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CHANGES IN SPECIES COMPOSITION AND ECOLOGICAL ATTRIBUTES OF PLANT SPECIES IN THE *BRACHIARIA RAMOSA* (STAPF.) DOMINATED GRASSLAND AS INFLUENCED BY DISTURBANCE

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ABSTRACT

The present study on the influence of disturbance in the dominated grassland near Bharathiar University, Coimbatore was studied over a period of one year from September, 2014 to August, 2015. The study was made during three seasons such as winter, summer and rainy so as to find out the seasonal changes as influenced by disturbance. The studied grassland is a semi-arid community containing most number of mesophytes with few xerophytes. To study the impact of disturbance, two sites such as undisturbed and disturbed ones spread over an area of 10 and 12 ha respectively were selected in the grassland. The floristic analysis showed that the undisturbed community was registered with 71 species and the disturbed community with 51 species. The family, Poaceae was represented by the high number of 14 and 13 species respectively in undisturbed and disturbed communities. Of the 71 species encounted, a sizable number of 66 species (92 %) harbour medicinal uses. It indicates that the study site was a potential habitat of medicinal plants with wide diversity. The quantitative ecological characters have been varied widely between the two sites due to the influence of disturbance. The resource apportionment for various species present in both study sites indicates that the grass, *Brachiaria ramosa* shared higher amount of resources than any other species present in the communities. The study suggested that the studied *Brachiaria ramosa* dominated grassland near Bharathiar University must be given conservation priority to protect the valuable medicinal species.

Keywords: Dominated grassland, Bharathiar University, *Brachiaria racemosa*.

1. INTRODUCTION

Grassland may be defined as a plant community which is dominated by perennial grasses, where there are few or no shrubs and trees are absent (Moore, 1964). Grasslands may be of two kinds, natural and artificial (Speeding, 1976). If origin is ignored, grasslands can be divided into cultivated and uncultivated (Davies, 1960). Grasslands are located across contrasting climatic and management gradients, which results in considerable variation in ecosystem structure, environmental conditions and disturbances regions (White *et al.,* 2000; Gilmanov *et al.,* 2010). The world's grasslands have been classified in many ways, chiefly on the basis of climatic factors (Moore, 1964) because this is often considered to be the major factor in determining the distribution of grasslands. Apart from the climate, edaphic, physiographic and the biotic factor, including fire play a major role in deciding the distribution of grasslands (Thomas, 1960). Throughout the world in the tropics, temperate and alpine regions the grassland occupy approximately 45.0 million sq.km. area and it is approximately 24% of the vegetation cover of the globe (Shantz, 1954). Based on the physiognomy and habitat, the grasslands of the world are classified under 7 types (Misra, 1968).

In tropical and subtropical India there are no examples of temperate or subtropical climax grassland and the typical tropical savannah type is also absent, the deciduous forest grading into thorn forest without any open park light stage. Even the alpine meadows are presumably secondary, owing to the existence of turf to grazing and lopping of the bushes. In the tropical zone grassland is common enough as a secondary seral stage and may be very stable preclimax under the influence of fire and grazing. In several regions of limited extent grassland also occurs as an edaphic climax. In all these cases the typical form is savannah or scrub, with or without scattered trees.

Grasslands of southern India exist due to biotic interferences, moisture stress, poor and shallow soils and long dry season on the plateau. Ranganathan (1938) considered the upland grass areas of Nilgiris as 'climatic climax' with species of *Andropogon pertusus, Themeda imberbis, Cymbopogan polyneuros* and *Eragrostis nigra* as common grasses. Meher – Homji (1969) has dicussed the phytogeographical aspects of the shola grasslands and considers frost as a controlling factor

for the perpetuation of these grasslands. Bor (1938) opines that once that we admit the existence of grazing and burning in the area, we cannot apply the term 'climatic climax' and so these grasslands should be considered as biotic climax.

Ecological studies in grassland ecosystem are comparatively easier than those of forest ecosystem. Grasslands are easily manoeuvreable and are more uniform in physiognomy and composition which conditions provide ample opportunities for extensive ecological investigations. Besides, the grasslands have been the centre of agronomic and industrial activities of man and so study of this system has received his early attention. Phytosociological analysis of a plant community is the first and foremost basis of the study of any piece of vegetation as it is a pre-request to the understanding of community structure and organization. In the following account, a case study of grassland near Bharathiar University has been discussed. The study includes floristic composition, life-forms, ecologically important species, distribution level of constituent species, their numerical strength and cover, the relative importance of all constituent species, dominance and diversity of the community. The disturbance index has been calculated on basis of local biotic influence and it has been discussed with the species richness.

2. MATERIALS AND METHODS

2.1. Description of study sites

The present study sites the semiarid grasslands are located near Bharathiar University, Coimbatore at the latitude 11° 13' N and the longitude 76° 38' E at an elevation of 426 m above M.S.L (Fig. 1). The undisturbed and the disturbed grassland taken for the present study are situated adjacently each other and they spread over an area of ca. 10ha (undisturbed) and ca.12ha (disturbed). The study was carried out for a period of 12 months from September, 2014 to August, 2015.

The climatic data of the study area is given in Table 1. The temperature generally ranged between 17°C (January) and 36°C (March). During the study period the lowest and highest minimum temperatures have varied between 17.1 (January, 2015) and 22.9°C (August, 2015). On the other hand, the lowest and highest maximum temperatures have ranged between 27.9 (December, 2014 and 35.5°C (March, 2015). From January to March was a dry season and less rainfall occurred during April and May months. Adequate rainfall usually occurs from June through August during south- west monsoon. The north-east monsoon starts from October. The average rainfall for the past 20 years was as much as 600 mm/year. The relative humidity generally ranged from 80 (July) to 90% (December). The velocity of the wind was generally moderate.

The vegetation of the undisturbed study area was *Brachiaria ramosa* – dominated grassland composed by thirteen other grasses, one sedge and fifty six forbs. In disturbed study area, the same grass, *Brachiaria ramosa* was dominant and the associated species comprised twelve grasses, one sedges and thirty seven forbs. No natural woody vegetation was found in the study area. However, attempts were made to raise some tree species. The fauna of the region included some domestic animals like cattle, sheep, goats etc which usually graze on the pasture land. A few peacock, jackles, snakes, rats etc. were also found in the study area.

2.2. Phytosociological studies

The minimum quadrat size of 1 × 1m was fixed by the species – area curve method for phytosociological observations. Each time 100 quadrats were laid by the randomized method in each site. The minimum number of quadrat required (ie.100) was determined as described by Griez – Smith (1964). For this, the mean number of individuals of the first two, four, six, eight and so on quadrat were calculated and plotted against the number of observations. It will be seen that the mean at first fluctuates, steadying as the required number of quadrats was reached.

The number and type of each species occurring in each quadrat were recorded. For grasses, each tiller was counted as an individual because it is impossible to decide from aerial shoots wheather it is separated or connected in the subterranean region, especially in perennial grasses. Different workers have used arbitrary units to represent individual. Armstrong (1907) and Stapledon (1913) have counted the entire individuals as far as possible in the case of erect plants, but in creeping grasses each rooting unit has taken as an individual. Stove and Fryer (1935) have considered an independent root system, as nearly as this could be determined without actually lifting the plant, to be a unit for counting. In the case of creeping plants, any portion of the plant upto 5 cm in length and having functional root was counted as one plant. Only the plants beyond seedling stage (ie., more than 2 cm height in case of monocots and beyond first leaf stage in dicots) were counted. The basal area at the point of emergence for the constituent species were measured. From the observations, the quantitative characters such as frequency, density, abundance, relative frequency,

relative density, relative dominance, importance value index and relative value of importance were calculated.

Frequency, density and abundance were calculated using the following formulae:

$$\text{Frequency} = \frac{\text{Number of quadrats in which the species present}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Number of quadrats of occurrence of the species}}$$

Basal area = Πr^2

Where,

Π = 3.14 and 'r' is the radius of the stem at the point of emergence.

Relative frequency, relative density and relative dominance were calculated from the following formulae:

$$\text{Relative Frequency} = \frac{\text{Number of occurence of the species}}{\text{Number of occurence of all species}} \times 100$$

$$\text{Relative density} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

Important Value Index (I.V.I) is the sum of quantities of relative frequency, relative density and relative dominance expressed per 300.

Relative value of importance (RVI) was calculated by using the formula: $\text{RVI} = \frac{\text{IVI}}{3}$

The frequency index community coefficient (FICC) was calculated by using the formula as given by Gleason (1920):

$$\text{FICC} = \frac{P}{Q} \times 100$$

Where,

P = $\frac{1}{2}$ of the frequencies of occurence of common species.

Q = $\frac{1}{2}$ of the frequencies of occurance of common species (P) + frequencies of occurance of exclusive species in all the four communities studied.

The similarity index (SI) has been calculated by the formula of Sorensen (1948):

$$SI = 2C / A + B$$

Where,

SI = Similarity index

C = Number of common species in both the sites

A and B = Number of species in the 1st and 2nd sites respectively.

Dominance index was determined by the following formula as given by Simpson (1949):

$$C = \Sigma (ni/N)^2$$

Where,

C = Dominance index

ni = Number of individuals of a species over unit area

N = Corresponding total number of individuals of all species over the same unit area

Σ = Summation

The Shannon – Wiener's index of species diversity was worked out by the following formula as given by Margelf (1968):

$$\overline{H} = \Sigma \, Pi \ln Pi$$

Where,

$\overline{H}$ = Shannon – Wiener's index of species diversity

Pi = S/N

S = Number of individuals of one species

N = Total number of all individuals in the sample

ln = The logrithim to the base 'e'

The disturbance index in both sites was calculated as per the method of Gunaga *et al*. (2013). To assess the biotic interference or the disturbance factors on vegetation, we considered scrapping, manual ploughing, litter collection, removal of soil, fire, gardening, grazing, building construction, trampling and collection of plants as the main parameters. For each site, the level of disturbance indicated by each of these ten parameters was scored from 0 (Undisturbed) to 3 (disturbed). The ten scores were added, and the sum multiplied by 100/30 to give a percentage Combined Disturbance Index (CDI).

3. RESULTS

The present study on the sociological attributes of various plant species present in the *Brachiaria ramosa* dominated grassland community was carried out over a period of one year from September 2014 to August 2015. The influence of disturbance over the community composition was

also assessed. The climatic data of the study area was given in Table 1. The range of temperature over the study period was existing between 17.1°C (January 2014) and 35.5°C (March 2015). The total rainfall during the study period of 2014-15 was 831.7 mm / year. Most of the rainfall was occurring during north-east monsoon (Oct - Dec). The south -west monsoon (June - July) was also brought certain rainfall but not at the level of north east monsoon during the study period. The relative humidity was always above 80 % with the peak of 90% during the month of December, 2014. The total number of plant species present in both the study areas was varying greatly higher number of 71 species was noted to be present in undisturbed site, whereas in the disturbed site, the species richness was drastically reduced through various anthropogenic activities to greater level of 28% loss.

The family-wise contribution of plant species to both disturbed and undisturbed study sites is given in Table 2. Among the 71 species present in the undisturbed site, a higher number of 14 species are belonging to the family, Poaceae. The other families such as Amaranthaceae and Euphorbiaceae have contributed 7 and 6 species respectively to the community. The remaining 20 families have contributed little number of less than 5 species only to the community. In the disturbed site, the Poaceae contributed the higher number of 13 species followed by Amaranthaceae with 6 species and Fabaceae and Convolvulaceae with 4 species each, the remaining 11 families contributed less number of species only to the disturbed community. The medicinal uses, parts used and mode of administration of various plants species present in both study area are given in Table 2. Of the 71 species, 66 (92%) harbour various medicinal uses. Majority of the plant species reported to have the medicinal uses for snake bite, kidney problem, hair growth, diabetes, jaundice and cancer. This wide usage of the plant species present in the study areas showed its potentiality for economic species.

The species composition during three different seasons such as winter (December), summer (March) and rainy (July) for the two study areas is given in Tables 3 and 4. Among the 71 species available in undisturbed site, 14 were grasses, 1 sedge and 56 forbs. In disturbed site, 13 were grasses, 1 sedge and 37 were forbs. The variation in species composition indicates that the members of Poaceae were known to be resistants against disturbance. Similarly the sedge, *Cyperus rotundus* was not distributed even in both sites. However, the forbs were disturbed drastically as 19 species such as *Abutilon indicum*, *Aerva lanata* , *A. tomentosa, Alternanthera pungens, A. sessilis, Boerhaavia erecta, Cardiospermum halicacabum, Commelina benghalensis, Corchorus tridens, Euphorbia hirta, Evolvulus alsinoides, Ipomea dissecta, Leucas aspera, Mirabilis jalapa, Oldenlandia umbellata, Passiflora foetida, Phyllanthus amarus, P. maderaspatensis* and *Plumbago zeylanica* have completely vanished in the disturbed site.

The quantitative ecological characters such as frequency, abundance, density and basal cover and synthetic characters such as relative frequency, relative density, relative dominance, importance value index and relative value of importance for all the study species present in the undisturbed and disturbed study sites for 3 different seasons are given in Tables 5 and 6 respectively. Generally, the grasses were disturbed more or less evenly in the respective communities than the sedges and forbs. In undisturbed site, the grasses like *Brachiaria ramosa, Cynodon dactylon, Chloris barbata* and *Sporobolus heterolepis* were distributed evenly than any other species in both the communities as they secured more than 50% of frequency value.

The sedge *Cyperus rotundus,* despite its consistency between the seasons in both study areas was determined to have restricted distribution. Among the forbs in undisturbed site, the species like *Boerhaavia diffusa, Achyranthes aspera, Parthenium hysterophorus* and *Alysicarpus monilifer* have higher frequency value than the rest of the species. However, in disturbed site, *Parthenium hysterophorus* was the only species having better distribution in terms of frequency percentage obtained. In general, it was observed that the rainy season was characterized by higher number of species with better distribution followed by winter and summer seasons. This fact shows that rainfall is the primary factor in this region having influence over the community composition and the distribution level as well.

In undisturbed site, the grasses such as *Brachiaria ramosa, Chloris barbata, Cynodon dactylon* and *Sporobolus heterolepis* and in forbs, the species like *Aerva tomentosa, Alysicarpus monilifer, Gomphrena decumbens* and *Macrotyloma uniflorum* have distributed abundantly than the other constituent species (Tables 5, 6 and 7). In the disturbed site, the same grass species as in undisturbed site and the forbs like *Acalypha indica*, *Amaranthus spinosus*, *Bidens pilosa*, *Euphorbia hirta*, *Evolvulus nummularius, Indigofera enneaphylla*, *Macrotyloma uniflorum, Merremia tridentate*, *Spermacoce hispida* and *Trichodesma indica* were present abundantly (Tables 8, 9 and 10).

As determined for frequency, the grass species such as *Brachiaria ramosa, Chloris barbata, Cyanodon dactylon* and *Sporobolus heterolepis* were registered higher density in undisturbed site. In the similar fashion, the species like *Achyranthes aspera, Alysicarpus monilifer, Boerrhavia diffusa, Euphorbia hirta, Parthenium hysterophorus, Tridax procumbens* and *Vernonia cinera* were determined to have higher density among the forbs in undisturbed site. In disturbed site generally the density of all species were reduced greatly (Tables 8, 9 and 10). The species such as *Brachiaria ramosa, Chloris barbata, Cyanodon dactylon* and *Sporobolus heterolepis* were the species of higher densities in undisturbed site. The species like *Alysicarpus monilifer, Euphorbia hirta, Tridax procumbens* and *Vernonia cinerea* were registered comparatively higher density among the forbs in the disturbed site.

Based on the basal cover, the grass species, *Brachiaria ramosa* was considered to be the dominant species in both the undisturbed and disturbed sites (Tables 5-10). Between the three studied seasons this grass secured the basal cover of 124.62 mm^2/m^2-245.92 mm^2/m^2. Similarly in undisturbed site, this grass species secured the basal cover between 29.57 and 95.05 mm^2/m^2. It shows that this grass species is a resistant against the various kinds of disturbances excerted over the community than the other species recorded in study site. Next to the dominant grass *Brachiaria ramosa*, the other perennial grass *Chloris barbata* occupied the high basal area in both study sites. When the forbs are considered altogether, this species such as *Acalypha indica*, *Achyranthes aspera, Alysicarpus monilifer, Boerrhavia diffusa, Calotropis gigantea, Commelina benghalensis, Croton bonplandianum, Eupatorium odoratum*, *Gomphrena decumbens, Indigofera enneaphylla, Lantana camera, Parthenium hysterophorus, Solanum torvum, Tephrosia purpurea, Trichodesma indicum, Tridax procumbens* and *Vernonia cinerea* were occupied higher basal cover than the other forbs in the undisturbed site (Tables 5-7). Similarly, in disturbed site also the species of forbs such as *Achyranthes aspera, Alysicarpus monilifer, Boerrhavia diffusa, Calotropis gigantea, Commelina benghalensis, Croton bonplandianum, Eupatorium odoratum*, *Indigofera enneaphylla, Lantana camera, Parthenium hysterophorus, Datura metel, Trichodesma indicum, Tridax procumbens* and *Vernonia cinerea* were have higher basal area (Tables 8-10).

The relative position of constituent species in terms of frequency, density and basal cover in the undisturbed and disturbed sites are presented in Tables 5-7 and 8-10 respectively. In undisturbed site the grass species such as *Brachiaria ramosa, Chloris barbata, Cyanodon dactylon* and *Sporobolus heterolepis* and the forbs such as *Eupatorium odoratum*, *Achyranthes aspera, Alysicarpus monilifer, Boerrhavia diffusa, Euphorbia hirta, Parthenium hysterophorus, Tridax procumbens* and *Vernonia cinera* were registered higher values of relative frequency, relative density and relative dominance. The same grasses such as *Brachiaria ramosa, Chloris barbata, Cyanodon dactylon* and *Sporobolus heterolepis* and the forbs such as *Eupatorium odoratum*, *Achyranthes aspera, Alysicarpus monilifer, Boerrhavia diffusa, Euphorbia hirta, Lantana camera Parthenium hysterophorus, Tridax procumbens* and *Vernonia cinera* have registered appreciated values of relative frequency, relative density and relative dominance. The same grass species mentioned for these relative values and the majority of the forbs mentioned for this purpose have in turn secured higher importance value index (IVI) (Tables 5-10) which indicates that all these species have received the maximum impact of environment in their respective site. The relative value of importance (RVI) was also determined to be higher for these mentioned species of higher IVI in their respective sites (Tables 5-10). The presence of higher ecological importance for these species in both sites showed that they are having well adaptive mechanism against the disturbance.

Table 1. Climatic data of the study area for the study period.

Year and month	Temperature (°C)		Rainfall (mm)	Relative humidity (%)
	Max.	Min.		
2014				
Sep	30.8	22.6	170.5	83
Oct	31.2	22.3	30.0	84
Nov	29.9	20.9	303.7	89
Dec	27.9	20.0	161.6	90
2015				
Jan	29.8	17.1	-	89
Feb	32.5	19.5	3.0	87
Mar	35.5	20.3	-	85
Apr	34.8	22.5	29.0	86
May	33.5	23.4	33.0	81
Jun	30.6	22.4	24.0	81
Jul	30.8	23.3	51.5	80
Aug	31.4	22.9	25.4	85

Table 2. List of plant species with their families and their medicinal uses in the *Brachiaria ramosa*dominated grassland.

S.No.	Species	Family	Medicinal uses	Part used
	Grasses			
1.	*Andropogon virginicus*	Poaceae	A decoction of the roots is used in the treatment of backaches. A tea made from the leaves is used in the treatment of diarrhea. Externally, it is used as a wash for frostbite, sores, itching, piles and poison ivy rash.	Root and leaves
2.	*Apluda mutica*	Poaceae	Fodder	Entire Plant
3.	*Brachiariaramosa*	Poaceae	Palatable during lean period.	Grain, leaf
4.	*Chloris barbata*	Poaceae	Skin diseases, fever, diarrhoea and diabetes. Fodder when young.	Leaf
5.	*Cymbopogon caesius*	Poaceae	Cereal and grass forages Forage plants.	Leaf
6.	*Cynodon dactylon*	Poaceae	Eye disorders, weak vision, pungent, bitter, fragrant, heating, appetizer, vulnerary, anthelmintic, antipyretic, alexiteric. It destroys foulness of breath, useful in leucoderma, bronchitis, piles, asthma, tumors, and enlargement of the spleen. Laxative, brain and heart tonic, aphrodisiac, alexipharmic, emetic, emmenagogue, expectorant, carminative and useful against grippe in children, and for pains, inflammations, and toothache; palatable.	Stem and leaf
7.	*Digitaria eriantha*	Poaceae	It is used to cure weak bones, infections.	Leaf
8.	*Eragrostis aspera*	Poaceae	Grains are eaten for asthma.	Grains
9.	*Heteropogon contortus*	Poaceae	In fever, muscle pain, atrophy and toothache, Asthma (Plant oil).	Whole plant
10.	*Melinis repens*	Poaceae	-	-
11.	*Pennisetum alopecuroides*	Poaceae	-	-
12.	*Perotis indica*	Poaceae	Good fodder.	Leaf
13.	*Setaria pumila*	Poaceae	It can be eaten as a sweet or savoury food in all the ways that rice is used, or ground into a powder and made into porridge, cakes, puddings etc.	Seed
14.	*Sporobolus heterolepis*	Poaceae	Native Americans ground the seeds of the grass to make a tasty flour, and many species of birds eat the seeds.	seeds
	Sedges			
15.	*Cyperus rotundus*	Cyperaceae	Acrid, cooling, astringent, appetizer, stomachic, anthelmintic and useful in treatment of leprosy, thirst, fever, blood diseases, biliousness, dysentery,	Tubers

			pruritus, pain, vomiting, epilepsy, opthalmia, erysipelas etc. According to the Unani system of medicine, the root is diuretic, emmenagogue, diaphoretic, anthelmintic, vulnerary and useful for ulcers and sores, fevers, dyspepsia, urinary concretions.	
	Forbs			
16.	*Abutilon indicum*	Malvaceae	Various parts of the plant are used as a demulcent, aphrodisiac, laxative, diuretic, sedative, astringent, expectorant, tonic, anti-inflammatory, anthelmintic, and analgesic and to treat leprosy, ulcers, headaches, gonorrhea, and bladder infection.	whole plant
17.	*Acalypha indica*	Euphorbiaceae	Leaves - laxative, anthelmintic. Leaf juice is a safe and speedy emetic for children, and is useful in chronic bronchitis and asthma. Decoction is employed in ear-ache. Leaves used for ulcers, snake- bites, skin diseases, rheumatism, scabies, headache and root acts as a cathartic.	Leaf, root, stalks (young shoots) and flower.
18.	*Achyranthes aspera*	Amaranthaceae	Pungent, laxative, stomachic, carminative and useful in the treatment of vomiting, bronchitis, heart diseases, piles, itching, abdominal pains, ascites, dyspepsia, dysentery, blood diseases etc. Useful for reclamation of wastelands. Leaf is consumed as pot herb. Seeds rich in protein, cooked and eaten. Used in religious ceremonies in India.	Leaf, seed
19.	*Aerva lanata*	Amaranthaceae	Diuretic and demulcent. The whole plant, especially the leaves are edible. The leaves are put into soup or eaten as spinach or as a vegetable. The plant provides grazing for stock, game in and chickens. A leaf- decoction is prepared as a gargle for treating sore-throat and used in various complex treatments against guinea-worm, smoke from the burning plant is inhaled. The leaf-sap - eye-complaints; infusion - diarrhoea and in an unspecified manner at childbirth, and on sores; root is used in snake-bite treatment. For pains in the lower part of the back leaves and flowers are reduced to ash which is rubbed into cuts on the back.	Leaf, root, flower.
20.	*A. tomentosa*	Amaranthaceae	Roots are chewed to form brush for cleaning teeth. Seeds are said to relieve head ache. They are also used against rheumatism. The herb is diuretic and demulcent. Its decoction is used to remove swellings.	Root and Seed
21.	*Alysicarpus monilifer*	Fabaceae	Roots - for the treatment of leprosy and urinary troubles. The decoction of root is being used for cough. Boiled leaves purgative. It has antiproliferation activity against tumor cells. The whole plant - antipyretic, antiperiodic and has expectorant properties. The leaves -to treat jaundice and stomach pain. Leaf paste - for coetaneous problems.	Leaf, stem, root, whole plant.
22.	*Alternanthera pungens*	Amaranthaceae	Purification of blood, and all sorts of impurities, decongestant, diuretic, anti-inflammatory, anti liver ailments, kidney problems, diarrhea in	Leaf

			children and teething problems in children.	
23.	*A. sessilis*	.Amaranthaceae	Diuretic, tonic and cooling. Juice of this plant deemed beneficial to eyes; an ingredient in the making of medicinal hair oils and used for simple stomach disorders, diarrhoea, dysentery and as a plaster for diseased or wounded skin parts and against fever, vomiting blood, headache and vertigo; Leaf sap is sniffed up the nose to treat neuralgia. Paste is used to draw out spines or any other object from the body and it is also used to cure hernia.	Whole plant
24.	*Amaranthus spinosus*	Amaranthaceae	Diabetes. The seed is used as a poultice for broken bones, internal bleeding, diarrhoea and excessive menstruation. Root - effective diuretic, gonorrhea, emmenagogue and antipyretic, toothaches. The bruised leaves are considered a good emollient and applied externally in cases of ulcerated mouths, eczema, burns, wounds, boils, earache and hemorrhoids. Leaves are also for gastroenteritis, gall bladder inflammation, abscesses, colic menorrhagia, arthritis and for the treatment of snakebites.	Root, leaf, seed, tender shoot.
25.	*Bidens pilosa*	Asteraceae	Antibacterial, antidysenteric, anti-inflammatory, antimicrobial, antimalarial, diuretic, hepato-protective and hypotensive activities.	Leaves, Root and Seed.
26. b	*Boerhaavia erecta*	Nyctaginaceae	Diuretic, stomachic, cardiotonic, hepatoprotective, laxative, anthelmintic, febrifuge, expectorant and, in higher doses, as an emetic and purgative. As a diuretic it is useful in cases of strangury, jaundice, enlarged spleen, gonorrhoea and other internal inflammations, asthma. Decoction of the whole plant - gastro-intestinal, liver and infertility problems and to treat convulsions in children. Paste of the root used to cure ulcers. Sap from the leaves is squeezed into the eye to treat conjunctivitis.	Whole plant, Root, leaves.
27.	*B. diffusa*	Nyctaginaceae	Cooling, astringent to bowels, useful in biliousness, blood purification, leucorrhoea, anaemia, inflammations, heart diseases and asthma. Leaves dyspepsia, tumours, spleen enlargement, abdominal pains. They are appetizer, alexiteric, in opthalmia,to treat joint pains. Seeds are tonic expectorant, carminative, useful in lumbago, scabies, and blood purifier.	Root, leaf, seed
28.	*Calotropis gigantean*	Asclepiadaceae	Used to treat common diseases like fevers, rheumatism, indigestion, cough, cold, eczema, asthma, elephantiasis, nausea, vomiting, diarrhea etc. Dried whole plant is a good tonic, expectorant, depurative, and anthelmintic. The root bark is febrifuge, anthelmintic, depurative, expectorant and laxative. The powdered root used for asthma, bronchitis, and dyspepsia. Leaves for the treatment of paralysis, arthralegia, swellings and intermittent fevers. Flowers are bitter, digestive, astringent, stomachic, anthelmintic and tonic.	Leaf, root bark, flower, seed.
29.	*Cardiospermum halicacabum*	Sapindaceae	It is used for arthritis and other painful conditions of the body. They can be used as a ear drops for ear ache, purulent discharge from ears. Root decoction can be given for haemorrhoids. Whole plant used for	Whole plant, Leaf.

			constipation and abdominal discomfort. The oil prepared from the paste of the leaves with gingilly oil can be used as a hair tonic and cure for dandruff.	
30.	*Cleome pentaphylla*	Capparidaceae	Plant pacifies vitiated kapha, intestinal worms, colic, stomach upset, cardio myopathy, headache, diarrhea, fever and dyspepsia.	Whole plant
31.	*Clitoria ternatea*	Fabaceae	Blood purifier, abortifacient, astringent, demulcent, emetic, purgative and in the treatment of anaemia, impetigo, menorrhagia and psoriasis. Seeds - antispermatogenic, anti-ovulatory and contraceptive activities.	Seed, arial parts
32.	*Coccinia indica*	Cucurbitaceae	It is used to treat ring worm, psoriasis and itch; when mixed with ghee cures sores, skin diseases, skin eruptions of small pox; causes cooling effect to eyes, heals big ulcers, small lesions of scabies, anuria and alleviate body heat and has antispasmodic effect. Green fruit when chewed cures sores on tongue; raw fruit used as vegetable; dried fruit removes eczema. Dried bark has cathartic properties. Juice of tuberous roots, stem and leaves cure diabetes, intermittent glycosuria, enlarged glands and skin diseases like pityriasis and urinary tract infection. Used in treating gastro – intestinal disturbances, liver weakness, dysentery, vomiting, infestation, purifies blood, curb infection in the body, effective against chronic cough and cold and gives good results for bronchitis and asthma. Tubers remove pain in joints, diabetes, skin lesions (Tenia), apthous ulcers, wheezing and phlegm. Decoction of stem and leaf cures bronchitis.	Leaf, stem, fruit, bark, root.
33.	*Commelina benghalensis*	Commelinaceae	For mouth thrush, inflammation of the conjunctiva, psychosis, epilepsy, nose blockage in children, insanity and exophthalmia; diuretic, febrifuge and anti- inflammatory; animal fodder, vegetable; laxative and to cure inflammations of the skin; leprosy.	Whole plant
34.	*Corchorus tridens*	Tiliaceae	Leaves - vegetable in stews eaten with starchy staple foods, and in soups and sauces.	Leaf
35.	*Crotalaria verrucosa*	Fabacaea	Juice of leaves diminishes salivation, juice used for scabies and impetigo, dyspepsia, blood impurities, diarrhea, dysentery, leprosy.	leaves
36.	*Croton bonplandianum*	Euphorbiaceae	Whole plant has been credited with potential to cure liver diseases and swelling of the body, cure against ring worms and skin diseases. Bark and roots - alternative and chologogue. Leaves - controlling B.P and for the treatment of skin diseases and cut and wounds and it is antiseptic and antidote.	Whole plant, Leaf, Bark, root.
37.	*Datura metel*	Solanaceae	Seeds along with other substances are used as a remedy for the symptoms of madness based on homeopathic principle; decoction of seeds - eye diseases. The seeds - potential source for hyoscine, pain relief, asthma and other illnesses. The seed extract to treat wounds, tooth decay and leprosy due to hyoscine.	Seeds, leaves, Flowers.

38.	*Erigeron annuus*	Asteraceae	Epilepsy, cough, cold, venereal disease, skin diseases.	Root
39.	*Eupatorium odoratum*	Asteraceae	It is good for colds. Boil the tea leaves in some water and serve as tea. Sweeten with honey or as people do, serve with a dash of salt.	Leaf
40.	*Euphorbia hirta*	Euphorbiaceae	Decoction or infusion, to treat gastrointestinal disorders, including intestinal parasites, diarrhoea, peptic ulcers, heart burn, vomiting and amoebic dysentery. It is used to treat respiratory system disorders, including asthma, bronchitis, hay fever, laryngeal spasms, emphysema, coughs and colds. Leaves - diuretic to treat uro-genital like kidney stones, menstrual problems, sterility and venereal diseases. The plant is also used to treat infections of the skin and mucous membranes, including warts, scabies, tinea, thrush, aphthae, fungal afflictions, measles, Guinea -worm and as an antiseptic to treat wounds, sores and conjunctivitis. The plant has a reputation as an analgesic to treat severe headache, toothache, rheumatism, colic and pains during pregnancy; axial parts palatable.	Leaf, tender shoot
41.	*E. microphylla*	Euphorbiaceae	Plant extract – jaundice; lower the elevated levels of serum bilirubin; antiulcer.	Leaf
42.	*Evolvulus nummularis*	Convolvulaceae	Cough cold, venereal disease, spermopiotic, fever, epilepsy, insanity, nervous debility, and loss of memory.	Whole plant
43.	*E. alsinoides*	Convolvulaceae	Roots - nerve tonic. Whole plant is widely used in ayurveda medicinal practice.	Root, Whole plant.
44.	*Gomphrena decumbens*	Amaranthaceae	Plant part is used for the treatment of diabetes.	Whole plant
45.	*Heliotrophium indicum*	Boraginaceae	Treating abdominal pains, dysmenorrhoea, hypertension, convulsion, post-partum inflammatory disorders, wounds and infections and skin rashes.	Whole plant
46.	*Hibiscus vitifolius*	Malvaceae	Treatment of jaundice in the folklore system of medicine in India and anti-tubercular drug induced hepatotoxicity.	Root
47.	*Indigofera enneaphylla*	Convolvulaceae	Wound healing.	Whole plant
48.	*Ipomea dissecta*	Convolvulaceae	Diuretic, fever, headache, pimples.	Leaves and Root.
49.	*I. obscura*	Convolvulaceae	Diabetes, hypertension, dysentery, constipation, fatigue, arthritis, rheumatism, hydrocephaly, meningitis, kidney ailments and inflammations.	Whole plant
50.	*Justicia tranquebariensis*	Acanthaceae	Used in the traditional system of medicine for the treatment of fever, pain, inflammation, diabetes, diarrhea and liver diseases; antitumoral, antiviral, analgesic and anti-inflammatory activities.	Leaf
51.	*Lantana camara*	Verbenaceae	Leaves - relieve itching, flu, colds, coughs, fevers, yellow fever, dysentery and jaundice. Roots - gonorrhea. Lantana oil - skin itches, antiseptic for	Leaf, bark, root,

			wounds and externally for leprosy and scabies. Plant extracts - anticancers, chicken pox, measles, asthma, ulcers, swellings, eczema, tumors, high blood pressure, bilious fevers, catarrhal infections, tetanus, rheumatism, malaria and atoxy of abdominal viscera.	flowering tops.
52.	*Leucas aspera*	Lamiaceae	Nasal congestion, cough, cold, fever, headache.	Whole plant
53.	*Macrotyloma uniflorum*	Fabaceae	Dysentery, venereal diseases, fever and diabetes.	Leaves and root.
54.	*Martynia annua*	Martyniaceae	Root decoction is administered for snakebite.Juice of leaf for epilepsy, tuberculosis and sorethroat. Stem of the plant is used by Tantriks in some parts of India.	Leaf, stem root.
55.	*Meremmia emarginata*	Convolvulaceae	-	-
56.	*M. tridentate*	Convolvulaceae	-	-
57.	*Mirabilis jalapa*	Nyctaginaceae	Parts of the plant may be used as a diuretic, purgative, and for vulnerary purposes. The leaves are used to reduce inflammation. A decoction of leaf is used to treat abscesses. Leaf juice may be used to treat wounds.The root is believed an aphrodisiac as well as diuretic and purgative. It is used in the treatment of dropsy.	Leaf, root.
58.	*Oldenlandia umbellata*	Rubiaceae	Decoction of the entire plant bronchial asthma. Decoction of the root is a febrifuge.	Whole plant
59.	*Parthenium hysterophrous*	Asteraceae	Decoction of root – dysentery; sub lethal doses of parthenium - antitumour activity.	Root
60.	*Passiflora foetida*	Passifloraceae	Leaves and fruits - asthma and biliousness. Leaf and root decoction is emmenagogue, used in hysteria and leaf paste is applied on the head for giddiness and headache. The herb is used in the form of lotions or poultices for erysipelas and skin diseases with inflammation.	Whole plant
61.	*Pavonia indicum*	Malvaceae	Nervous debility, hysteria and other nervous disorders and atomic dyspepsia.	Seed
62.	*Peristrophe bicalyculata*	Acanthaceae	Traditional healers are using this species in the treatment of many skin related problems; antidote for snake poison when macerated in an infusion of rice; insect repellant; used as horse feed; green manure; analgesic, anti-inflammatory and antibacterial.	Whole plant
63.	*Phyllanthus amarus*	Euphorbiaceae	Hair, teeth, bones, kidneys, memory, sight, and hearing.	Whole plant
64.	*P. maderaspatensis*	Euphorbiaceae	The plant sap and leaf decoction are credited with emetic and purgative activities. The whole plant is powdered and the solution is applied to scabies. Root decoction constipation, diarrhoea, appetite, intestinal pain, menstrual problems, gastrointestinal disorders, testicular swelling, chest complaints and snake bites. Gastrointestinal trouble in infants is treated by	Whole plant, root.

			giving them a root decoction. Plant sap is used as no se drops to treat toothache. Ground leaves are rubbed on the skin with lemon juice to treatment for rheumatism; palatable.	
65.	*Plumbago zeylanica*	Plumbaginaceae	treatment of toothache, applied externally to treat swellings, rheumatism, leprosy, tumors, and ringworm.	Root
66.	*Solanum torvum*	Solanaceae	The juice to treat fever and alleviate pain; fruit - cosmetic; as rubbing its seeds on the cheeks helps remove freckles; diabetes liver-related ailments, jaundice; juice of the herb certain skin problems and tumors; decoction of the stalk, leaves, and roots - wounds and cancerous sores. Freshly prepared extract of the plant is effective in treating cirrhosis of the liver and also works as an antidote to poisoning by opium.	Fruit, whole plant.
67.	*Spermacoce hispida*	Rubiaceae	Seeds – cooling, demulcent and given in diarrhea and dysentery; recommended as a substitute for coffee; Crushed into paste and taken orally to treat stomach problems; antihypertensive.	Whole plant
68.	*Tephrosia purpurea*	Fabaceae	The plant is reported to cure diseases of the kidney, liver, spleen, heart and blood. The dried herb - tonic, laxative, and diuretic; Used in the treatment of bronchitis, bilious febrile attack, boils, pimples, and bleeding piles. The roots and seeds - insecticidal, pesticidal, and vermifugal properties; roots - leprous wounds and root juice to skin eruptions. Aerial plant parts- anticancer activity against a human nasopharyngeal epidermoid tumor cell line.	Leaf, root, root bark, aerial parts, seed.
69.	*Trichodesma indicum*	Boraginaceae	Leaves and roots are remedy for snake bites; diuretic. Cold infusion of leaves - depurative. Crushed roots, dysentery in children, diarrhea and fever, swollen joints, inflammations and superficial skin injuries; used for arthralgias, inflammations, dyspepsia, diarrhea, dysentery, dysmenorrhea.	Root, leaf, flower.
70.	*Tridax procumbens*	Asteraceae	Plant pacifies vitiated pitta, inflammation, wound, ulcers, anal fistula, and hemorrhoids. Anticoagulant, antifungal and insect repellent; in bronchial catarrh, diarrhoea and dysentery. Wound healing activity and promotes hair growth.	Whole plant
71.	*Vernonia cinerea*	Asteraceae	Plant pacifies vitiated vata, pitta, tonsillitis, stomach pain, diarrhea, intermittent fever, eczema, herpes, ringworm, and elephantiasis. Leaves - conjunctivitis and in lacrimation. Seeds - worm infestation , cough, psoriasis, leukoderma and for other skin diseases. Plant possess anticancer property. Used for abortion, cancer and various gastrointestinal disorders.	Whole plant

Table-3. Species with their individuals in undisturbed grassland during three different seasons.

S. No	Species	Winter (Dec	Summer (Mar)	Rainy (Jul)
	Grasses			
1.	*Andropogon virginicus*	12 (4)	10 (2)	21(6)
2.	*Apluda mutica*	10(2)	8(2)	18(6)
3.	*Brachiaria ramosa*	563(85)	413(61)	815(100)
4.	*Chloris barbata*	598(79)	411(55)	965(100)
5.	*Cymbopogon caesius*	52(13)	40(8)	76(18)
6.	*Cynodon dactylon*	996(84)	632(71)	1332 (100)
7.	*Digitaria eriantha*	19(8)	12(5)	31(11)
8.	*Eragrostis aspera*	33(10)	21(6)	55(11)
9.	*Heteropogon contortus*	8(3)	6(3)	32(9)
10.	*Melinis repens*	9(2)	6(2)	16(3)
11.	*Pennisetum alopecoroides*	15(5)	10(3)	28(8)
12.	*Perotis indica*	11(3)	7(2)	19(5)
13.	*Setaria pumila*	89(26)	75(16)	120(48)
14.	*Sporobolus heterolepis*	903(70)	753(48)	1519 (100)
	Sedges			
15.	*Cyperus rotundus*	16(9)	13(4)	43(18)
	Forbs			
16.	*Abutilon indicum*	2(2)	2(1)	5(4)
17.	*Acalypha indica*	3(2)	2(2)	19(9)
18.	*Achyranthes aspera*	55(29)	48(15)	66(50)
19.	*Aerva lanata*	11(3)	-	18(6)
20.	*A. tomentosa*	8(2)	5(2)	15(3)
21.	*Alysicarpus monilifer*	34(12)	24(10)	71(19)
22.	*Alternanthera pungens*	6(2)	3(2)	15(5)
23.	*A. sessilis*	5(3)		9(4)
24.	*Amaranthus spinosus*	7(3)	4(2)	6(16)
25.	*Bidens pilosa*	3(2)	2(1)	5(2)
26.	*Boerhaavia erecta*	2(4)	2(1)	3(8)
27.	*B. diffusa*	54(40)	43(15)	89(63)
28.	*Calotropis gigantea*	3(2)	2(1)	6(5)
29.	*Cardiospermum halicacabum*	2(2)	-	4(3)
30.	*Cleome pentaphylla*	-	-	5(2)
31.	*Clitoria ternatea*	4(3)	3(3)	5(4)
32.	*Coccinia indica*	2(1)		3(2)
33.	*Commelina benghalensis*	-	-	3(2)
34.	*Corchorus tridens*	-	-	3(2)
35.	*Crotalaria verrucosa*	-	-	4(3)
36.	*Croton bonplandianum*	6(2)	3(1)	16(9)
37.	*Datura metel*	3(2)	2(1)	5(3)
38.	*Erigeron annuus*	4(1)	-	7(4)
39.	*Eupatorium odoratum*	15(6)	8(3)	26(16)
40.	*Euphorbia hirta*	36(10)	21(8)	52(20)
41.	*E. microphylla*	5(4)	3(3)	13(9)
42.	*Evolvulus nummularius*	8(3)	-	13(5)
43.	*E. alsinoides*	11(6)	-	21(10)
44.	*Gomphrena decumbens*	18(6)	7(4)	39(11)
45.	*Heliotrophium indicum*	6(3)	-	15(5)
46.	*Hibiscus vitifolius*	-	-	2(2)
47.	*Indigofera enneaphylla*	26(11)	9(16)	40(25)
48.	*Ipomea dissecta*	2(1)	-	6(3)
49.	*I. obscura*	-	-	5(3)
50.	*Justicia tranquebariensis*	4(2)	2(1)	8(5)
51.	*Lantana camara*	3(2)	3(1)	4(4)
52.	*Leucas aspera*	7(3)	-	14(6)
53.	*Macrotyloma uniflorum*	-	-	5(3)
54.	*Martynia annua*	4(2)	2(1)	7(3)
55.	*Meremmia emarginata*	5(2)	3(1)	11(4)
56.	*M. tridentata*	-	2(1)	6(3)
57.	*Mirabilis jalapa*	2(1)	2(1)	4(2)
58.	*Oldenlandia umbellata*	-	-	4(2)
59.	*Parthenium hysterophrous*	65(20)	49(15)	89(45)
60.	*Passiflora foetida*	2(1)	-	3(3)
61.	*Pavonia*	-	-	3(3)

	indicum			
62.	*Peristrophe bicalyculata*	9(2)	5(2)	17(14)
63.	*Phyllanthus amarus*	4(2)	6(2)	10(5)
64.	*P. maderaspatensis*	2(2)	2(1)	6(3)
65.	*Plumbago zeylanica*	-	-	3(2)
66.	*Solanum torvum*	4(2)	-	8(5)
67.	*Spermacoce hispida*	-	-	5(5)
68.	*Tephrosia purpurea*	6(2)	3(2)	16(8)
69.	*Trichodesma indicum*	17(6)	9(2)	26(15)
70.	*Tridax procumbens*	40(11)	21(5)	69(38)
71.	*Vernonia cinerea*	48(14)	30(8)	59(41)

Figures in parenthesis are the number of quadrats in which the species present out of 100 quadrats studied.

Table 4. Species with their individuals in disturbed grassland during three different seasons.

S.No	Species	Winter (Dec)	Summer (Mar)	Rainy (Jul)
	Grasses			
1.	*Andropogon virginicus*	6(3)	4(3)	13(8)
2.	*Apluda mutica*	4(3)	2(1)	8(5)
3.	*Brachiaria ramosa*	186(65)	98(49)	315(79)
4.	*Chloris barbata*	211(58)	109(31)	412(90)
5.	*Cynodon dactylon*	315(59)	165(30)	518(79)
6.	*Digitaria eriantha*	5(3)	3(2)	11(5)
7.	*Eragrostis aspera*	13(6)	9(4)	27(11)
8.	*Heteropogon contortus*	5(3)	3(2)	19(7)
9.	*Melinis repens*	5(3)	3(2)	13(6)
10.	*Pennisetum alopecuroides*	8(4)	5(3)	19(10)
11.	*Perotis indica*	7(5)	4(2)	10(5)
12.	*Setaria pumila*	43(15)	21(8)	89(30)
13.	*Sporobolus heterolepis*	189(48)	111(31)	310(69)
	Sedges			
14.	*Cyperus rotundus*	7(4)	3(2)	26(15)
	Forbs			
15.	*Acalypha indica*	2(1)	1(1)	6(3)
16.	*Achyranthes aspera*	20(13)	13(6)	30(18)
17.	*Alysicarpus monilifer*	15(10)	10(6)	32(18)
18.	*Amaranthus spinosus*	5(3)	3(2)	10(4)
19.	*Bidens pilosa*	1(1)	1(1)	2(1)
20.	*Boerhaavia diffusa*	25(11)	15(8)	42(29)
21.	*Calotropis gigantea*	1(1)	1(1)	4(1)
22.	*Cleome pentaphylla*	-	-	1(1)
23.	*Clitoria ternatea*	2(1)	2(1)	5(3)
24.	*Coccinia indica*	-	-	2(2)
25.	*Crotalaria verrucosa*	-	-	1(1)
26.	*Croton bonplandianum*	3(2)	1(1)	8(6)
27.	*Datura metel*	1(1)	1(1)	3(3)
28.	*Erigeron annuus*	2(2)	-	4(3)
29.	*Eupatorium odoratum*	13(6)	7(3)	22(13)
30.	*Euphorbia hirta*	25(9)	19(5)	36(13)
31.	*E. microphylla*	2(2)	2(1)	6(4)
32.	*Evolvulus nummularius*	2(2)	-	6(3)
33.	*Gomphrena decumbens*	8(6)	3(2)	15(10)
34.	*Heliotrophium indicum*	3(2)	-	9(7)
35.	*Hibiscus vitifolius*	-	-	1(1)
36.	*Indigofera enneaphylla*	9(5)	5(3)	16(8)
37.	*Ipomea obscura*	-	-	2(2)
38.	*Justicia tranquebariensis*	3(2)	1(1)	5(3)
39.	*Lantana camara*	3(2)	2(2)	5(4)
40.	*Macrotyloma uniflorum*	-	-	2(1)
41.	*Martynia annua*	2(1)	1(1)	3(2)
42.	*Meremmia emarginata*	2(1)	1(1)	5(3)
43.	*M. tridentata*	-	-	2(1)
44.	*Parthenium hysterophrous*	33(23)	16(9)	80(46)
45.	*Pavonia indicum*	-	-	1(1)
46.	*Peristrophe bicalyculata*	3(2)	1(1)	7(5)
47.	*Solanum torvum*	1(1)	-	3(2)
48.	*Spermacoce hispida*	-	-	2(1)
49.	*Trichodesma indicum*	5(3)	2(1)	16(8)
50.	*Tridax procumbens*	25(16)	10(9)	46(26)
51.	*Vernonia cinerea*	18(11)	11(9)	38(25)

Figures in parenthesis are the number of quadrats in which the species present out of 100 quadrats studied.

Table 5. Species composition in undisturbed grassland: frequency, abundance, density and basal cover and their relative values withimportance value index (IVI) and relative value of importance (RVI) during winter (Dec. 2014).

S.No	Species	Quantitative attributes				Synthetic attributes				
		Frequency (%)	Abundance (individuals/m²)	Density (individuals/m²)	Basal cover (mm²/m²)	R.F (%)	R.DE (%)	R.DO (%)	IVI	RVI
	Grasses									
1.	*Andropogan virginicus*	4	3	0.12	1.22	0.62	0.30	0.21	1.13	0.37
2.	*Apluda mutica*	2	5	0.1	1.38	0.31	0.25	0.24	0.79	0.26
3.	*Brachiaria ramose*	85	7	5.63	169.88	13.19	14.44	30.60	58.23	19.41
4.	*Chloris barbata*	79	7.56	5.98	82.8	12.26	15.34	14.91	42.51	14.17
5.	*Cymbopogon caesius*	13	4	0.52	18.11	2.01	1.33	3.26	6.6	2.2
6.	*Cynodon dactylon*	84	11.85	9.96	20.01	13.04	25.55	3.60	42.19	14.06
7.	*Digitaria eriantha*	8	2.37	0.19	0.49	1.24	0.48	0.08	1.8	0.6
8.	*Eragrostis aspera*	10	3.3	0.33	1.04	1.55	0.84	0.18	2.57	0.85
9.	*Heteropogon contortus*	3	2.66	0.08	0.21	0.46	0.2	0.03	0.96	0.32
10.	*Melinis repens*	2	4.55	0.09	0.18	0.31	0.23	0.03	0.57	0.19
11.	*Pennisetumalopecuroides*	5	3	0.15	0.68	0.77	0.38	0.12	1.27	0.42
12.	*Perotis indica*	3	3.66	0.11	0.59	0.46	0.28	0.10	0.84	0.28
13.	*Setaria pumila*	26	3.42	0.89	4.03	4.03	2.28	0.73	7.04	2.34
14.	*Sporobolusheterolepis*	70	12.9	9.03	22.97	10.86	23.17	4.13	38.26	12.75
	Sedges									
15.	*Cyperus rotundus*	9	1.77	0.16	2.22	1.39	0.41	0.40	2.2	0.73
	Forbs									
16.	*Abutilon indicum*	2	1	0.02	1.64	0.31	0.05	0.29	0.65	0.21
17.	*Acalypha indica*	2	1.5	0.03	1.37	0.31	0.07	0.25	0.63	0.21
18.	*Achyranthes aspera*	29	1.89	0.55	14.52	4.5	1.41	2.61	8.52	2.84
19.	*Aerva lanata*	3	3.66	0.11	1.39	0.46	0.28	0.25	0.99	0.33
20.	*A. tomentosa*	2	4	0.08	1.22	0.31	0.2	0.22	0.73	0.24

21.	*Alysicarpus monilifer*	12	2.83	0.34	5.65	1.86	0.87	1.01	3.74	1.24
22.	*Alternanthera pungens*	2	3	0.06	1.82	0.31	0.15	0.32	0.78	0.26
23.	*A. sessilis*	3	1.66	0.05	1.42	0.46	0.12	0.25	0.83	0.27
24.	*Amaranthus spinosus*	3	2.83	0.07	2.26	0.46	0.17	0.40	1.03	0.34
25.	*Bidens pilosa*	2	1.5	0.03	1.16	0.31	0.07	0.20	0.58	0.19
26.	*Boerhaavia erecta*	4	0.5	0.02	0.49	0.62	0.05	0.08	0.75	0.25
27.	*B. diffusa*	40	1.35	0.54	14.26	6.21	1.38	2.56	10.15	3.38
28.	*Calotropis gigantean*	2	1.5	0.03	6.03	0.31	0.07	1.08	1.46	0.48
29.	*Cardiospermum halicacabum*	2	1	0.02	0.77	0.31	0.05	0.13	0.49	0.16
30.	*Clitoria ternatea*	3	1.33	0.04	0.36	0.46	0.1	0.06	0.62	0.20
31.	*Coccinia indica*	1	2	0.02	0.28	0.15	0.05	0.05	0.25	0.08
32.	*Croton bonplandianum*	2	3	0.06	4.35	0.31	0.15	0.78	1.24	0.41
33.	*Datura metel*	2	1.5	0.03	6.49	0.31	0.07	1.16	1.54	0.51
34.	*Erigeron annus*	1	4	0.04	1.99	0.15	0.1	0.35	0.6	0.2
35.	*Eupatorium odoratum*	6	2.5	0.15	22.43	0.93	0.38	4.04	5.35	1.78
36.	*Euphorbia hirta*	10	3.6	0.36	1.14	1.55	0.92	0.20	2.67	0.89
37.	*E. microphylla*	4	1.25	0.05	0.08	0.62	0.12	0.01	0.75	0.25
38.	*Evolvulus nummularis*	3	2.66	0.08	0.37	0.46	0.2	0.06	0.72	0.24
39.	*E. alsinoides*	6	1.83	0.11	0.35	0.93	0.28	0.06	1.27	0.42
40.	*Gomphrena decumbens*	6	3	0.18	3.54	0.93	0.46	0.63	2.02	0.67
41.	*Heliotrophium indicum*	3	2	0.06	1.93	0.46	0.15	0.34	0.95	0.31
42.	*Indigofera enneaphylla*	11	2.36	0.26	8.36	1.7	0.66	1.50	3.86	1.28
43.	*Ipomea dissecta*	1	2	0.02	1.69	0.15	0.05	0.30	0.5	0.16
44.	*Justicia tranquebariensis*	2	2	0.04	1.92	0.31	38.97	0.34	39.62	13.20
45.	*Lantana camara*	2	1.5	0.03	10.58	0.31	0.07	1.90	2.28	0.76
46.	*Leucas aspera*	3	2.33	0.07	1.73	0.46	0.17	0.16	2.79	0.93
47.	*Martynia annua*	2	2	0.04	16.28	0.31	0.1	2.93	3.34	1.11

48.	*Meremmia emarginata*	2	2.5	0.05	2.52	0.31	0.12	0.45	0.88	0.29
49.	*Mirabilis jalapa*	1	2	0.02	1.06	0.15	0.05	0.19	0.39	0.13
50.	*Parthenium hysterophrous*	20	3.25	0.65	29.48	3.1	1.66	5.31	10.07	3.56
51.	*Passiflora foetida*	1	2	0.02	0.28	0.15	0.05	0.05	0.25	0.08
52.	*Peristrophe bicalyculata*	2	4.5	0.09	2.55	0.31	0.23	0.45	0.99	0.33
53.	*Phyllanthus amarus*	2	2	0.04	0.51	0.31	0.1	0.09	0.5	0.16
54.	*P. maderaspatensis*	2	1	0.02	0.49	0.31	0.05	0.08	0.44	0.14
55.	*Solanum torvum*	2	2	0.04	4.83	0.31	0.1	0.87	1.28	0.42
56.	*Tephrosia purpurea*	2	3	0.06	7.48	0.31	0.15	1.34	1.8	0.6
57.	*Trichodesma indicum*	6	2.83	0.17	8.12	0.93	0.43	1.46	2.82	0.94
58.	*Tridax procumbens*	11	3.63	0.4	19.11	1.7	1.02	3.44	6.16	2.05
59.	*Vernonia cinerea*	14	3.42	0.48	15.44	2.17	1.23	2.78	6.18	2.06

R.F: Relative Frequency, R.DE: Relative Density, R.DO: Relative Dominance.

Table 6. Species composition in undisturbed grassland: frequency, abundance, density and basal cover and their relative values with importance value index (IVI) and relative value of importance (RVI) during summer (April,2015).

S.No	Species	Quantitative attributes				Synthetic attributes				
		Frequency (%)	Abundance (individuals/m^2)	Density (individuals/m^2)	Basal cover (mm^2/m^2)	R.F (%)	R.DE (%)	R.DO (%)	IVI	RVI
	Grasses									
1.	*Andropogon virginicus virginicus*	2	5	0.1	1.01	0.48	0.36	0.25	1.09	0.36
2.	*Apluda mutica*	2	4	0.08	1.1	0.48	0.29	0.27	1.04	0.34
3.	*Brachiaria ramose*	61	6.77	4.13	124.62	14.8	15.01	31.41	61.22	20.40
4.	*Chloris barbata*	55	7.47	4.11	56.91	13.34	14.94	14.34	42.62	14.20
5.	*Cymbopogon caesius*	8	5	0.4	13.67	1.94	1.45	3.44	6.83	2.27
6.	*Cynodon dactylon*	71	8.9	6.32	12.7	17.23	22.98	3.20	43.41	14.47
7.	*Digitaria eriantha*	5	2.4	0.12	0.3	1.21	0.43	0.07	1.71	0.57
8.	*Eragrostis aspera*	6	3.5	0.21	0.65	1.45	0.76	0.16	2.37	0.79

9.	*Heteropogon contortus*	3	2	0.06	0.15	0.72	0.21	0.03	0.96	0.32
10.	*Melinis repens*	2	3	0.06	0.12	0.48	0.21	0.03	0.72	0.24
11.	*Pennisetumalopecuroides*	3	3.33	0.1	0.45	0.72	0.36	0.11	1.19	0.39
12.	*Perotis indica*	2	3.5	0.07	0.37	0.48	0.25	0.09	0.82	0.27
13.	*Setaria pumila*	16	4.68	0.75	3.39	3.88	2.72	0.85	7.43	2.48
14.	*Sporobolus heterolepis*	48	15.68	7.53	19.15	11.65	27.38	4.82	43.85	14.61
	Sedges									
15.	*Cyperus rotundus*	4	3.25	0.13	1.86	0.97	0.07	0.46	1.50	0.5
	Forbs									
16.	*Abutilon indicum*	1	2	0.02	1.63	0.24	-	0.41	0.65	0.21
17.	*Acalypha indica*	2	1	0.02	0.9	0.48	0.07	0.22	0.77	0.25
18.	*Achyranthes aspera*	15	3.2	0.48	12.67	3.64	1.74	3.19	8.57	2.85
19.	*Aerva tomentosa*	2	2.5	0.05	0.75	0.48	0.18	0.18	0.84	0.28
20.	*Alysicarpus monilifer*	10	2.4	0.24	3.98	2.42	0.77	1	4.19	1.39
21.	*Alternanthera pungens*	2	1.5	0.03	0.9	0.48	0.1	0.22	0.80	0.26
22.	*Amaranthus spinosus*	2	2	0.04	1.28	0.48	0.14	0.32	0.94	0.31
23.	*Bidens pilosa*	1	2	0.02	0.76	0.24	0.07	0.19	0.50	0.16
24.	*Boerhaavia erecta*	1	2	0.02	0.49	0.24	0.07	0.12	0.43	0.14
25.	*B. diffusa*	15	2.86	0.43	11.35	1.64	1.56	2.86	6.06	2.02
26.	*Calotropis gigantean*	1	2	0.02	4.01	0.24	0.07	1.01	1.32	0.44
27.	*Clitoria ternatea*	3	3	0.03	0.73	0.72	0.1	0.18	1.0	0.33
28.	*Croton bonplandianum*	1	3	0.03	2.17	0.24	0.1	0.54	0.88	0.29
29.	*Datura metal*	1	2	0.02	4.32	0.24	0.07	1.08	1.39	0.46
30.	*Eupatorium odoratum*	3	2.66	0.08	11.98	0.72	0.29	3.01	4.02	1.34
31.	*Euphorbia hirta*	8	2.62	0.21	0.65	1.94	0.76	0.16	2.86	0.95
32.	*E. microphylla*	3	1	0.03	0.04	0.72	0.1	0.01	0.83	0.27
33.	*Gomphrena decumbens*	4	-	0.07	1.37	0.97	0.25	0.34	1.56	0.52
34.	*Indigofera enneaphylla*	6	1.5	0.09	32.15	1.45	0.32	8.10	9.87	3.29

35.	*Justicia tranquebariensis*	1	2	0.02	0.95	0.24	0.07	0.23	0.54	0.18
36.	*Lantana camara*	1	3	0.03	10.58	0.24	0.1	2.66	3.0	1.0
37.	*Martynia annua*	1	2	0.02	0.81	0.24	0.07	0.20	0.51	0.17
38.	*Meremmia emarginata*	1	3	0.03	1.5	0.24	0.1	0.03	0.37	0.12
39.	*M. tridentate*	1	2	0.02	0.9	0.24	0.07	0.22	0.53	0.17
40.	*Mirabilis jalapa*	1	2	0.02	1.05	0.24	0.07	0.26	0.57	0.19
41.	*Parthenium hysterophorus*	15	3.26	0.49	22.21	3.64	1.78	5.59	11.0	3.66
42.	*Peristrophe bicalyculata*	2	2.5	0.05	1.41	0.48	0.18	0.35	1.01	0.33
43.	*Phyllanthus amarus*	2	3	0.06	0.25	0.48	0.21	0.06	0.75	0.25
44.	*P. maderaspatensis*	1	2	0.02	0.49	0.24	0.07	0.12	0.43	0.14
45.	*Tephrosia purpurea*	2	1.5	0.03	3.73	0.48	0.1	0.94	1.52	0.50
46.	*Trichodesma indicum*	2	4.5	0.09	4.29	0.48	0.32	1.08	1.88	0.62
47.	*Tridax procumbens*	5	4.2	0.21	10.02	1.21	0.76	2.52	4.49	1.49
48.	*Vernonia cinerea*	8	3.75	0.31	9.96	1.94	1.12	2.51	5.57	1.85

R.F: Relative Frequency, R.DE: Relative Density, R. DO: Relative Dominance.

Table 7. Species composition in undisturbed grassland: frequency, abundance, density and basal cover and their relative values with importance value index (IVI) and relative value of importance (RVI) during rainy (July,2015).

S.No	Species	Quantitative attributes				Synthetic attributes				
		Frequency (%)	Abundance (individuals/m^2)	Density (individuals/ m^2)	Basal cover (mm^2/m^2)	R.F (%)	R.DE (%)	R.DO (%)	IVI	RVI
	Grasses									
1.	*Andropogon virginicus virginicus*	6	3.5	0.21	2.13	0.54	0.34	0.23	1.11	0.37
2.	*Apluda mutica*	6	3	0.18	2.49	0.54	0.29	0.27	1.1	0.36
3.	*Brachiariaramose*	100	8.15	8.15	245.92	9.09	13.35	27.42	49.86	16.62
4.	*Chloris barbata*	100	9.65	9.65	133.62	9.09	15.8	14.9	39.79	13.26
5.	*Cymbopogon caesius*	18	4.22	0.76	25.98	1.63	1.24	2.89	5.76	1.92
6.	*Cynodon dactylon*	100	13.32	13.32	26.76	9.09	21.8	2.98	33.87	11.29

7.	*Digitaria eriantha*	11	2.81	0.31	0.78	1	0.5	0.08	1.58	0.52
8.	*Eragrostis aspera*	11	5	0.55	1.72	1	0.9	0.19	2.09	0.69
9.	*Heteropogon contortus*	9	3.55	0.32	0.81	0.81	0.52	0.09	1.42	0.47
10.	*Melinis repens*	3	5.33	0.16	0.32	0.27	0.2	0.03	0.5	0.16
11.	*Pennisetumalopecuroides*	8	3.5	0.28	1.26	0.72	0.45	1.41	2.58	0.86
12.	*Perotis indica*	5	3.8	0.19	1.01	0.45	0.31	0.11	0.87	0.29
13.	*Setaria pumila*	48	2.5	1.2	5.42	4.36	1.96	0.6	6.92	2.30
14.	*Sporobolus heterolepis*	100	15.19	15.19	38.63	9.09	24.88	4.3	38.27	12.75
	Sedges									
15.	*Cyperus rotundus*	18	2.38	0.43	5.95	1.63	0.7	0.66	2.99	0.99
	Forbs									
16.	*Abutilon indicum*	4	1.25	0.05	4.08	0.36	0.08	0.45	0.89	0.29
17.	*Acalypha indica*	9	2.11	0.19	8.61	0.81	0.31	0.96	2.08	0.69
18.	*Achyranthes aspera*	50	1.32	0.66	17.42	4.54	0.08	1.94	6.56	2.18
19.	*Aerva lanata*	6	3	0.18	2.26	0.54	0.29	0.25	1.08	0.36
20.	*A. tomentosa*	3	5	0.15	2.27	0.27	0.24	0.25	0.76	0.25
21.	*Alysicarpus monilifer*	19	3.73	0.71	11.79	1.72	1.16	1.31	4.19	1.39
22.	*Alternanthera pungens*	5	3	0.15	4.52	0.45	0.24	0.5	1.19	0.39
23.	*A. sessilis*	4	2.25	0.09	2.54	0.36	0.14	0.28	0.78	0.26
24.	*Amaranthus spinosus*	16	0.37	0.06	1.92	1.45	0.09	0.21	1.75	0.58
25.	*Bidens pilosa*	2	2.5	0.05	1.92	0.18	0.08	0.21	0.47	0.15
26.	*Boerhaavia erecta*	8	0.37	0.03	0.73	0.72	0.04	0.08	0.84	0.28
27.	*B. diffusa*	63	1.41	0.89	23.5	5.73	1.45	2.62	9.8	3.26
28.	*Calotropis gigantean*	5	1.2	0.06	12.05	0.45	0.09	1.34	1.88	0.62
29.	*Cardiospermum halicacabum*	3	1.33	0.04	1.53	0.27	0.06	0.17	0.5	0.16
30.	*Cleome pentaphylla*	2	2.5	0.05	0.98	0.18	0.08	0.1	0.36	0.12
31.	*Clitoria ternatea*	4	1.25	0.05	1.23	0.36	0.08	0.13	0.57	0.19

32.	*Coccinia indica*	2	1.5	0.03	0.41	0.18	0.04	0.04	0.26	0.08
33.	*Commelina benghalensis*	2	1.5	0.16	8.15	0.18	0.26	0.9	1.34	0.44
34.	*Corchorus tridens*	2	1.5	0.03	0.79	0.18	0.04	0.08	0.3	0.1
35.	*Crotalaria verrucosa*	3	1.33	0.04	3.93	0.27	0.06	0.43	0.76	0.25
36.	*Croton bonplandianu*	9	1.77	0.16	11.57	0.81	0.26	1.29	2.36	0.78
37.	*Datura metal*	3	1.75	0.05	10.81	0.27	0.08	1.2	1.55	0.51
38.	*Erigeron annus*	4	1.62	0.07	3.34	0.36	0.11	0.37	0.84	0.28
39.	*Eupatorium odoratum*	16	1.62	0.26	38.86	1.45	0.42	4.33	6.2	2.06
40.	*Euphorbia hirta*	20	2.6	0.52	1.63	1.81	0.85	0.18	2.84	0.94
41.	*E. microphylla*	9	1.44	0.13	0.2	0.81	0.21	0.02	1.04	0.34
42.	*Evolvulus nummularis*	5	2.6	0.13	0.58	0.45	0.21	0.06	0.72	0.24
43.	*E. alsinoides*	10	2.1	0.21	0.65	0.9	0.34	0.07	1.31	0.43
44.	*Gomphrena decumbens*	11	3.54	0.39	7.65	0.18	0.63	0.85	1.66	0.55
45.	*Heliotrophium indicum*	5	3	0.15	4.82	0.45	0.24	0.53	1.22	0.40
46.	*Hibiscus vitifolius*	2	1	0.02	2.49	0.18	0.03	0.27	0.48	0.16
47.	*Indigofera enneaphylla*	25	2	0.4	12.86	2.27	0.65	1.43	4.35	1.45
48.	*Ipomea dissecta*	3	2	0.06	5.09	0.27	0.09	0.56	0.92	0.30
49.	*I.obscura*	3	1.66	0.05	3.61	0.27	0.08	0.4	0.75	0.25
50.	*Justicia tranquebariensis*	5	1.6	0.08	3.82	0.45	0.13	0.42	1	0.33
51.	*Lantana camara*	4	1	0.04	14.11	0.36	0.06	1.57	1.99	0.66
52.	*Leucas aspera*	6	2.33	0.14	3.44	0.54	0.22	0.38	1.14	0.38
53.	*Macrotyloma uniflorum*	3	2.75	0.05	1.92	0.27	0.08	0.21	0.56	0.18
54.	*Martynia annua*	3	2	0.07	2.84	0.27	0.11	0.31	0.69	0.23
55.	*Meremmia emarginata*	4	2	0.11	5.52	0.36	0.18	0.61	1.15	0.38
56.	*M.tridentate*	3	2	0.06	2.72	0.27	0.09	0.3	0.66	0.22
57.	*Mirabilis jalapa*	2	1.97	0.04	2.11	0.18	0.06	0.23	0.47	0.15
58.	*Oldenlandia umbellata*	2	2	0.04	0.1	0.18	0.06	0.02	0.26	0.08
59.	*Parthenium hysterophorus*	45	1.97	0.89	40.35	4.09	1.45	4.49	10.03	3.34

60.	*Passiflora foetida*	3	1	0.03	0.41	0.27	0.04	0.04	0.35	0.11
61.	*Pavonia indicum*	3	1	0.03	1.15	0.27	0.04	0.12	0.43	0.14
62.	*Peristrophe bicalyculata*	14	1.21	0.17	4.8	1.27	0.27	0.52	2.06	0.68
63.	*Phyllanthus amarus*	5	2	0.1	1.25	0.45	0.16	0.13	0.74	0.24
64.	*P. maderaspatensis*	3	2	0.06	1.47	0.27	0.09	0.16	0.52	0.17
65.	*Ricinus communis*	2	1.5	0.03	1.5	0.18	0.04	0.16	0.38	0.38
66.	*Solanum torvum*	5	1.6	0.08	9.65	0.45	0.13	1.07	1.65	0.55
67.	*Spermacoce hispida*	5	1	0.05	4.41	0.45	0.08	0.49	1.02	0.34
68.	*Tephrosia purpurea*	8	2	0.16	19.94	0.72	0.26	2.22	3.2	1.06
69.	*Trichodesma indicum*	15	1.73	0.26	12.41	1.36	0.42	1.38	3.16	1.05
70.	*Tridax procumbens*	38	1.81	0.69	32.95	3.45	1.13	3.67	8.25	2.75
71.	*Vernonia cinerea*	41	1.43	0.69	22.18	3.73	1.13	2.47	7.33	2.44

R.F: Relative Frequency, R.DE: Relative Density, R. DO: Relative Dominance.

Table 8. Species composition in disturbed grassland: frequency, abundance, density and basal cover and their relative values with importance value index (IVI) and relative value of importance (RVI) during winter (Dec. 2014).

S.No	Species	Quantitative attributes				Synthetic attributes				
		Frequency (%)	Abundance (individuals/m^2)	Density (individuals/m^2)	Basal cover (mm^2/m^2)	R.F (%)	R.DE (%)	R.DO (%)	IVI	RVI
	Grasses									
1.	*Andropogon virginicus*	3	2	0.06	0.61	0.71	0.46	0.29	1.46	0.48
2.	*Apluda mutica*	3	1.33	0.04	0.55	0.71	0.3	0.26	1.27	0.42
3.	*Brachiaria ramosa*	65	2.86	1.86	56.12	15.51	14.29	27.23	57.0	19
4.	*Chloris barbata*	58	3.63	2.11	29.21	13.84	16.21	14.17	44.22	14.74
5.	*Cynodon dactylon*	59	5.33	3.15	6.33	14.08	24.21	3.07	41.36	13.78
6.	*Digitaria eriantha*	3	1.66	0.05	0.12	0.71	0.38	0.05	1.14	0.38
7.	*Eragrostis aspera*	6	2.16	0.13	0.4	1.43	0.99	0.19	1.61	0.53
8.	*Heteropogon contortus*	3	1.66	0.05	0.12	0.71	0.38	0.05	1.14	0.38

9.	*Melinis repens*	3	1.66	0.05	0.1	0.71	0.38	0.04	1.13	0.37
10.	*Pennisetum alopecuroides*	4	2	0.08	0.36	0.95	0.61	0.17	1.73	0.57
11.	*Perotis indica*	5	1.4	0.07	0.37	1.19	0.53	0.17	0.89	0.29
12.	*Setaria pumila*	15	2.86	0.43	1.94	3.57	3.3	0.94	7.81	2.60
13.	*Sporobolus heterolepis*	48	3.93	1.89	4.8	11.4	14.52	2.32	18.24	6.08
	Sedges									
14.	*Cyperus rotundus*	4	1.75	0.07	0.96	0.95	0.53	0.29	1.46	0.48
	Forbs									
15.	*Acalypha indica*	1	2	0.02	0.9	0.23	0.15	0.43	0.81	0.27
16.	*Achyranthus aspera*	13	1.53	0.2	5.28	3.1	1.53	2.56	7.19	2.39
17.	*Alysicarpus monilifer*	10	1.5	0.15	2.49	2.38	1.15	1.20	4.73	1.57
18.	*Amaranthus spinosus*	3	1.66	0.05	1.6	0.71	0.38	0.77	1.86	0.62
19.	*Bidens pilosa*	1	1	0.01	3.84	0.73	0.07	1.86	2.66	0.88
20.	*Boerhaavia diffusa*	1	2.27	0.25	6.6	2.62	1.92	3.20	5.74	1.91
21.	*Calotropis gigantea*	-	1	0.01	2	0.73	0.07	0.97	1.77	0.59
22.	*Clitoria ternatea*	1	2	0.02	0.49	0.23	0.15	0.23	0.61	0.20
23.	*Croton bonplandianum*	2	1.5	0.03	2.17	0.47	0.23	1.05	1.75	0.58
24.	*Datura metal*	1	1	0.01	2.16	0.23	0.07	1.04	1.34	0.44
25.	*Erigeron annus*	2	2	0.02	0.95	0.47	0.15	0.46	1.08	0.36
26.	*Eupatorium odoratum*	6	2.16	0.13	19.43	1.43	0.99	9.41	11.83	3.94
27.	*Euphorbia hirta*	9	2.77	0.25	0.78	2.14	1.92	0.37	4.43	1.47
28.	*E. microphylla*	2	1	0.02	0.03	0.47	0.15	0.01	0.63	0.21
29.	*Evolvulus nummularis*	2	1	0.02	0.09	0.47	0.15	0.04	0.66	0.22
30.	*Gomphrena decumbens*	6	1.33	0.08	1.57	1.43	0.61	0.76	2.80	0.93

31.	*Heliotrophium indicum*	2	1.5	0.03	0.96	0.47	0.23	0.47	1.17	0.39
32.	*Indigofera enneaphylla*	5	1.8	0.09	2.89	1.19	0.69	1.40	3.28	1.09
33.	*Justicia tranquebariensis*	2	1.5	0.03	1.43	0.47	0.23	0.69	1.39	0.46
34.	*Lantana camara*	2	1.5	0.03	10.58	0.47	0.23	5.13	5.83	1.94
35.	*Martina annua*	1	2	0.02	0.81	0.23	0.15	0.39	0.77	0.25
36.	*Meremmia emarginata*	1	2	0.02	1	0.23	0.15	0.48	0.86	0.28
37.	*Parthenium hysterophorus*	23	1.43	0.33	14.96	5.48	2.53	7.26	15.27	5.09
38.	*Peristrophe bicalyculata*	2	1.5	0.03	0.84	0.47	0.23	0.40	11.0	3.66
39.	*Solanum torvum*	1	1	0.01	1.2	0.23	0.07	0.58	0.88	0.29
40.	*Trichodesma indicum*	3	1.66	0.05	2.38	0.71	0.38	1.15	2.24	0.74
41.	*Tridax procumbens*	11	1.63	0.81	38.68	2.62	6.22	4.16	13.0	4.33
42.	*Vernonia cinerea*	16	1.56	0.25	8.03	3.81	1.92	3.89	9.62	3.20

R.F: Relative Frequency, R.DE: Relative Density, R.DO: Relative Dominance.

Table 9. Species composition in disturbed grassland: frequency, abundance, density and basal cover and their relative values with importance value index (IVI) and relative value of importance (RVI) during summer (April, 2015).

S.No	Species	Quantitative attributes				Synthetic attributes				
		Frequency (%)	Abundance (individuals/m^2)	Density (individuals/m^2)	Basal cover (mm^2/m^2)	R.F (%)	R.DE (%)	R.DO (%)	IVI	RVI
	Grasses									
1.	*Andropogon virginicus*	3	1.33	0.04	0.4	1.22	0.59	0.36	2.17	0.72
2.	*Apluda mutica*	1	2	0.02	0.27	0.4	0.29	0.22	0.91	0.30
3.	*Brachiariaramose*	49	2	0.98	29.57	20	14.67	27.24	43.91	14.63
4.	*Chloris barbata*	31	3.51	1.09	15.09	12.65	16.31	13.90	42.86	14.28

5.	*Cynodon dactylon*	30	5.5	1.65	3.31	12.24	24.7	3.04	39.98	13.32
6.	*Digitaria eriantha*	2	1.5	0.03	0.07	0.81	0.44	0.06	1.31	0.43
7.	*Eragrostis aspera*	4	2.25	0.09	0.28	1.63	1.34	0.25	3.22	1.07
8.	*Heteropogon contortus*	1	2	0.02	0.05	0.4	0.29	0.04	0.73	0.24
9.	*Melinis repens*	2	1.5	0.03	0.06	0.81	0.44	0.05	1.3	0.43
10.	*Pennisetum alopecuroides*	3	1.66	0.05	0.22	1.22	0.74	0.20	2.16	0.72
11.	*Perotis indica*	2	2	0.04	0.21	0.81	0.59	0.19	1.59	0.53
12.	*Setaria pumila*	8	2.62	0.21	0.94	3.26	3.14	0.86	7.26	2.42
13.	*Sporobolus heterolepis*	31	3.58	1.11	2.82	12.65	16.61	2.59	31.85	10.61
	Sedges									
14.	*Cyperus rotundus*	2	1.5	0.03	0.41	0.81	0.44	0.37	1.62	0.54
	Forbs									
15.	*Acalypha indica*	1	1	0.01	0.45	0.4	0.14	0.41	0.95	0.31
16.	*Achyranthes aspera*	6	2.16	0.13	3.43	2.44	1.94	3.16	7.54	2.51
17.	*Alysicarpus monilifer*	6	1.66	0.1	1.66	2.44	1.49	1.52	5.45	1.81
18.	*Amaranthus spinosus*	2	1.5	0.03	0.96	0.81	0.44	0.88	2.13	0.71
19.	*Bidens pilosa*	1	1	0.01	0.38	0.4	0.14	0.35	0.89	0.29
20.	*Boerhaavia diffusa*	8	1.87	0.15	3.96	3.26	2.24	3.64	9.14	3.04
21.	*Calotropis gigantean*	1	1	0.01	2	0.4	0.14	1.84	2.38	0.79
22.	*Clitoria ternatea*	1	2	0.02	0.49	0.4	0.29	0.45	1.14	0.38
23.	*Croton bonplandianum*	1	1	0.01	0.72	0.4	0.14	0.66	1.2	0.40
24.	*Datura metal*	1	1	0.01	2.16	0.4	0.14	1.99	2.53	0.84
25.	*Eupatorium odoratum*	3	2.33	0.07	10.46	1.22	1.04	9.63	11.89	3.96
26.	*Euphorbia hirta*	5	3.8	0.19	0.59	2.04	2.84	0.54	5.42	1.80
27.	*E. microphylla*	1	2	0.02	0.03	0.4	0.29	0.02	0.71	0.23
28.	*Gomphrena decumbens*	2	1.5	0.03	0.58	0.81	0.44	0.53	1.78	0.59
29.	*Indigofera enneaphylla*	3	1.66	0.05	1.6	1.22	0.74	1.47	3.43	1.14
30.	*Justicia tranquebariensis*	1	1	0.01	0.47	0.4	0.14	0.43	0.97	0.32

31.	*Lantana camara*	2	1	0.02	7.05	0.81	0.29	6.49	7.59	2.53
32.	*Martynia annua*	1	1	0.01	0.4	0.4	0.14	0.36	0.90	0.30
33.	*Meremmia emarginata*	1	1	0.01	0.5	0.4	0.14	0.46	1.0	0.33
34.	*Parthenium histeroporus*	9	1.77	0.16	7.25	3.67	2.39	6.68	12.74	4.24
35.	*Peristrophe bicalyculata*	1	1	0.01	0.28	0.4	0.14	0.25	0.79	0.26
36.	*Trichodesma indicum*	1	2	0.02	0.95	0.4	0.29	0.87	1.56	0.52
37.	*Tridax procumbens*	9	1.22	0.11	5.25	0.67	1.64	4.83	7.14	2.38
38.	*Vernonia cinerea*	9	1.11	0.1	3.21	3.67	1.49	2.95	8.11	2.70

F: Relative Frequency, R.DE: Relative Density, R.DO: Relative Dominance.

Table 10. Species composition in disturbed grassland: frequency, abundance, density and basal cover and their relative values with importance value index (IVI) and relative value of importance (RVI) during rainy (July, 2015).

S.No	Species	Quantitative attributes				Synthetic attributes				
		Frequency (%)	Abundance (individuals/m²)	Density (individuals/m²)	Basal cover (mm²/m²)	R.F (%)	R.DE (%)	R.DO (%)	IVI	RVI
	Grasses									
1.	*Andropogon virginicus*	8	1.62	0.13	1.32	1.13	0.57	0.32	2.02	0.67
2.	*Apluda mutica*	5	1.6	0.08	1.1	0.71	0.35	0.27	1.33	0.44
3.	*Brachiariaramose*	79	3.98	3.15	95.05	11.22	13.88	23.7	48.8	16.26
4.	*Chloris barbata*	90	4.57	4.12	57.05	12.78	18.16	14.22	45.16	15.05
5.	*Cynodon dactylon*	79	6.55	5.18	10.4	11.22	22.83	2.59	36.64	12.21
6.	*Digitaria eriantha*	5	2.2	0.11	0.27	0.71	0.48	0.06	1.25	0.41
7.	*Eragrostis aspera*	11	2.45	0.27	0.84	1.56	1.19	0.2	2.95	0.98
8.	*Heteropogon contortus*	7	2.71	0.19	0.48	0.99	0.83	0.11	1.93	0.64
9.	*Melinis repens*	6	2.16	0.13	0.26	0.85	0.57	0.06	1.48	0.49
10.	*Pennisetum alopecuroides*	10	1.9	0.19	0.85	1.42	0.83	0.21	2.46	0.82
11.	*Perotis indica*	5	2	0.1	0.53	0.71	0.44	0.13	1.28	0.42
12.	*Setaria pumila*	30	2.96	0.89	4.02	4.26	3.92	1	9.18	3.06

13.	*Sporobolus heterolepis*	69	4.49	3.1	7.88	9.8	13.66	1.96	25.42	8.47
	Sedges									
14.	*Cyperus rotundus*	15	1.73	0.26	3.6	2.13	1.14	0.89	4.16	1.38
	Forbs									
15.	*Acalypha indica*	3	2	0.06	2.72	0.42	0.26	0.67	1.35	0.45
16.	*Achyranthes aspera*	18	1.66	0.3	7.92	2.55	1.32	1.97	5.84	1.94
17.	*Alysicarpus monilifer*	18	1.77	0.32	5.31	2.55	1.41	1.32	5.28	1.76
18.	*Amaranthus spinosus*	4	2.5	0.1	3.21	0.56	0.44	0.8	1.8	0.6
19.	*Bidens pilosa*	1	2	0.02	0.76	0.14	0.08	0.18	0.4	0.13
20.	*Boerhaavia diffusa*	29	1.44	0.42	11.09	4.11	1.85	2.76	8.7	2.9
21.	*Calotropis gigantean*	4	1	0.04	8.03	0.56	0.17	2	2.73	0.91
22.	*Cleome pentaphylla*	1	1	0.01	0.19	0.14	0.04	0.04	0.22	0.07
23.	*Clitoria ternatea*	3	1.66	0.05	1.23	0.42	0.22	0.3	0.94	0.31
24.	*Coccinia indica*	2	1	0.02	0.27	0.28	0.08	0.06	0.42	0.14
25.	*Crotalaria verrucosa*	1	1	0.01	0.98	0.14	0.04	0.24	0.42	0.14
26.	*Croton bonplandianum*	6	1.33	0.08	5.78	0.85	0.35	1.44	2.64	0.88
27.	*Datura metal*	3	1	0.03	6.48	0.42	0.13	1.61	2.16	0.72
28.	*Erigeron annus*	3	1.33	0.04	1.91	0.42	0.17	0.47	1.06	0.35
29.	*Eupatorium odoratum*	13	1.69	0.22	32.88	1.84	0.97	8.19	11	3.66
30.	*Euphorbia hirta*	13	2.76	0.36	1.13	1.84	1.58	0.28	3.7	1.23
31.	*E. microphylla*	4	1.5	0.06	0.09	0.56	0.26	0.02	0.84	0.28
32.	*Evolvulus nummularis*	3	2	0.06	0.27	0.42	0.26	0.06	0.74	0.24
33.	*Gomphrena decumbens*	10	1.5	0.15	2.94	1.42	0.66	0.73	1.42	0.47
34.	*Heliotrophium indicum*	7	1.28	0.09	2.89	0.99	0.39	0.72	2.81	0.93
35.	*Hibiscus vitifolius*	1	1	0.01	1.24	0.14	0.04	0.3	0.48	0.16
36.	*Indigofera enneaphylla*	8	2	0.16	5.14	1.13	0.7	1.28	3.11	1.03
37.	*Ipomea obscura*	2	1	0.02	1.44	0.28	0.08	0.35	0.71	0.23
38.	*Justicia tranquebariensis*	3	1.66	0.05	2.38	0.42	0.22	0.59	1.23	0.41

39.	*Lantana camera*	4	1.25	0.05	17.64	0.56	0.22	4.39	5.17	1.72
40.	*Macrotyloma uniflorum*	1	2	0.02	0.76	0.14	0.08	0.18	0.4	0.13
41.	*Martynia annua*	2	1.5	0.03	1.22	0.28	0.13	0.3	0.71	0.23
42.	*Meremmia emarginata*	3	1.66	0.05	2.51	0.42	0.22	0.62	1.26	0.42
43.	*M.tridentate*	1	2	0.02	0.9	0.19	0.08	0.22	0.05	0.01
44.	*Parthenium hysterophorus*	46	1.73	0.8	36.27	6.53	3.52	9	19.05	6.35
45.	*Pavonia indicum*	1	1	0.01	3.84	0.14	0.04	0.95	1.13	0.37
46.	*Peristrophe bicalyculata*	5	1.4	0.07	1.97	0.71	0.3	0.49	1.5	0.5
47.	*Solanum torvum*	2	1.5	0.03	3.62	0.28	0.13	0.9	1.31	0.43
48.	*Spermacoce hispida*	1	2	0.02	1.76	0.14	0.08	0.43	0.65	0.21
49.	*Trichodesma indicum*	8	2	0.16	7.64	1.13	0.7	1.9	3.73	1.24
50.	*Tridax procumbens*	25	1.52	0.38	18.14	3.55	1.67	4.52	9.74	3.24
51.	*Vernonia cinerea*	26	1.76	0.46	14.79	3.69	2.02	3.68	9.39	3.13

R.F: Relative Frequency, R.DE: Relative Density, R.DO: Relative Dominance.

Table - 11. Similarity index (SI) and frequency index community coefficient (FICC) obtained for the study sites during three different seasons.

S.No.	Season	Attributes	
		SI	FICC
1.	Winter	0.68	95.28
2.	Summer	0.63	96.26
3.	Rainy	0.83	94.30

Table 12. Simpson index of dominance and Shanno-Wiener's index of diversityfor the study sites during three different seasons.

S.No	Study sites	Attributes					
		Dominance index			Shanno-Wiener's index of diversity		
		Winter	Summer	Rainy	Winter	Summer	Rainy
1.	Undisturbed	0.14	0.12	0.13	1.72	1.5	1.44
2.	Disturbed	0.12	0.10	0.09	1.78	1.74	1.7

Table 13. Combined Disturbance Index (out of 30) scored by the study sites.

S. No.	Disturbance factors	Scores in study areas	
		Disturbed	Undisturbed
1.	Scrapping	2	0
2	Manual ploughing	1	0
3.	Litter collection	1	0
4.	Removal of soil	2	0
5.	Fire	2	0
6.	Gardening	1	1
7.	Grazing	3	1
8.	Building construction	3	0
9.	Trampling	3	1
10.	Collection of plants	2	2
	Total Score	20	5

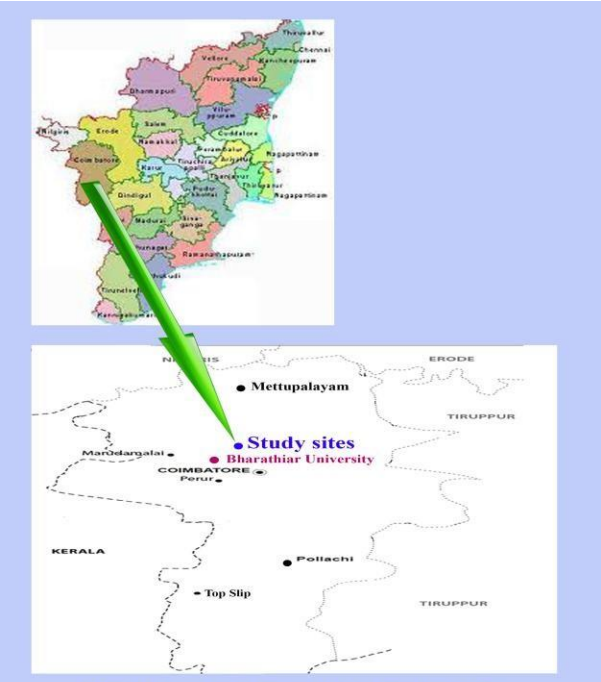

Fig.1. Location of the study sites

Of the various plant species available in the two different study areas, the grass species *Brachiaria ramosa* secured the highest value of IVI of above 49.86 in undisturbed site (Figs. 2-4). The same species also showed its higher ecological importance in undisturbed site by securing higher IVI of more than 43.91 (Figs. 5-7). The other species like *Boerhaavia diffusa, Cynodon dactylon* and *Parthenium hystoporous* were also showing higher IVI in both sites. The species of least significance (lowest IVI) was varied in both sites across the seasons studied (Figs. 8-11). In undisturbed site, the species such as *Ipomea dissecta* and *Phyllanthus amarus, Merremia emarginata* and *Coccinia indica* were present with lowest IVI during winter, summer and rainy season respectively. In disturbed site, the species such as *Clitoria ternatea, Heteropogon contortus* and *Merremia tridenteta* were secured lowest IVI during winter, summer and rainy season respectively. Based on the IVI score made by these species, it is understood that these are poorly established species in the communities of the study sites.

The resource apportionment for the various species present during different seasons is explained by dominance – diversity curves (Figs. 8-10 and 11-13 respectively for undisturbed site and disturbed site). For both sites the geometric curve obtained exhibited that single species dominance was more pronounced during all seasons. The dominant species, *Brachiaria ramosa* received the higher impact of environment and could able to draw more resources from both the study sites.

The similarity index between the two sites studied for the respective seasons is given in Table 11. The species composition was determined to be more highly similar (83%) during rainy season between the two sites. However, during winter and summer also the similarity was above 60 %. This fact showed that both the study areas were originally contained similar species composition. However, due to disturbance factor, the composition of the species has been changed.

Many constituent species in both study sites have established very poorly, based on their distribution level, density and the ecological importance (Tables 5-10). The grass species such as *Melines repens, Perotis indica, Andropogon virgincus and Apluda mutica* and the forbs such as *Coccinia indica, Oldenlandia umbellata, Passiflora foetida* and *Cleome pentaphylla* have scored very lower values of frequency, density, basal cover and importance value index in the undisturbed site. Therefore, these species are requiring special care to increase their population in undisturbed study site. Similarly, in disturbed study site also, many species were present with poor perpetuation. The grass species such as *Apluda mutica, Digera arvensis, Melines repens* and *Perotis indica* and the forbs like *Cleome pentaphylla, Hibiscus vitifolius, Merremia tridentate* and *Spermacoce hispida* have occurred with least ecological perpetuation, as they obtained very lower values for quantitative ecological characters. Therefore these species also need special care for protection.

On basis of frequency index community co-efficient (FICC), it is known that both the study sites were homogenous to each other (> 94 % FICC) at all

seasons (Table 12). The dominance index obtained in both sites is less than 0.14. So both sites are not dominated by any single species on basis of number of individuals contributed (Table 12). The Shannon-Wiener's index of diversity obtained for the two study areas is given in Table 12. As the index value was around 1.5 in both study areas during all the three studied seasons, the diversity of species was not note worthy. This score showed that both the study sites were not having contusive environment for the development of saturated community.

The combined disturbance index (CDI) scored by the two sites is presented in the Table 13. It exhibited that the disturbed site scored 20 CDI whereas, undisturbed site scored only 5 CDI. It is known from this fact that the disturbed site studied was highly influenced by many external factors including anthropogenic disturbances due to which many of the species lost in the disturbed site.

4. DISCUSSION

The effect of disturbance on the changes in species composition and certain quantitative ecological attributes of the constituent species in *Brachiaria ramosa* dominated grassland were studied for a period of one year. The temperature data shows that there are no well marked seasons in the study area. The differences between summer and winter minimum temperatures were ranging between 4 and 5°C only. The maximum of that was varying from 6 to 8°C only. It is of common fact that in tropical climatic zone, the seasons are not marked well. The rainfall and humidity data exhibited that the study area is having semi–arid habitats which are mainly constituted by mesophytes and zerophytes.

The development of vegetation in terms of the number of individuals in the study area is directly proportional to rainfall. The grasslands of the present study area are having abundant number of individuals of various plant species during south-west monsoon and north-east monsoon months (July – August and October – December respectively). It indicates that the rainfall is the limiting factor mainly influenced in the community development. It is well known that in tropical climatic areas water is the limiting factor as the other climatic factors like intensity of light, photoperiod, humidity, temperature, etc are available enormously, except the rainfall which is occurring during seasons only.

Among the 71 species available altogether in both study sites, a higher number of 66 species (92%) possessed medicinal uses. It indicates the potentiality of study area for the inhabitation of medicinal plants. It may be explained that the semi-arid condition with water stress during most of the months in a year can induce the plant species to produce secondary metabolites as defence mechanism against water stress (Frank *et al.*, 2012; Elisa *et al.,* 2013). The uses of species for diverse medicinal purposes show the production of different kinds of secondary metabolites with rich varieties of bioactive compounds in the study sites.

Phytosociological analysis of a plant community is the first and foremost basis of the study of any piece of vegetation as it is a pre-requisite for the understanding of community structure and organization. The appearance of a plant community is largely dependent upon the life-form of the dominant plants, classification based on the criteria given by Raunkiar (1934) who gave different terms to designate different types of life-forms. In the present study, the life-form classes indicate a chamaephytic flora. This supports the view that the herbaceous flora mainly composed by annuals and fresh vegetative growth takes place every rainy season (Ambasht, 1987). But the usefulness of the Raunkiaer's biological spectrum as indicative of climatic condition is limited as the other ecological factors such as biotic disturbances are not taken into account. The present study area also met with certain biotic disturbances like mild grazing and construction attempts.

For understanding the community structure and organization, species composition is foremost requisite. Species composition is one of the major characters of plant community (Dansereau, 1960). It is evident from the data that the study area comprised a considerable number of herbs among them, forbs contributed more species than grasses. However, the number of individuals contributed by the grass was considerably higher than the forbs. This may be attributed to the presence of wide ecological amplitude in grasses (Misra, 1980; Manorama, 1996).

Of the 71 and 51 species present in the undisturbed and disturbed study sites respectively, the grasses like *Brachiaria ramosa, Cynodon dactylon, Chloris barbata* and *Sporobolus heterolepis* and the forbs like *Boerhaavia diffusa, Achyranthes aspera, Parthenium hysterophorus* and *Alysicarpus monilifer* in undisturbed site and in disturbed site in addition to these forbs, *Euphorbia hirta* and *Tridax procumbens* were distributed evenly by securing more than 70% frequency value. According to Misra (1980) this may be attributed to their high reproductive capacity, quick dispersal of seeds and wind pollination to produce viable seeds. Due to the

lacking of these attributes, the other constituent species may show poor distribution.

In addition to higher distribution, these grasses and forbs in the two study sites were present with higher density and basal cover also. Shantz (1954) opined that the presence of tolerance to poor conditions, adaptability and suit various ecological niches for certain grass species could be the possible reasons for the successful establishment in the grasslands as the dominant and important grasses.

In both study sites many species registered lower values of frequency, density and basal cover and hence the importance value index. They are the grass species such as *Melinis repens, Perotis indica, Andropogon virginicus, Apluda mutica* and the forbs such as *Coccinia indica, Oldenlandia umbellata, Pasiflora foetida* and *Cleome pentaphylla.* The poor distribution mechanism, less seed output and lower viability of seeds may be the factor responsible for the weaker establishment of the above mentioned species in the studied sites (Paulsamy, *et al.,* 2008).

It was further observed that a sizable number of 20 species such as *Abutilon indicum, Aerva lanata, A. tomentosa, Alternanthera pungens, A. sessilis, Boerhaavia erecta, Cardiospermum halicacabum, Commelina benghalensis, Corchorus tridens, Euphorbia hirta, Evolvulus alsinoides, Ipomea dissecta, Leucas aspera, Mirabilis jalapa, Oldenlandia umbellata, Pasiflora foetida, Phyllanthus amarus, P. maderaspatensis* and *Plumbago zeylanica* have disappeared in distributed site. This may be due to poor adaptability of these species against the disturbance caused in the disturbed site. Gunaga *et al.* (2013) also observed the same trend of disappearance of many species in disturbed site as their adaptive variations are determined to be not enough for survival.

Despite the dominance exerted by the grass species, *Brachiaria ramosa,* the dominance index obtained in both sites showed that there was no single species dominance in the study area. This contradiction may be due to the number of individuals contributed by all the remaining species altogether was greater than the total number of individuals contributed by the single species, *Brachiaria ramosa.* However, the resource apportionment by the individual species indicates (Figs. 8-13) that the communities were dominated by single species. Therefore, the functional behaviour of individual species in terms of community metabolism was playing major role in deciding the species importance in the present study areas rather than the numerical strength contributed to communities. This fact is at par with the generalizations made for community metabolism and stability of ecosystem in majority of natural communities at global level (McNaughton, 1985).

The combined disturbance index scored by disturbed site (Table 13) indicates that this site was severely influenced by anthropogenic disturbances which resulted in the drastic changes in species composition and community organization. It is quite clear that greater protection leads to better regeneration of community. From the commercial point of view, these studied grasslands are valuable as they contain many medicinal and other economically important plants. Repeated annual fires, continued grazing, scraping, collection of medicinal plants and other anthropogenic disturbances resulted in the low regeneration as well as low density of the vegetation. Varghese and Menon (1998), Hedge *et al*. (2005), Gunaga *et al*. (2013) have also reported the effect of human disturbance on the community composition and possible management practices to be followed for the effective regeneration of the vegetation.

5. CONCLUSION

In conclusion, it is suggested that the studied *Brachiaria ramosa* dominated grassland near Bharathiar University must be given conservation priority to protect the valuable medicinal species. Despite the seasonal changes, the anthropogenic disturbances were determined to be most influencing factor to affect the species composition and the quantitative ecological attributes of many sensitive species. Therefore, construction activities, over grazing by domestic animals, fire, scraping, collection of medicinal plants etc must be checked so as to protect the species in their habitats. Further, ecosystem - specific management plans must be developed to protect the individual species and the grassland community as well. Protection of such natural grassland will also aid in the regulation of ecological process like energy flow, food chain and food web and cycling of materials which would results in ecological balance and stability of ecosystem.

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