fuel wood, nitrogen fixing, soil amelioration/protection purposes. Keeping in view the agro-climatic conditions of the semi-arid region, this species may be promoted for reclamation of wasteland, road side plantations and for agroforestry.

Keywords: Importance value index (IVI), mean basal area (MBA), tree density, total basal area (TBA)

Introduction
Uttar Pradesh has about 24.04 million hectare land area which is about 7.3% of the total land area of the country (328.7 million hectare). It lies between latitude 23°52' to 31°28' N and longitude 73°3' to 84°39 E longitude. The climate of state is tropical wit average annual rainfall 1000 to 1200 mm and means temperature 22.5 to 25°C. The total forest cover in U.P. is 1,4679 km^2 which is 6.09 % of the state is geographical area (24.04 million hectare) in which very dense forest area, moderate dense area and open forest area are 2617 km^2, 4069 km^2 and 7993 km^2, respectively (Forest survey of India -2017)

The sustainability of forest eco-system can be assessed on the basis of presence of plant species. Biodiversity of species in forest is affected by various factor such as climatic, altitude, soil, biotic pressure. Sub-tropical, ecosystem are complex and fragile because of their geographical topography. Therefore, many problem are associated in the conservation and development of natural resources such as forests, water, soil and land. Besides these, there are various biotic and abiotic factors, which are greatly affecting natural resources in these area.

The growing demand of increasing population for timber fuel wood, fodder etc. has created disturbances in existing forest, resulting in soil and water erosion and loss of bio-diversity. Therefore, it is imperative to study the vegetational parameters and prioritization of species for domestication in farmers' field, development of wastelands *vis a vis* fulfillment of various needs of farmers. Such type of studies has been carried out by various researcher in different parts of country (Singh, (2005) [19], Bisth (2002) [2], Shah (2002) [22] and Lodhiyal *et al.* (2002) [10]. Keeping in view the importance of the study, the present study was carried out in semi-arid region of Uttar Pradesh.

Materials and Methods
The present study was conducted in Agra (S_1), Mathura (S_2) and Hathrus (S_3) sites of Uttar Pradesh which lies between 27° 10' N to 26° '4 N' latitude and 78°02' E to 79°7'E longitude between elevation 165 and 179.8 m AMSL

The tree vegetation parameters were done by placing 10 quadrats of 10 x 10 m in each selected site in May-June, 2004. The DBH (diameter at breast height-1.37 m) and height of trees was measured with the help of trees caliper and Haga's altimeter, respectively. The tree species in each site were identified with the help of a taxonomist. On the basis of field data, the tree-density, frequency, abundance and Abundance/ Frequency ratio were calculated on the bases

of formulae given by Curtis and McIntosh (1950) [4], and Saxena and Singh (1982) [15]. The relative density, relative frequency, relative dominance and important value index (IVI) were calculated as per the methodology adopted by Curtis (1959) [3].

Result and Discussion

Data presented in table 1 showed the tree species diversity in the study area irrespective of sites. It has been observed that in total 13 number of tree species were reported in the study area which belong to Leguminosae, Meliaceae, Malvaceae and Buxaceae etc. *Accacia nilotica* tree belonging to leguminosae family were dominant in all sites. The species found in the study area were *Acacia catechu, Acacia nilotica, Acacia tortilis, Azadirachta indica, Albizia lebbek, Bombex ceiba, Buxus sempervirens, Cassia siamea, Cassia fistula, Dalbergia sissoo, Leucaena leucocephala, Prosopis juliflora, Prosopis cineraria etc*. these tree species are being used for various purposes by the local people such as timber, fodder, fuel, nitrogen fixing, soil amelioration/protection. The trees of leguminosae family are also found in the farmers fields in the region. Some of the tree species are lopped regularly for fodder purpose such as *Leucaena leucocephala*. Domestication of such species in various agroforestry systems will fulfill the farmers' demand and also relieve the pressure on nearby forests. It is also reported by other researchers, also, in different tree species Similarly reported by Parkesh, Ram and Hocking Drarake 1986 [12]. Data presented in table 2 showed that total 13 number of tree species were found in Agra (S_1). The tree density varied from 3.52 to 74.72 tree/ha and the maximum density was tree observed for *Buxus sempervirens* followed by *Prosopis juliflora* and *Acacia nilotica*. Similarly Mean Basal Area (MBA) varied from 0.011 to 0.062 m^2/tree with maximum value for *Acacia nilotica*. Total basal area was found maximum under *Acacia nilotica* (1.714 m^2/ha) and for different species it varied from 0.020 to 1.714 m^2/ha at site1. Further it has been observed that IVI varied from 3. 66 to 54.51 with maximum value for Acacia nilotica Thus, Acacia was dominant tree species at Agra (S_1) and also reported by Bisth (2002) [2], and Dhaundiyal, N. (2007) [6] in Kumaun Himalaya, Data presented in table 3 showed that total 11 number of tree species were found in Mathura (S_2). The total density of forest tree vegetation was 184.96 tree/ha. The density ranged between 3.52 to 30.24 trees/ha and the maximum density was 30.24 tree/ha for Acacia nilotica and minimum value of density find 3.52 tree/ha for *Acacia catechu, and Cassia fistula*. The mean basal area (MBA) ranged from 0.005 to 0.086 m^2/tree with maximum value for *Acacia catechu*. Total basal area was found maximum under *Acacia nilotica* (1.188 m^2/ha) and for different species it varied from 0.026 to 1.188 m^2/ha at S_2. Further it has been observed that IVI varied from 6.68 to 60.36 with maximum value for *Acacia nilotica* Thus, *Acacia nilotica* was also dominant tree species at Mathura (S_2) and also reported in different forest sites of India by Singh, (2005) [19], and Shah (2002) [22], Lodhiyal *et al*. (2002) [10], Khera *et al.*, (2001) [8], Kohli, (1998) [9], Lodhiyal and Lodhiyal (1997) [11] and Singh *et al.*, (1994) [18]

Data presented in table 3 showed that total 11 number of tree species were found in Hathrus (S_3) the total density of forest tree vegetation was 174.24 tree/ha. The individual density of forest vegetation ranged from 1.76 to 35.52 tree/ha. It was maximum 35.52 tree/ha for *Leucaena leucocephala* and minimum 1.76 tree/ha for *Acacia catechu.* The mean basal area (MBA) ranged from 0.006 to 0.151m^2/tree with maximum value for *Albizia lebbeck.* Total basal area was found maximum under *Acacia nilotica* (1.415 m^2/ha) and for different species it varied from 0.034 to 1.415m^2/ha at S_3. Further it has been observed that IVI varied from 8.05 to 64.25 with maximum value for *Acacia nilotica.* vegetational parameters/ Structural characteristic of the Himalayan forest were also reported by other researchers, also, in Ralhan *et al.*, 1982 [13], Sexana and Singh 1982, Saxena *et al.* 1984 [16], Tewari and Singh 1985 [23], Singh and Singh 1986, 1987 [20]. Singh *et al.*, 1994 [18], Rathore *et al.*, (1997) [14] Dhar *et al.*, (1997) [5], Behra *et al.*, (2002) [1], Silori (2001) [17] and Khera *et al.*, (2001) [8] in degraged himalayan forest.

Conclusion

From the present study, it may be concluded that the tree species belonging to family leguminosae were dominant in the study area and these trees were used as as timber, fodder, fuel, nitrogen fixing, soil amelioration/protection by the local people. These species have potential for reclamation of wastelands, development of agroforestry systems, and fulfillment of local people needs. At all sites Acacia species was found dominating and it can be used for domestication, massive plantation, wasteland development. In addition to this other species such as *Leucaena leucocephala Acacia catechu, Acacia nilotica, Acacia tortilis, Azadirachta indica, Albizia lebbek, Bombex ceiba, Buxus sempervirens, Cassia siamea, Cassia fistula, Dalbergia sissoo, Leucaena leucocephala, Prosopis cineraria etc.* are also potential tree species which can be promoted for various plantation program viz. Afforestation, reforestation, social forestry, farm forestry program etc. Domestication of such species will contribute in enhancing the forest cover as well as conservation of these species in the natural habitat in the forests.

Table 1: Tree species diversity and their importance in study area

S. No	Species	Common name	Family	Uses
1.	*Accacia catechue*	Katha	Leguminosae (Mimosoideae)	Fodder, fuel, nitrogen fixing, soil amelioration/protection, Timber
2	*Acacia nilotica*	Deshi Babbool	Leguminosae (Mimosoideae)	Fodder, fuel, nitrogen fixing, soil amelioration/protection, Timber
3	*Acacia tortilis*		Leguminosae Mimosoideae	Fodder, fuel, nitrogen fixing, soil amelioration/protection, Timber
4	*Albizia lebbeck*	Siris	Leguminosae (Fabaceae)	Fodder, fuel, industrial use, nitrogen fixing, soil amelioration/protection, Timber
5	*Azadirachta indica*	Neem	Meliaceae	Fodder, food, fuel, industrial use, soil amelioration/protection, Timber
6	*Bombex ceiba*	Semal	Malvaceae	Food, medicine, industrial use, live fencing,
7	*Buxus sempervirens*	Boxwood,	Buxaceae	Medicine, industrial use, Timber
8	*Cassia siamea.*	Seemia, Kassod	Leguminosae Caesalpiniaceae	Fodder, fuel and soil amelioration/protection
9	*Cassia fistula*	Golden rain tree	Leguminosae (Fabaceae)	Fodder, fuel and Timber
10	*Dalbergia sissoo*	Shishum	Leguminosae (Fabaceae)	Fodder, Fuel, Nitrogen fixing, soil amelioration/protection, Timber
11	*Leucaena leucocephala*	Subabul	Leguminosae (Fabaceae)	Fodder, Fuel, Nitrogen fixing, soil amelioration/protection
12	*Prosopis juliflora*	Vilayati babbol	Leguminosae (Fabaceae)	Fodder, Fuel, Nitrogen fixing, soil amelioration/protection
13	*Prosopis cineraria*	Jammi, Shami, Khejri Tree	Leguminosae (Fabaceae)	Fodder, food, Fuel, Nitrogen fixing, soil amelioration/protection

Table 2: Tree Vegetational parameters at Agra forest site

S. No.	Name of plant species	Density tree/ha	M.B.A m^2/tree	T.B.A. m^2/ha	IVI
1.	*Acacia catechu*	19.5	0.028	0.305	22.17
2.	*Acacia nilotica*	49.8	0.062	1.714	54.51
3.	*Acacia tortilis*	3.52	0.014	0.027	3.66
4.	*Albizia lebbeck*	19.5	0.011	1.220	31.19
5.	*Azadirachta indica*	33.6	0.021	0.407	33.80
6.	*Bombex ceiba*	10.72	0.057	0.343	17.26
7.	*Buxus sempervirens*	74.72	0.023	0.936	45.76
8.	*Cassia siamea.*	3.52	0.019	0.039	5.73
9.	*Cassia fistula*	7.04	0.005	0.020	6.79
10.	*Dalbergia sissoo*	7.04	0.024	0.096	7.94
11.	*Leucaena leucocephala*	39.0	0.016	0.341	25.76
12.	*Prosopis juliflora*	58.72	0.023	0.936	51.77
13.	*Prosopis cineraria*	3.52	0.035	0.069	6.48
	Total	330.2		6.45	312.82

Table 3: Tree Vegetational parameters at Mathura forest site

S. No.	Name of plant species	Density tree/ha	M.B.A m^2/tree	T.B.A. m^2/ha	IVI
1.	*Acacia catechu*	3.52	0.086	0.173	10.10
2.	*Acacia nilotica*	30.24	0.069	1.188	60.36
3.	*Albizia lebbeck*	19.52	0.066	0.721	38.65
4.	*Azadirachta indica*	26.7	0.029	0.433	40.75
5.	*Bombex ceiba*	10.72	0.005	0.029	8.44
6.	*Buxus sempervirens*	24.96	0.014	0.199	31.89
7.	*Cassia siamea.*	7.04	0.006	0.026	12.01
8.	*Cassia fistula*	3.52	0.019	0.039	6.68
9.	*Dalbergia sissoo*	12.48	0.035	0.244	24.42
10.	*Leucaena leucocephala*	28.48	0.017	0.263	31.65
11.	*Prosopis juliflora*	17.78	0.054	0.543	34.99
	Total	184.96		3.85	299.94

Table 4: Tree Vegetational parameters at Hathrus forest site

S. No.	Name of plant species	Density tree/ha	M.B.A m^2/tree	T.B.A. m^2/ha	IVI
1.	*Acacia catechu*	1.76	0.084	0.085	4.93
2.	*Acacia nilotica*	32.0	0.079	1.415	64.25
3.	*Albizia lebbek*	12.48	0.151	1.057	40.24
4.	*Azadirachta indica*	28.48	0.014	0.227	37.85
5.	*Bombex ceiba*	7.04	0.041	0.164	15.23
6.	*Buxus sempervirens*	14.24	0.007	0.057	23.46
7.	*Cassia siamea.*	10.72	0.006	0.034	13.95
8.	*Cassia fistula*	5.28	0.020	0.060	8.05
9.	*Dalbergia sissoo*	12.48	0.023	0.159	23.45
10.	*Leucaena leucocephala*	35.52	0.021	0.411	43.27
11.	*Prosopis juliflora*	14.24	0.016	0.128	25.32
	Total	174.24		3.797	300.00

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