LIFE - FORM AND PRIMARY PRODUCTIVITY OF A GRASSLAND COMMUNITY OF RANGAMATIA (DIST: MAYURBHANJ) IN ORISSA

Thesis submitted to North Orissa University
for the Degree of Doctor of Philosophy
in
SCIENCE (BOTANY)

BY
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CERTIFICATE

This is to certify that, the thesis entitled “Life-form and primary productivity of a grassland community of Rangamatia (Dist: Mayurbhanj) in Orissa” submitted for the award of the degree of Doctor of Philosophy in Science (Botany) is the original work done by Pramod Kumar Kar under my supervision. I further certify that, no part of this work has been submitted to any other University or any Institution for award of any degree.

(Kamal L. Barik)

DECLARATION

I Sri Pramod Kumar Kar, Lecturer in Botany, Bana Bhumi College, Rangamatia do hereby declare that, the thesis entitled “Life-form and primary productivity of a grassland community of Rangamatia (Dist: Mayurbhanj) in Orissa” is the outcome of my original work carried out for the award of Doctor of Philosophy in Science (Botany) under the guidance of Dr. K.L. Barik, Lecturer, Department of Botany, North Orissa University, Baripada. Further, I have declared that this thesis has not been submitted to any other University for the award of any degree.

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ABSTRACT

The life-form and primary productivity of a grassland community of Rangamatia (21^0 56’ N ; 86^0 41’ E) situated at a distance of 15 kms away from North Orissa University and 11 kms from Baripada, the District headquarter of Mayurbhanj in the state of Orissa was analysed. The experimental site was protected from grazing and human interferences for a period of 1 year prior to start of the investigation. The soil of the experimental site was moderately acidic (pH = 5.5). The climate of the locality is monsoonal with three distinct seasons viz. rainy (July to October), winter (November to February) and summer (March to June). The total rainfall during the study period was 1906.2 mm of which a maximum of 499.8 mm was recorded during July. The minimum and maximum atmospheric temperature during the study period was found to be normal.

The floristic composition of the grassland community comprises of 36 species (15 were grasses and 21 were non - grasses). *Cynodon dactylon, Digitaria abludens*, *Eleusine indica*, *Vetiveria zizanioides* among the grasses and *phyllanthus fraternus* and *Sida cordifolia* among the non-grasses were found dominant during the study period. The life-form of the community consisted of the class chamaephyte (27.78%), hemicryptophyte (25%), cryptophyte (16.67%) and the therophyte (30.55%). Out of 36 species, 9 species were top strata, 10 were middle strata and 17 species were found to be lower strata. The frequency, density, abundance etc. of the experimental grassland community were determined month wise using 1m x 1m size quadrats as determined by species area curve. All the dominant species exhibited higher percentage of frequency through out the sampling period. The community represented high density value in the month of September and less in the month of April. The grasses showed highest density values as compared to that of the density of non-grasses. The total basal cover of the experimental site showed minimum during April and maximum in the month of September. The grasses showed higher important value index than that of the non - grasses. The dominance index based on density value showed an opposite

trend compared to diversity index value. A negative correlation was found between diversity and dominance indices.

Sequential harvest method was employed for the determination of biomass in the last week of every month. The live green biomass showed lowest value in the month of April and peak during September. The standing dead biomass revealed a decreasing trend from December to June. The value then started an increasing trend and attained peak in the month of December. Minimum standing dead biomass was recorded in the month of June. The litter biomass of the community exhibited an increasing trend from December to May. Thereafter the value showed a declined trend till August. Again it showed an increasing trend showing a maximum of 108.08 g m^{-2} during the last sampling period (December). The total above ground biomass, below ground biomass and total biomass of the community were found to be minimum in the month of April and maximum during September.

The annual net live green production, standing dead production and litter production were found to be 5535.6 g m^{-2} yr^{-1}, 176.06 g m^{-2} yr^{-1} and 85.72 g m^{-2} yr^{-1} respectively. Net above ground and below ground production of the community were found to be 5711.69 g m^{-2} yr^{-1} and 691.38 g m^{-2} yr^{-1} respectively. Gross primary production of the community was estimated to be 8323.99 g m^{-2} yr^{-1}. The transfer function of above ground net production was 8.09 times higher than that of below ground net production. It was also observed that the transfer function of above ground net production to live green production and standing dead production were 0.97 and 0.03 respectively. The system transfer function of standing dead to litter production was found to be 0.49. The disappearance of belowground was high compared to litter disappearance. The above ground net live green production to standing dead production was estimated to be very less among the other components of the community. The turnover rate of non-grasses was found to be maximum (98.01%) as compared to that of grasses (90.81%). Among the components of the community i.e. live green, standing dead and below ground the turnover rates were not significantly different from each other. The litter component showed less turnover rate (79.31%) in the community. The turnover time of livegreen non-grasses exhibited one month less time compared to livegreen grasses. The turnover time of the livegreen, standing dead and below ground did not show any differences whereas the litter component exhibited a maximum turnover time among the components of the community.

The interrelationship study among the 6 dominant species (based on density value) revealed that out of six species, *Cynodon dactylon, Digitaria abludens, Eleusine indica, Vetiveria zizanioides* and *Phyllanthus fraternus* were dependent on each other, where as they had independent existence with respect to *Sida cordifolia*. Among the compartmental biomass - live green grass biomass and live green non-grass biomass, live green biomass and below ground biomass, total above ground biomass and below ground biomass showed interdependence. The density of the community with rainfall showed correlationship significant at $p = 0.05$. Besides, the density of grasses and live green grass biomass, density of non-grasses and live green non-grass biomass, total density and total live green biomass, total density and total above ground biomass, total density and below ground biomass, total density and total biomass, all were dependent on each other.

Compared to other grassland communities, the present grassland community showed little variation. However, the factors like soil condition, rainfall, atmospheric temperature, wind velocity and such others, regulates the life-forms and primary productivity of the community.

CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Grasslands are anomalies in the context of world vegetation units. They cover as much as 25% of the earth's surface. Basing upon the ecological and economical point of view grassland plays a very important role. Grasses control soil erosion, absorb rain fall, restore soil fertility and are the cheapest sources of nutrients for livestock. They are rich in proteins, vitamins and minerals. Some of the plant species are used as fodder for grasshoppers, rabbit, deer, domestic animals i.e. cow, buffalo, goat, sheep and many other herbivores. Various species of grasses i.e. *Heteropogon, Narenga, Saccharum*, *Themeda* etc. are being used for paper and pulp making industries. A number of species belonging to the genera *Cymbopogon, Vetiveria, Bothriochloa* etc. are used to produce aromatic oil. Some of the species are used as herbal medicines also. *Vetiveria* roots are used to prepare curtains which are used during the summer months to cool down houses inside. It also gives pleasant smell. *Phargmties, Sacharum, Imperata* etc. are used to make roof thatching in rural areas. Grasses increase the water holding capacity of the soil and control the runoff especially in arid and semiarid regions (Dhaliwal ***et al***., 2000). It is therefore important to collect information on both structural and functional aspects of vegetation in order to utilize various components for human welfare. The structural aspects of the investigation is usually connected with the physical, chemical and biological characteristics of the vegetation during different periods of its life history including phytosociological characters, biomass, leaf area, pigmentation and also the nutrient levels of the habitat (Odum,1962). According to Golley (1965), physiology, vegetational development, cycling of nutrients, energy flow, production and growth form the functional aspects of the ecosystems. Human exploitation causes a heavy damage to the natural ecosystems. The task of recovery of the natural ecosystems to the earlier balanced state and its preservation has now posed a formidable challenge to all sections of the ecologist and environmentalist all over the world.

Review of Literature

Human activities have chiefly affected the grasslands, as a result much of the area has been converted into agriculture land and it is hard to locate a virgin grassland in thickly populated regions like India. The characteristic features pertaining to structural and functional aspects of a community are essential for any in-depth studies relating to ecology of a place. It provides the knowledge to interpret the ecological imbalance and builds up a picture of the type of vegetation of an area. Although such studies seem to be classical yet, it forms the core of ecological research pertaining to vegetation analysis.

Ecological research is greatly expanded by the establishment of ecological societies and publication of ecological journals. The European ecologist concerned themselves largely with the static approach of classifying vegetation on floristic basis, while their counterparts in America developed the dynamic system of vegetation analysis which emphasizes temporal changes in the community. Clements (1916) studied the phytogeography and the vegetation of North America and gave a comprehensive account of plant successions. Braun - Blanquet in France established the Zurich-Montpellier school of phytosociology and compiled a book (1932) "Plant Sociology" - the study of plant communities. Raunkiaer (1934) gave the concept of life-forms of plants. Tansley (1935), the first president of British Ecological Society introduced the term "ecosystem". Champion (1936), proposed the classification of vegetation in his publication "A preliminary survey of the forest types of India and Burma". Lindman (1942) studied the tropic dynamic aspects of ecology. The grasslands of Southern British Columbia were analyzed by Tisdale (1947). Odum (1957),Whittaker (1954, 1965 & 1970), Ovington ***et al.*** (1963), Golley (1960, 1961, 1965 & 1972), Iwaki ***et al.*** (1964), Phillipson (1966), Daubenmire (1968), Lieth (1975 &1977), Precsenyi (1969, 1970, 1971 & 1973), Sims and Singh (1971), Golley and Misra (1972), Lieth and Whittaker (1975) and Murphy (1975) made outstanding contributions to ecological energetic, productivity , dominance and ecological modeling.

Baker (1963) has reviewed various aspects of grassland research and much of the information of grassland biome under the International Biological Programme (IBP) in America which has been included in the "Grassland

Ecosystem" edited by Dix and Beidleman (1969). In temperate regions a lot of work has been done on grassland by Odum (1960), and Golley and Gentry (1966) in South Eastern Michigan. Tundra vegetation was analyzed by Bliss (1962 & 1970) and Wielgolaski (1975) with regard to above ground standing crop and primary productivity. Dahlman and Kucera (1965) studied the underground biomass and productivity of prairie. Mueller- Dombois and Ellenberg (1974) published a book, Aims and methods of vegetation ecology. Redmann (1975) analyzed the productivity and distribution of grassland in West North Dakota.

Williamson (1976) studied the aboveground primary productivity of Chalk grassland. The nutrient composition and grazing stress of the tropical grassland was analyzed by Billore and Mall (1976). Christie (1978 & 1979) studied the primary productivity and nutrient dynamics in some semi-arid grassland. Sims ***et al.*** (1978) analyzed the abiotic and vegetational characteristics of Western North American grassland. They also studied the net primary production, turn over and energy capturing efficiency of some grasslands of Western North America. The effects of water and nitrogen on plant community structure in semiarid grasslands were studied by Lauenroth ***et al.*** (1978).

Bazilevich and Titlyanova (1980) made a comparative study on the functioning of grassland ecosystem. The distribution and cycling of nitrogen in soil-components of a tropical grassland was studied by Yadava (1980). Barbour ***et al.*** (1980) made a review of the progress of ecology in the western countries. Sala ***et al.*** (1981) studied the productivity dynamics of a temperate grassland in Argentina. Abrams ***et al.*** (1986) studied the effects of fire and topographic position on the above ground biomass of Kansas grasses. The effect of fertilizer on biomass and production of tundra was analyzed by Shaver and Chapin (1986). Deshmukh (1986) studied the primary production of grassland in Nairobi National Park of Kenya. Milchunas ***et al.*** (1988) made a study on the effects of grazing on various structural attributes of a grassland community. Sala ***et al.*** (1988) studied the primary production of central grassland region of the United States. Noy-Meir ***et al.*** (1989) analyzed the response of Mediterranean grassland flora in relation to grazing. Defosse and Bertiller (1991) studied the structural and functional aspects, nitrogen cycling, growth patterns, species area curves, dynamics of nitrogen competition among the species and productivity of grassland communities.

Defosse ***et al.*** (1990) studied the aboveground phytomass dynamics of a grassland of Argentina. The tropical and sub-tropical grasslands in relation to primary productivity were analyzed by Long ***et al.*** (1992). Soriano (1992), Coupland ***et al.*** (1992), Le Houerou (1993) and Thompson ***et al.*** (1996) made extensive studies on the structural and functional aspects of Western Hemisphere and limestone grassland communities whereas the effects of grazing and fire on species composition and diversity were studied by Belsky (1992) and Blair (1997). Frank and Naughton (1993) worked on the promotion of aboveground grassland production of a national park. The grassland communities of Oceania and East Africa were studied by Gillison (1993) and Herlocker ***et al.*** (1993). Lavernko and Karamysheva (1993) analyzed the steppes of the former Soviet Union. Knapp ***et al.*** (1993) worked on the landscape patterns in soil- water relation and primary production of tall grass Prairie. The biodiversity and stability of grasslands were studied by Tilman and Downing (1994), Huston (1994), Briske (1996), Tilman ***et al.*** (1996), Tilman (1997), Tainton ***et al.*** (1996), Huston (1997) and Hopper and Vitousek (1997). Daiz ***et al.*** (1994) made a comprehensive study on the community structure of montane grasslands in Central Argentina. Smith and Rushton (1994) studied the effects of grazing and management of mesotrophic (meadow) grassland of North England. Anderson and Briske (1995) worked on herbivore induced species replacement in grasslands. Fisher ***et al.*** (1996) studied the dispersal of plants and animals by sheep in calcareous grasslands. Viragh and Bartha (1998) worked on the intraspecific association in different successional stages of *Brachypodium pinnatum* grassland of Hungary. Modulation of diversity by grazing and mowing in native tall grass prairie was analyzed by Collins ***et al***. (1998). Poschlod ***et al.*** (1998) studied the richness of plant species in calcareous grasslands affected by dispersibility in space and time. Woodward ***et al***. (1999) made a comprehensive study on plant diversity and productivity in some European grassland. Austrheim ***et al.*** (1999) studied the land use impact on plant communities in semi-natural sub-alpine grasslands of Budalen in central Norway. Volk ***et al.*** (2000) worked on the soil moisture effect on grassland species. The impact of grazing on biodiversity and productivity of various grasslands were studied by Watkinson and Ormerod (2001), Tilman ***et al.*** (2001) and Nick (2002). Vandvik and Birks (2002) analyzed the pattern and processes of Norwegian upland grasslands. The floristic, frequency and vegetation spectra of a Cerrado site was studied by Batelha and Martins (2002 & 2004). Morgan ***et al.*** (2004) analyzed the role of water relations in grassland and desert ecosystem responses to rising atmospheric CO_2. Planturex ***et al.*** (2005) and Isselstein ***et al.*** (2005) worked on various management aspect of grassland biodiversity. Duru ***et al.*** (2005) studied the functional diversity in law-input grassland farming system. Nazir and Malik (2006) studied the life-form and index of similarity of plant communities at Sarsawa hills of Kotli District whereas Ghani and Khalik (2006) analyzed the floristic diversity and phytogeography of the Gebel Elba National Park of South-East Egypt.

The study of ecology in India is not very different from that of any other countries in the West. Indeed it has been much influenced by western school which provides the leadership. Ecological investigation in India also provided enough opportunity for Botanical exploration. Indian ecology was developed under the leadership of R. Misra first in Sagar and later at Varanasi by the leadership of R. S. Ambasht. Consequently many school of ecology emerged at Ujjain, Ahmedabad, Pilani, Jodhpur, Pondichery, Berhampur and at many other places of India. Misra (1958) summarized ecological work done in Madhya Pradesh. Misra and Singh (1971) reviewed the progress of ecology in India. Sharma and Ambasht (1987) reviewed the ecological research in Indian Universities.

Ecological status of Indian grassland community is mainly controlled by biotic activities as a result of which, the community gradually changes its composition partially or completely. Champion (1936) stated that the grassland in India are stable pre-climax vegetation as a result of impact of fire and grazing .Whyte (1974) reported that most of the grasslands are of seral in nature and belongs to territory communities. Misra (1983) reported that all tropical grasslands of India are of savanna type, a kind of grass dominated land besiege with isolated growth of shrubs or trees at wide intervals and have changed from mesic to xeric in nature during the past few decades.

An appreciable amount of work has been done in temperate zone as revealed by the literature survey pertaining to the structure and function of grassland ecosystems. Very few data are available on tropical grasslands, especially in India. With respect to phytosociology, reproductive capacity, production in relation to a variety of ecological factors especially grazing was studied by Sant (1962 & 1965), Singh (1967), Choudhury (1964), Ambasht and Maurya (1970), etc. Ambasht ***et al.*** (1972) studied the primary production and turnover in certain protected grasslands of Vanarasi and Varshney (1972) studied on the productivity of Delhi grasslands. Singh and Yadava (1974) studied the seasonal variation in composition, plant biomass and net primary productivity of a tropical grassland at Kurukshetra. Singh and Ambasht (1975) reported inter-relationships among community structure and productivity. Billore and Mall (1977) made extensive studies on the biomass structure and nutrient dynamics especially on grazing land of Ujjain. Singh ***et al.*** (1979) analyzed the photosynthetic structure in relation to organic matter production of grassland community. Singh and Ambasht (1980) worked on the floristic composition and phytosociology of three grass strands in Naugarh forest of Vanarasi division. Ambasht and Singh (1980) worked on the productive status of grasslands in deciduous forests of Vindhyan hills. Ambasht and Pandey (1981) analyzed the seasonal changes in the phytosociological and productive structure of two strands of *Aristida cyanantha*. Misra (1983) has given a detailed account of Indian Savannas. Ram and Ramakrishnan (1988) studied hydrology and soil fertility of some degraded grasslands at Cherapunji of Meghalaya. Ambasht and Sharma (1989) reviewed fifty years of ecological research of Banaras Hindu University. Umashanker (1991) analyzed the nutrient cycling in degraded grassland ecosystem of Meghalaya. Ram and Arya (1991) worked on the plant forms and vegetation dynamics of an alpine meadow of Central Himalaya. Whereas Umashankar ***et al.*** (1991) studied the structure and seasonal dynamics of a humid tropical grassland in India. The rain fall and grazing effects on net primary production in a tropical savanna was analyzed by Pandey and Singh (1992).Umashanker ***et al.*** (1993) studied the phytomass dynamics and primary productivity of a humid grassland. Ram and Ramakrishnan (1992) worked on the fire and nutrient cycling in grasslands of Cherrapunji in North Eastern India.

The ecological study of various grassland communities in Orissa has been initiated by B. N. Misra and his scholars since two and half decades. Phytosociology as well as primary productivity of certain grassland communities of Orissa have been carried out by Misra (1978), Misra and Misra (1979, 1981 & 1982), Naik (1985) and Pradhan (1994). Behera ***et al.*** (1981) derived a method of indirect estimation of belowground biomass of individual species of a natural grassland community. Misra and Misra (1984 & 1986) also studied the biomass, primary productivity and energetic of an Indian grassland. Impact of some environmental factors like grazing was studied by Rath (1980), Rath and Misra (1980 & 1981) and burning by Malana (1981), Malana and Misra (1980, 1981 & 1982). Tripathy (1989) analyzed the effect of chipping and fertilization on the structure and function of a grassland community. Ecological study of South Orissa has been carried out by Misra (1992) and Patnaik (1993). Whereas Barik and Misra (1995; 1996; 1997; 1998 & 2000) and Barik (2006) studied the structure and function of an upland grassland community of Eastern Orissa.

The life-form and primary productivity of a grassland community provides necessary data and information to the observers, researchers and planner to build up a correct ecological picture of an area. The ecologist and environmentalist in both developed and developing countries are increasingly being engaged now-a-days in the research projects relating to analysis of various grassland communities with a view to conserve the nature through International Biological Programme (IBP), Man and Biosphere (MAB), Grassland Foundation (GF) , World Wildlife Fund (WWF) etc. Much emphasis is given on the life-form and primary productivity of various grassland communities and their interaction with various biotic and abiotic factors affecting the flora of a particular habitat.

Literature review revealed a lot of information's in the life-form and primary productivity of various grassland communities of India and abroad. In Orissa some work has been done particularly in the southern and eastern regions. However, no work has been made so far to study the ecology of grassland community especially in the northern belt of the state. Keeping all these fact in view an attempt has been made to study the life - form and primary productivity of grassland communities of this region.

The **aim and objectives** of this investigation are as follows -

1. To find out the life - form and stratification of the grassland community.

2. To study the frequency, density, abundance, basal cover, relative frequency, relative density, relative dominance and Importance Value Index of various species occurring in the community.

3. To determine the various compartmental biomasses i.e. live green, standing dead, litter, aboveground, bellow ground and the total biomass of the community.

4. To study the primary productivity of the grassland community.

5. To draw the relationship existing among the various attributes of the community.

6. To analyze the data statistically and co-relating the findings with other grassland communities of various climatic regions.

7. The climatic conditions i.e. rain fall, atmospheric temperature, wind velocity, soil pH, organic carbon, nitrogen, availability of phosphorous and potassium and soil conductivity that influence the grassland community are also taken into consideration in this investigation.

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FLORISTIC COMPOSITION

The plant specimens preferably along with reproductive parts were collected from the experimental site and brought to the laboratory for identification (Mueller Dombois and Ellenberg, 1974). Identification of all the species were made in consultation with various regional and national flora books i.e. The Botany of Bihar and Orissa (Haines, 1921-25); Supplement to the Botany of Bihar and Orissa (Mooney, 1950); Flora of Madras presidency (Gamble, 1915-36); Flora of Similipal (Saxena and Brahmam, 1989); Flora of Orissa (Saxena and Brahmam, 1994-96) and Flora of Madhya Pradesh (Verma ***et al.***, 1993; Mudgal ***et al.***, 1997 and Singh ***et al.***, 2001). The voucher specimens were preserved and housed in the laboratory for future use and reference.

2.1 LIFE- FORM

The life-form classes were analyzed as per Raunkiaer's (1934) system which was subsequently modified by Dansereau (1960) and Rao (1968). This was based on the positions of the regenerating parts of the plants found in the grassland community. The rainy season (July to October) data were generally considered for enumeration of different life - form classes: -

(a) Phanerophytes

These are trees or shrubs or climbers. Growing buds are located on the upright shoot much above the ground surface and are least protected.

(b) Chamaephytes

The buds are located close to the ground surface or up to a maximum height of 25cm. Sometimes the rest of the aerial parts die in the cold season.

(c) Hemicryptophytes

Plants of this type are predominantly present in cold climatic regions. Here the perennating buds are present just below the surface soil and remain protected there. Mostly these are biennial or perennial herbs, whose vegetative growth and aerial parts are conspicuous in warm season only. Buds may also be present at the soil surface but they are never exposed, they remain concealed under dead leaves and twigs.

(d) Cryptophytes

These are also called geophytes. Here the buds are invariably buried in the soil or in the substratum such as rhizomes. These are adopted to withstand long periods of adverse climatic condition. The storage of food in the perennating organ is also important aspect.

(e) Therophytes

These plants can survive in the form of seeds during adverse season. Flowers and seeds of these plants are formed in the favourable season. They are annuals, predominantly found in extremes dry, hot or cold conditions.

2.2 STRATIFICATION

Stratification or layering is the occurrence of organisms (plants) at different level in an ecosystem. It depends on the type of community. In forest ecosystem five to seven strata may be found, however a grassland ecosystem comprises with a maximum of three strata. The plant height ranges from 50cm to 1 meter considered as highest or top strata, 25 - 50cm is the middle strata and the plant height below 25cm are placed in lower strata. All most all runners are considered under lower strata.

2.3 QUADRAT SIZE AND SAMPLING PERIOD:

One of the important aspects for sampling the vegetation is the size of the quadrat. Different workers have employed various quadrat sizes for the study of diverse communities. For small plants like mosses, lichens and liverworts growing in patches, quadrats of 20cm x 20cm will be useful. However in grasslands, if it is relatively homogeneous 50cm x 50cm quadrat may serve the purpose. In grassland with large number of species 1m x 1m or more may be needed. In the present investigation 1m x 1m size quadrat was determined as per species area curve method (Goodall, 1952; Oasting, 1956; Odum, 1971; Mueller-Dombois & Ellenberg, 1974) and the sampling were made during the last week of every months, starting from December 2006 to December 2007.

2.4 DETERMINATION OF FREQUENCY, DENSITY, ABUNDANCE ETC.:

For determining frequency, density, abundance, basal cover etc., 100 quadrats of 1m x 1m size were laid randomly in each month. Each tiller was counted as an individual plant in case of grasses whereas each forb was considered as an individual. In case of runners each node rooted at the base was considered as an individual. Basing upon these principles the percentage of frequency, density, abundance and such others were calculated following the formulae -

(a) Frequency $= \dfrac{\text{Number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \times 100$

(b) Density $= \dfrac{\text{Number of individuals of a species in all quadrats}}{\text{Total number of quadrats taken.}}$

(c) Abundance $= \dfrac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats in which the species occurred.}}$

Basal area of each species was determined by taking the diameter of the cross-section of the individual species by using ink pad and graph sheet. The stem above the ground was cut transversely and the lower transverse section of the twig was then pressed on an ink pad and finally transferred to the graph sheet. The area was obtained directly by counting the squares covered by the cross section. In this way 10 randomly sampling species were marked during each month and the average area was calculated. This average area of the individual species was multiplied with the respective density value to get the basal cover of the species and was expressed as $cm^2\ m^{-2}$.

The relative frequency, relative density and relative dominance were also determined in each month using the value of frequency, density and abundance as follows -

$$\text{Relative Frequency (R.F.)} = \frac{\text{Number of occurrence of the species}}{\text{Number of occurrence of all species}} \times 100$$

$$\text{Relative Density (R.De.)} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100$$

$$\text{Relative Dominance (R.Do.)} = \frac{\text{Basal area of the species}}{\text{Total basal area of all species}} \times 100$$

IMPORTANCE VALUE INDEX (IVI)

The Importance Value Index (IVI) for each species was determined by summing up the values of relative frequency, relative density and relative dominance.

$$\text{IVI} = \text{R.F} + \text{R.De.} + \text{R.Do.}$$

2.5 SPECIES DIVERSITY AND DOMINANCE

Plant species diversity (H') was calculated by the Shannon and Weaver's (1949) formula –

$$\mathbf{H' = -\sum pi\ \ ln\ \ pi}$$

Where H' = diversity index

pi = the proportion of the total number of individuals/green biomass belonging to its ith species.

ln = natural logarithm.

The dominance index (C) was calculated by Simpson's (1949) Formula

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

Where ni = Density of species i.e. total number of individuals/green biomass of the species.

N = Total number of individuals of all species.

pi = ni/N or in other words

$C = \Sigma (pi)^2$

2.6 BIOMASS

Biomass of the study site was divided into

I. Above ground biomass and

II. Below ground biomass

The above ground biomass was again sub-divided into

(a) Live green biomass

(b) Standing dead biomass and

(c) Litter biomass

Harvest method of Odum (1960) was employed for the estimation of plant biomass. 10 quadrats of 50cm x 50cm size were randomly harvested / clipped, 1cm above the ground during the last week of each month. The samples were packed in polythene bags separately. The dead leaves, stems, seeds, flowers etc. lying on the ground, known as litter were hand picked from each clipped plot, bagged and labelled. Roots including the remaining shoot bases were collected by excavating 25cm x 25cm monolith to a depth of 30cm at the center of each clipped plot. All these samples were labelled properly and brought to the laboratory.

- All green plant materials were separated into different species components and are referred as live green compartment.
- All yellow dry plant materials known as standing dead were separated from the mother plant.

- Some of the materials remaining at the ground level were separately collected using water floating technique.

- The below ground portion containing root, rootstocks, rhizomes etc. were washed with low pressure tap water. Care was taken not to leave any plant material escape during processing.

All these materials i.e. live green, standing dead, litter and below ground compartments were first dried in open and than transferred to the oven for drying at 80^0C for 24 hours and weighed. The biomass values were expressed as g m^{-2}.

2.7 PRIMARY PRODUCTIVITY

Primary productivity of the grassland community was determined from the biomass values following "short term harvest" method as proposed by Odum (1960). The productivity for each category of plant materials i.e. live green, standing dead, litter and below ground parts was calculated by summing up of the positive increments of concerned biomass during the study period and was expressed as g m^{-2} yr^{-1}.The above ground net production was calculated by summing the value of live green and standing dead. Total net production was obtained by summing the value of above ground net production and below ground production. The rate of respiration i.e. Respiratory loss was not measured in the present investigation and was calculated by multiplying the total net production with 0.3 factor, which is the median ratio of respiration to net production for different types of vegetation (Odum, 1960).

Gross primary production of the community was estimated by adding respiratory loss to the total net production. Litter disappearance (LD) was calculated by subtracting the total net productivity of litter during the year from the difference between final and initial litter biomass (Golley, 1965).

Below ground disappearance (BGD) was calculated from the difference between peak below ground biomass and succeeding minimum below ground biomass (Sims & Singh, 1971).

Total disappearance was obtained by adding litter disappearance and below ground disappearance.

TURNOVER OF ORGANIC MATTER

The turnover rate was determined following the formula of Dahlman & Kucera (1965).

$$T = A/B$$

Where T = turnover rate
A = annual increment
B = maximum biomass
$1/T$ = turnover time

The annual increment was calculated by summing +ve increments of concerned biomass during the sampling period.

For the analysis of soil, soil samples were collected from three different depths i.e. 0 to 10, 10 to 20 and 20 to 30cm with the help of a soil corer. Five samples were taken from each depth, labelled and were mixed thoroughly in order to make a composite soil samples. The samples were dried under open, rolled and sent to the soil testing laboratory, Department of Agriculture, Government of Orissa, District Headquarter branch, Baripada, for the determination of soil pH, conductivity, Organic carbon, nitrogen, available phosphorous and potash content of the experimental site.

The meteorological data i.e. rainfall number of rainy days, minimum and maximum atmospheric temperature and wind velocity were collected from District Agriculture Office, Baripada, Mayurbhanj and incorporated in this investigation.

****

3.1 LOCATION

The experimental site was selected at Rangamatia (Fig.-1), situated at a distance of 15 kms away from North Orissa University and 11 kms from Baripada, the District headquarter of Mayurbhanj in the state of Orissa. It is located at 86^0 41' E longitudes and 21^0 56' N latitude. The altitude of the site is above 135.7 m.

3.2 CLIMATIC CONDITION

The climate of the locality is monsoonal with three distinct seasons viz. rainy (July to October), winter (November to February) and summer (March to June). The seasons are classified according to the amount of rainfall and also to the prevailing atmospheric temperature.

Rainfall (mm)

The total rainfall during the study period (December 2006 to December 2007) was 1906.2 mm of which a maximum of 499.8 mm was recorded during July. No rainfall was observed in the month of December (Fig.-2). Total no of rainy days was found to be 74 days (Fig.-3) during the study period.

Atmospheric temperature (^{0}C)

The minimum and maximum atmospheric temperature recorded during the study period was found to be normal (Fig.-2). December showed the lowest temperature (9.93^0C) whereas May experienced the highest temperature (38.9^0 C).

Wind velocity (km h^{-1})

The wind velocity was found to be maximum (4.31 km h^{-1}) during April and minimum (1.99 km h^{-1}) in the month of November (Fig. - 4).

3.3 SOIL

The soil of the experimental site was found to be moderately acidic (pH = 5.5). The available phosphorus content was high (1.2 ppm) in lower soil and minimum (0.5 ppm) in middle soil profile. The potassium showed gradual reduction from surface (100.3 ppm) to middle (87.6 ppm) and then to lower (81.1 ppm) soil depth. However, the over all organic carbon (0.61%), nitrogen based on organic carbon content (0.5 to 0.75%), and available potassium (59 to 140 ppm) were found to be normal where as the available phosphorus was found to be very low (< 2 ppm) in the soil. Table -1 represents the pH, conductivity, organic carbon, available phosphorus and potassium content of soil of the experimental site.

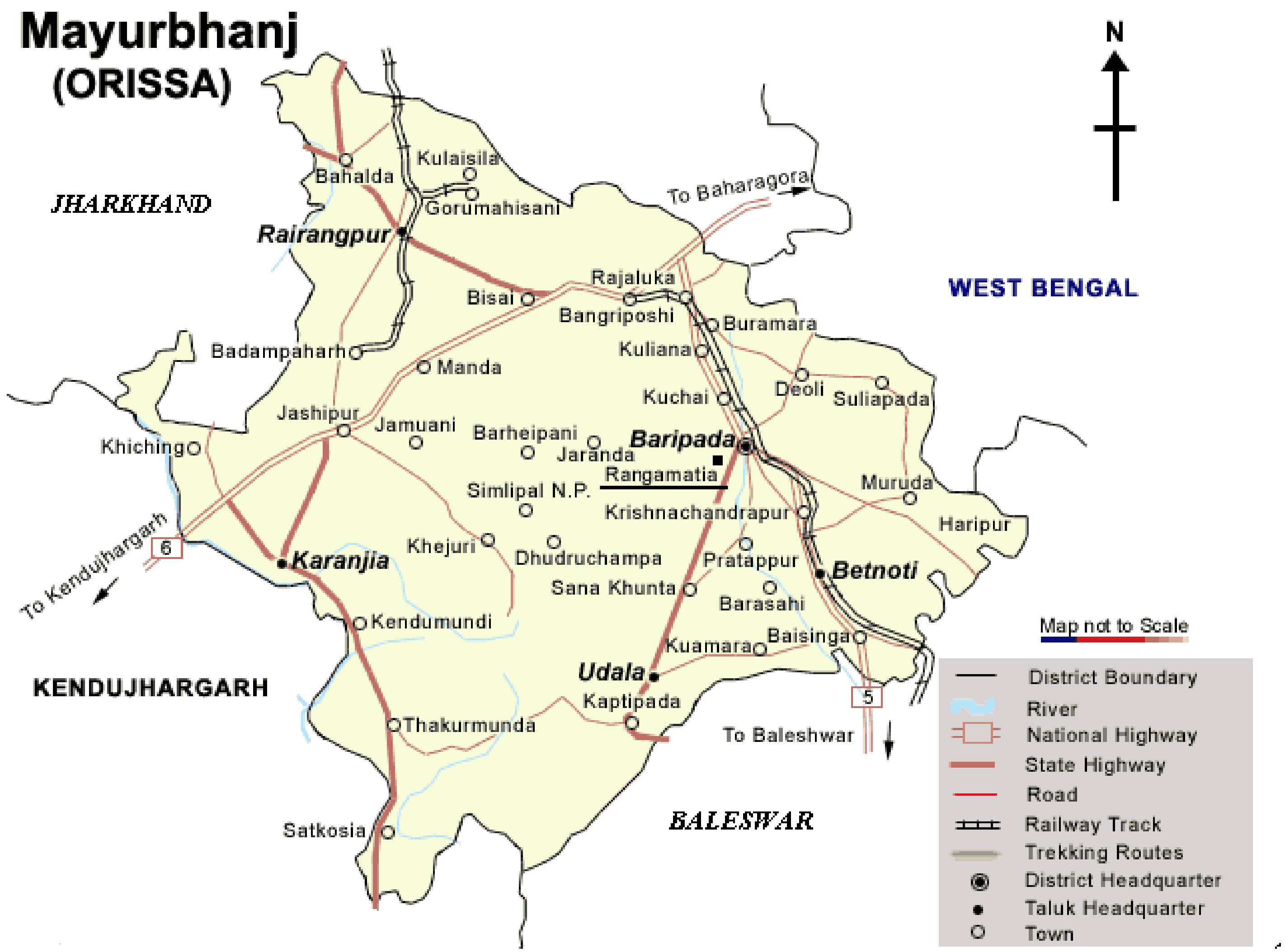

Fig. 1 District Map of Mayurbhanj showing the experimental site.

Photograph showing experimental site at Rangamatia.

Photograph showing experimental site at Rangamatia.

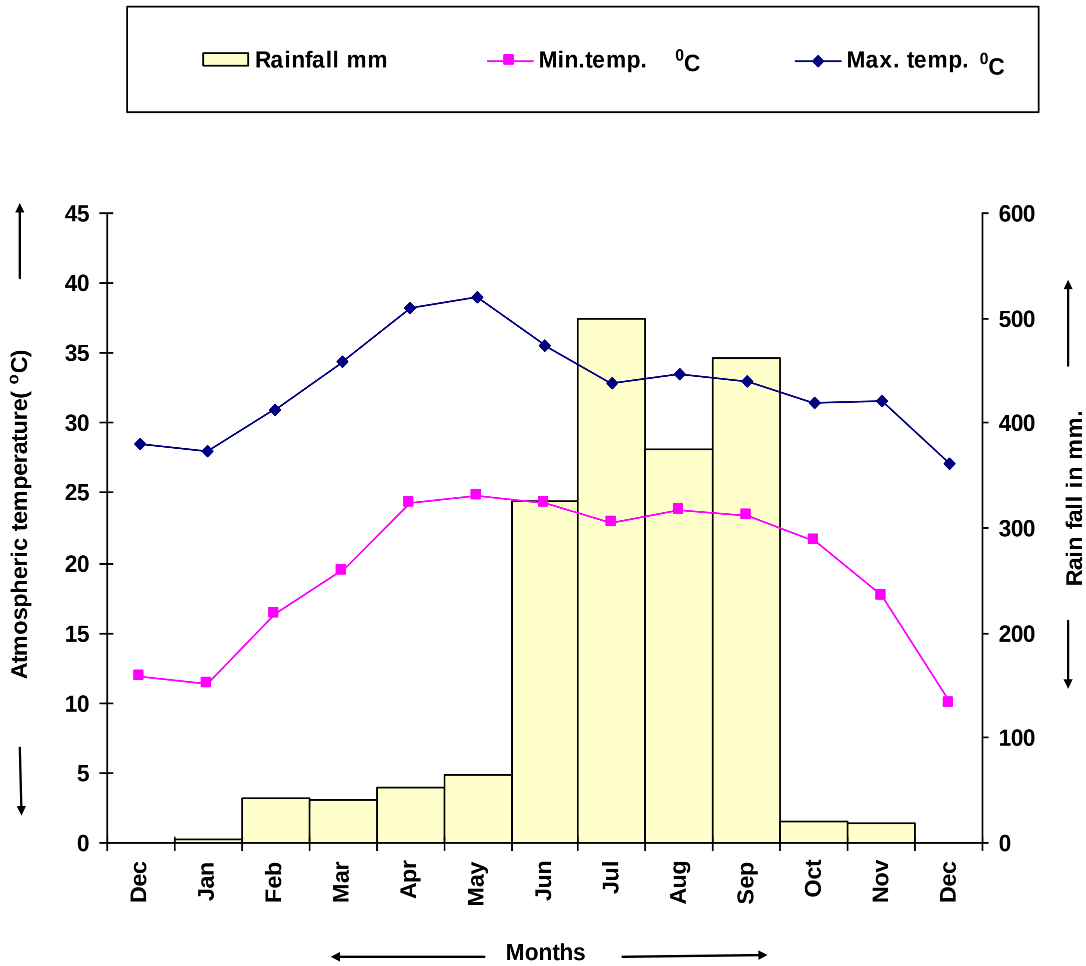

Fig. 2 Monthly rainfall, mean minimum and mean maximum atmospheric temperature of the experimental site during the study period.

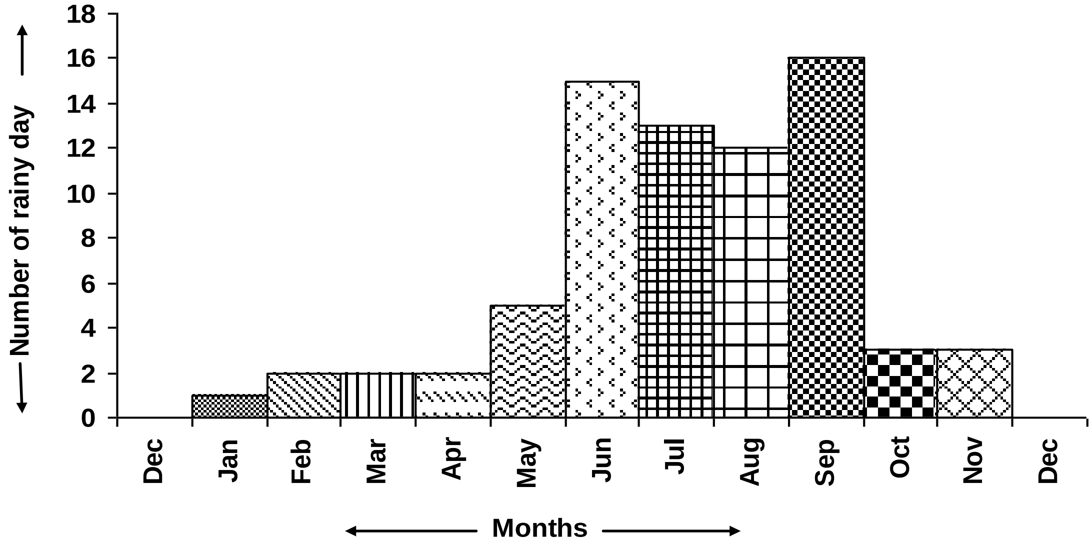

Fig. 3 Number of rainy days during the study period.

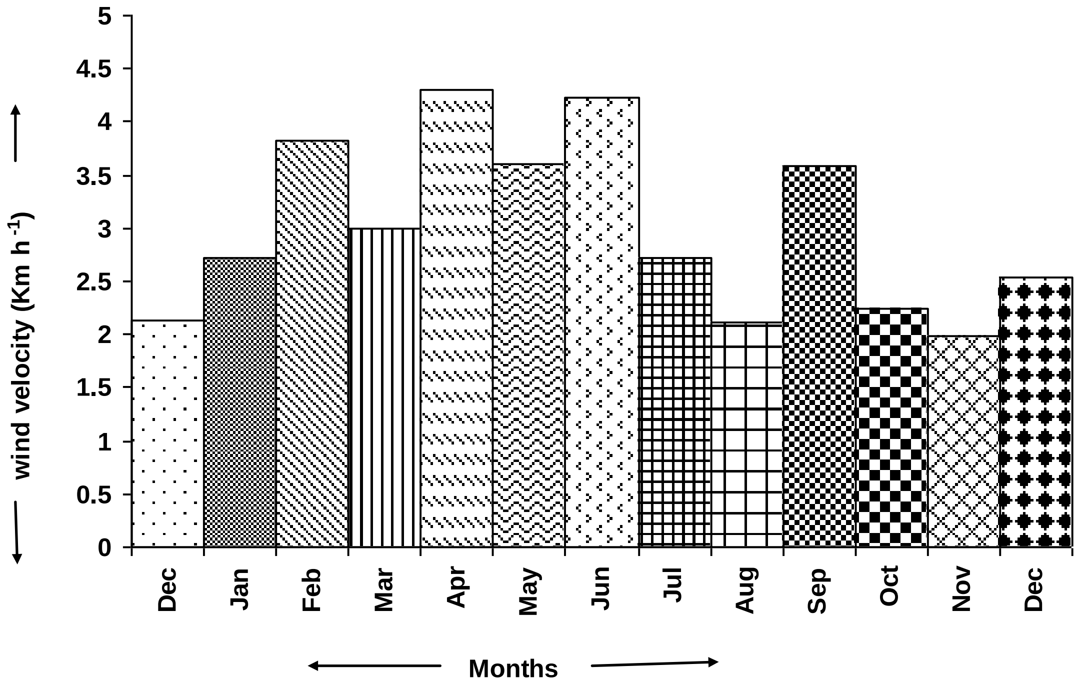

Fig. 4 Monthly variation of wind velocity (Km h^{-1}) during the study period.

Table - 1. The pH, conductivity , organic carbon (%), available phosphorus and potassium content of the soil content of the study site (values are in mean ± SD, n = 5 each).

Surface depth in cm	pH	Conductivity	Organic carbon (C) (%)	Available phosphorus (P) (ppm)	Available potassium (K) (ppm)
0 to 10	5.46 ± 0.385	0.68 ± 0.179	0.56 ± 0.057	0.66 ± 0.321	100.3 ± 28.409
10 to 20	5.38 ± 0.311	0.50 ± 0.000	0.64 ± 0.092	0.50 ± 0.467	87.6 ± 26.658
20 to 30	5.64 ± 0.358	0.50 ± 0.000	0.62 ± 0.107	1.20 ± 0.689	81.1 ± 18.716

****

4.1 INTRODUCTION

The characteristic features pertaining to structural aspect of vegetation are essential for any in-depth studies relating to ecology of a place. This study provides the knowledge to interpret the ecological imbalance and builds up a picture of the type of vegetation of the area, its floristic composition, life-form pattern and also the dynamics in the vegetational unit. Although such study seems to be classical yet it forms the core of the ecological study pertaining to vegetation analysis.

The floristic composition of a particular community highly depends upon the climatology and soil texture of that area. Warming (1909) was the first to develop the concept of life-form, "Plants related to climate". Plants always adapt to different unfavourable conditions of the environment by which the species are in dynamic equilibrium with it. Raunkiaer (1934) classified the plants into different life-forms basing on the perennating buds, which is a type of adaptation having much relevance to the climatological fluctuations. According to him, "the life – form is the sum of adaptability of a plant to climate" and the phyto-climate of a locality can be found out by studying the flora of that area. He proposed a normal spectrum (Raunkiaer's normal spectrum) of the phanerophytic flora of the world to compare the differences and similarities of various community structures. According to Hanson & Churchill (1961) the life-form type of a locality is always identified by the dominant species of that area. Rao (1968) suggested that by studying the life-form of the species, one can indicate, how a plant passed the unfavourable season.

Kershaw (1973) was of the opinion that in order to know the ecology of vegetation or a locality, it is necessary to study the life-forms of the species of that area and the physiognomy of a plant community is determined by the life-forms of the dominant species. The life-forms of an association indicate the character of the habit and the nature of climate. He also revealed that, the study of floristic composition of the vegetation is a prerequisite to understand the phytosociology of a community.

The floristic distribution of species as life-form is called “Biological spectrum” or “phytoclimatic spectrum”. In a plant community individual species has the dynamic equilibrium with the condition of the environment adapting to different traits. One such trait is the placement of perennating bud with respect to its distance from the surface and accordingly Raunkiaer (1934) established 5 classes to study the life-form pattern of various plant communities.

The structural dynamics of a community is based on the composition and sociological attributes like frequency, density, abundance, dominance, IVI etc. The manner by which the species are located or dispersed in the community is termed as frequency and is generally expressed as percentage. When the frequency of one species is related to the manner of dispersion by other species of the same community, then it is termed as relative frequency.

Misra (1968) had expressed that, the abundance and density represents the numerical strength of species in the community. Abundance considered along with frequency, gives an idea of the distribution pattern of the species. While the density represents the number of individuals per unit area. Oosting (1956) suggested that the density and frequency taken together are of prime importance in determining community structure and have a variety of uses far beyond those of other quantitative values. Relative density is an expression for the numerical strength of a species in relation to the total number of all species.

Basal area refers to the ground actually penetrated by the stem and is readily seen when the stem is clipped at ground surface (Hanson & Churchil, 1961). It is an index for determining the dominance and the nature of the community.

Importance Value Index (IVI) is the sum total of the percentage values of relative frequency, relative density and relative dominance, which reveals overall structure of the community.

Species diversity and dominance plays a major role to study the nature of community. In the strict sense, species diversity is principally a mechanism which generates the stability of the plant community where as dominance generates the productivity of the plant community.

In this investigation structural variable i.e. floristic composition, life-forms, stratification, frequency, density, abundance, basal cover, importance value index etc. of the community has been analyzed month wise.

4.2 RESULTS

4.2.1 FLORISTIC COMPOSITION

The grassland community comprises with 36 species. Out of which, 15 species were grasses (includes all members of Cyperaceae and Poaceae) and 21 species were non grasses (includes rest of the herbaceous elements). The community exhibited almost all species during the month of July, August, September, October and November but during April 6 species were observed (4 grasses and 2 non grasses).*Cynodon dactylon, Digitaria abludens*, *Eleusine indica*, *Vetiveria zizanioides* were among the grasses and *phyllanthus fraternus* and *Sida cordifolia* among the non-grasses were found dominant during the study period (Table-2). A complete floristic list of grasses and non-grasses along with their families of the experimental grassland are presented in appendix - I.

4.2.2 LIFE - FORMS

The life-form of various species occurring in the grassland community is enlisted in appendix - II. Out of 36 species, 10 species belonged to the class

Table- 2 Floristic list of experimental grassland community showing the occurrence (+) of various species during the study period.

No	Species name	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	GRASSES													
1	*Alloteropsis cimicina*	+	–	–	–	–	–	+	+	+	+	+	+	+
2	*Cynodon dactylon*	+	+	+	+	+	+	+	+	+	+	+	+	+
3	*Cyperus castaneus*	+	+	–	–	–	–	+	+	+	+	+	+	+
4	*Digitaria abludens*	+	+	+	+	+	+	+	+	+	+	+	+	+
5	*Digitaria longiflora*	+	+	+	–	–	–	+	+	+	+	+	+	+
6	*Eleusine indica*	+	+	+	+	+	+	+	+	+	+	+	+	+
7	*Eragrostis tenella*	+	+	+	–	–	–	+	+	+	+	+	+	+
8	*Eragrostis unioloides*	+	+	+	+	+	–	+	+	+	+	+	+	+
9	*Fimbristylis dichotoma*	+	+	+	+	–	–	+	+	+	+	+	+	+
10	*Fimbristylis ovata*	+	–	–	–	–	–	+	+	+	+	+	+	+
11	*Lipocarpha sphacelata*	–	–	–	–	–	–	+	+	+	+	+	+	–
12	*Paspalum scrobiculatum*	+	+	–	–	–	+	+	+	+	+	+	+	+
13	*Scleria lithosperma*	+	+	+	–	–	–	+	+	+	+	+	+	+
14	*Setaria intermedia*	+	–	–	–	–	–	+	+	+	+	+	+	+
15	*Vetiveria zizanioides*	+	+	+	+	+	+	+	+	+	+	+	+	+
	NON GRASSES													
1	*Aclisia secundiflora*	+	–	–	–	–	–	+	+	+	+	+	+	+
2	*Ageratum conyzoides*	+	–	–	–	–	–	+	+	+	+	+	+	+
3	*Alysicarpus vaginalis*	+	+	+	–	–	–	+	+	+	+	+	+	+
4	*Centranthera indica*	+	+	–	–	–	–	+	+	+	+	+	+	+
5	*Desmodium triflorum*	+	+	+	–	–	+	+	+	+	+	+	+	+
6	*Elephantopus scaber*	+	+	+	+	–	–	+	+	+	+	+	+	+
7	*Emilia sonchifolia*	+	+	+	–	–	+	+	+	+	+	+	+	+
8	*Evolvulus nummularius*	+	+	+	–	–	+	+	+	+	+	+	+	+
9	*Hedyotis herbacea*	+	+	–	–	–	–	+	+	+	+	+	+	+
10	*Lindernia angllis*	+	+	–	–	–	–	+	+	+	+	+	+	+
11	*Lindernia crustacea*	+	+	+	–	–	–	+	+	+	+	+	+	+
12	*Ludwigia hyssopifolia*	+	–	–	–	–	–	–	+	+	+	+	+	+
13	*Mecardonia procumbens*	+	–	–	–	–	–	+	+	+	+	+	+	+
14	*Melochia corchorifolia*	+	+	+	+	–	–	+	+	+	+	+	+	+
15	*Murdannia nudiflora*	–	–	–	–	–	–	–	+	+	+	+	+	–
16	*Oxalis corniculata*	+	+	+	–	–	–	+	+	+	+	+	+	+
17	*Phyllanthus fraternus*	+	+	+	+	+	+	+	+	+	+	+	+	+
18	*Rungia pectinata*	+	+	+	+	–	+	+	+	+	+	+	+	+
19	*Sida cordifolia .*	+	+	+	+	+	+	+	+	+	+	+	+	+
20	*Spermacoce ramanii*	+	+	–	–	–	+	+	+	+	+	+	+	+
21	*Zornia gibbosa*	+	+	–	–	–	–	+	+	+	+	+	+	+

chamaephyte, 9 species to hemicryptophyte, 6 species to geophyte (cryptophyte) and 11 species to therophyte. Phanerophytes were found to be absent. Among the classes chamaephyte showed the maximum (27.78%) where as geophyte showed the minimum (16.67%) percentage contribution to the biological spectrum. Table - 3 gives the percentage contribution of different life-form classes, of the experimental grassland community.

Table - 3 Biological spectrum showing the percentage contribution and number of species with respect to various life-form classes of the grassland community.

Class	No. of species	Percentage contribution
Phanerophyte	—	—
Chamaephyte	10	27.78
Hemicryptophyte	9	25
Geophyte	6	16.67
Therophyte	11	30.55
	36	**100**

4.2.3 STRATIFICATION

The stratification of the study site revealed all the 3 strata in the grassland community. Out of 36 species, 9 species i.e. *Ageratum conyzoides, Alysicarpus vaginalis, Digitaria abludens, Digitaria longiflora, Eleusine indica, Emilia sonchifolia, Setaria intermedia, Sida cordifolia* and *Vetiveria zizanioides* were found to be top strata where as middle and lower strata comprises of 10 and 17 species respectively. The details about the stratification of the experimental grassland community are placed in appendix -III.

4.2.4. FREQUENCY, DENSITY, ABUNDANCE, BASAL COVER, RELATIVE FREQUENCY, RELATIVE DENSITY, RELATIVE DOMINANCE AND IMPORTANCE VALUE INDEX OF VARIOUS SPECIES

The structural attributes i.e. Frequency, density, abundance, basal cover, IVI etc. of the experimental grassland community were determined month wise. It was observed that *Cynodon dactylon*, *Digitaria abludens*, *Eleusine indica*, *Vetiveria zizanioides* among the grasses and *Phyllanthus fraternus* and *Sida cordifolia* among the non - grasses showed higher percentage frequency through out the sampling period. *Ageratum conyzoides* and *Mecardonia procumbens* exhibited a lower frequency percentage among all the grasses and non- grasses respectively (Table- 4).

The peak density of the community i.e. 3439.8 Ind m^{-2} was found in the month of September. The grasses contributed 2568.2 Ind m^{-2} to the total community whereas non-grasses contributed only 871.6 Ind m^{-2} . A minimum value density (204.9 Ind m^{-2}) was observed during April whereas the grasses and non grasses exhibited 199.8 Ind m^{-2} and 5.1 Ind m^{-2} respectively. The density value of the community showed gradual declined in trend from December (1445.3 Ind m^{-2}) to January (966.5 Ind m^{-2}), then to February (661.9 Ind m^{-2}), March (252.4 Ind m^{-2}) and lowest in the month of April (204.9 Ind m^{-2}). There after the value increased from April to May (284.2 Ind m^{-2}), June (1385.4 Ind m^{-2}), July (2527.9 Ind m^{-2}), August (3176.1 Ind m^{-2}) and then to September (3439.8 Ind m^{-2}). Again a declined trend of density value was observed from September onwards i.e. from September to October (2975.1 Ind m^{-2}), November (2364.1 Ind m^{-2}) and December (1496.0 Ind m^{-2}). Among the dominated species , the grasses i.e. *Cynodon dactylon* (Fig.-5), *Digitaria abludens* (Fig.-6), *Eleusine indica* (Fig.-7) and *Vetiveria zizanioides*(Fig.-8) showed gradual declined in their density values from December/January to February, then to March and exhibited lower value during April/May. The values were then increased onwards and attained peak during September (except *Vetiveria zizanioides* which showed peak value in the month of August). There after again declined trend in density values were marked till to the end of the sampling period (i.e. December). Besides, among the non-grasses, the dominated species i.e. *Phyllanthus fraternus* (Fig.-9) and *Sida cordifolia* (Fig.-10) exhibited minimum density value in the month of May and March respectively and maximum in the month of September. However, the total density value of grasses and non- grasses gradually declined from the beginning i.e. from the month of December to January, February, March and April which showed the lowest value. May onwards the value exhibited gradual increase in trend and showed a peak during September. Thereafter, the value again showed a declined trend till to the end of sampling period (i.e. December).The grasses showed highest density values as compared to that of the density of non-grasses (Table -5). In this investigation abundance was expressed as Ind m^{-2} .The values obtained followed similar trend to that of the density value observed throughout the sampling period (Table -6).

The basal area (cm^2 m^{-2}) of different species during the sampling period is presented in (Table- 7). The basal area (grasses + non grasses) was found to be maximum in the month of October and minimum in the month of April. The value showed a gradual declined in trend from December to January, to February, then to March and lowest in the month of April. Thereafter, an increasing trend in value was observed from April onwards and attained a peak during October. Again a declined trend of basal area was noticed till to the end of the sampling period (December). The total basal cover of the experimental site showed minimum during April and maximum in the month of September. The basal cover gradually decreases from December to April and then it increases till September and onward the value exhibited a declined trend till to the end of the sampling period (Table-8).

The Importance value index (IVI) of the community was the sum total value of relative frequency (Table-9), relative density (Table-10) and the relative dominance (Table-11). The IVI was found to be near about 300 in each month (Table-12). The grasses showed higher IVI value than that of the non - grasses through out the sampling period. The grasses contributed lowest IVI in the month of September (154.839) and non-grasses in the month of April (59.396).

Table- 4 Frequency (%) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	40	—	—	—	—	—	100	40	30	50	70	70	40
2	*Cynodon dactylon*	100	100	100	100	100	100	100	100	100	100	100	100	100
3	*Cyperus castaneus*	90	70	—	—	—	—	100	100	100	100	100	100	100
4	*Digitaria abludens*	100	100	100	100	100	100	100	100	100	100	100	100	100
5	*Digitaria longiflora*	100	100	100	—	—	—	100	100	100	100	100	100	100
6	*Eleusine indica*	100	100	100	100	100	100	100	100	100	100	100	100	100
7	*Eragrostis tenella*	100	100	40	—	—	—	100	100	100	100	100	100	100
8	*Eragrostis unioloides*	100	100	100	100	80	—	100	100	100	100	100	100	100
9	*Fimbristylis dichotoma*	100	100	100	50	—	—	90	100	100	100	100	100	100
10	*Fimbristylis ovata*	100	—	—	—	—	—	90	100	100	100	100	90	100
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	90	70	90	100	70	80	—
12	*Paspalum scrobiculatum*	100	60	—	—	—	100	100	100	100	100	100	100	100
13	*Scleria lithosperma*	100	100	80	—	—	—	100	90	100	100	100	100	100
14	*Setaria intermedia*	100	—	—	—	—	—	100	80	100	100	100	100	100
15	*Vetiveria zizanioides*	100	100	100	100	80	100	100	100	100	100	100	100	100
	NON GRASSES													
1	*Aclisia secundiflora*	50	—	—	—	—	—	10	80	90	100	90	90	20
2	*Ageratum conyzoides*	30	—	—	—	—	—	10	30	50	20	50	30	20
3	*Alysicarpus vaginalis*	100	100	40	—	—	—	90	100	100	100	100	100	100
4	*Centranthera indica*	100	80	—	—	—	—	100	100	90	100	90	90	50
5	*Desmodium triflorum*	100	100	100	—	—	100	100	100	100	100	100	100	100
6	*Elephantopus scaber*	100	100	100	—	—	—	100	90	100	100	100	100	100
7	*Emilia sonchifolia*	90	100	40	90	—	50	100	100	100	100	100	100	90
8	*Evolvulus nummularius*	100	100	100	—	—	90	100	100	100	100	100	100	100
9	*Hedyotis herbacea*	100	100	—	—	—	—	90	100	100	100	100	100	90
10	*Lindernia anagllis*	50	100	—	—	—	—	60	40	90	90	80	50	60
11	*Lindernia crustacea*	100	100	50	—	—	—	80	100	100	100	100	100	80
12	*Ludwigia hyssopifolia*	50	—	—	—	—	—	—	70	50	100	100	60	40
13	*Mecardonia procumbens*	20	—	—	—	—	—	30	50	40	40	50	30	10
14	*Melochia corchorifolia*	90	100	80	70	—	—	50	100	90	80	100	80	60
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	40	90	100	70	60	—
16	*Oxalis corniculata*	80	100	40	—	—	—	80	90	100	100	60	80	70
17	*Phyllanthus fraternus*	100	100	100	80	80	50	100	100	100	100	100	100	100
18	*Rungia pectinata*	100	100	100	100		60	40	100	100	100	100	100	100
19	*Sida cordifolia*	50	70	80	70	60	40	80	80	50	100	70	50	80
20	*Spermacoce ramanii*	80	100	—	—	—	100	100	100	80	100	70	90	80
21	*Zornia gibbosa*	100	100	—	—	—	—	100	80	100	100	100	100	100

Table- 5 Density (Ind m^{-2}) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	0.80	–	–	–	–	–	7.50	12.40	13.30	12.80	12.00	3.20	1.20
2	*Cynodon dactylon*	105.00	121.00	110.80	61.20	51.10	71.90	139.90	176.00	182.10	188.60	141.30	138.20	108.70
3	*Cyperus castaneus*	58.50	3.10	–	–	–	–	31.20	116.00	114.20	104.00	86.00	79.60	56.00
4	*Digitaria abludens*	81.50	72.00	58.20	46.90	40.20	41.10	63.70	103.40	128.60	141.50	134.70	126.30	80.50
5	*Digitaria longiflora*	412.00	329.60	250.00	–	–	–	265.00	512.90	559.30	819.20	789.20	629.70	460.10
6	*Eleusine indica*	79.60	74.10	70.20	68.40	67.60	69.00	118.60	154.20	203.70	225.00	189.60	110.30	80.80
7	*Eragrostis tenella*	11.50	8.20	1.10	–	–	–	45.70	99.20	100.70	81.50	71.60	51.60	11.20
8	*Eragrostis unioloides*	41.00	31.00	21.10	10.60	3.60	–	68.70	127.50	167.60	166.40	115.50	90.80	40.60
9	*Fimbristylis dichotoma*	44.50	22.00	11.10	1.60	–	–	36.70	103.20	114.50	81.20	72.00	71.00	45.00
10	*Fimbristylis ovata*	11.50	–	–	–	–	–	76.40	191.60	198.40	156.00	107.20	42.90	11.20
11	*Lipocarpha sphacelata*	–	–	–	–	–	–	15.60	32.70	35.10	23.60	14.40	8.30	–
12	*Paspalum scrobiculatum*	31.50	2.20	–	–	–	22.80	61.10	130.70	191.50	188.50	136.00	85.50	31.20
13	*Scleria lithosperma*	63.00	45.00	2.50	–	–	–	45.00	66.10	139.40	147.60	132.70	110.80	61.60
14	*Setaria intermedia*	19.00	–	–	–	–	–	8.60	40.50	109.70	88.90	76.10	57.00	19.20
15	*Vetiveria zizanioides*	97.70	82.00	56.00	48.00	37.30	34.70	116.20	133.20	174.30	143.40	132.20	112.00	98.80
	Grasses total	**1057.10**	**790.20**	**581.00**	**236.70**	**199.80**	**239.50**	**1099.90**	**1999.60**	**2432.40**	**2568.20**	**2210.50**	**1717.20**	**1106.10**
	NON GRASSES													
1	*Aclisia secundiflora*	1.90	–	–	–	–	–	3.40	57.50	90.10	96.10	40.10	22.60	2.40
2	*Ageratum conyzoides*	0.40	–	–	–	–	–	0.30	1.70	1.50	2.70	1.70	0.90	0.30
3	*Alysicarpus vaginalis*	9.60	6.40	2.40	–	–	–	11.90	35.40	47.30	47.40	33.50	26.80	10.30
4	*Centranthera indica*	6.80	2.80	–	–	–	–	9.40	20.00	20.80	21.50	16.10	13.60	6.20
5	*Desmodium triflorum*	34.10	20.60	8.60	–	–	11.60	37.60	54.10	64.20	51.10	51.10	47.10	32.90
6	*Elephantopus scaber*	33.80	23.30	17.30	–	–	–	29.10	23.40	39.30	51.40	53.40	54.00	33.20
7	*Emilia sonchifolia*	5.10	1.70	0.80	2.60	–	1.50	7.70	14.80	24.60	27.50	14.90	12.20	4.80
8	*Evolvulus nummularius*	29.80	21.20	10.10	–	–	18.00	56.70	65.20	60.70	65.90	78.00	50.60	31.00
9	*Hedyotis herbacea*	13.10	5.50	–	–	–	–	14.90	26.60	35.00	42.30	45.60	30.50	14.40
10	*Lindernia anagllis*	2.20	1.30	–	–	–	–	3.30	6.20	5.60	7.70	4.70	5.50	2.60
11	*Lindernia crustacea*	11.00	5.60	1.60	–	–	–	6.00	16.00	12.00	19.80	19.60	17.20	9.50
12	*Ludwigia hyssopifolia*	1.30	–	–	–	–	–	–	3.10	13.30	15.50	13.60	5.60	1.40
13	*Mecardonia procumbens*	0.20	–	–	–	–	–	0.40	1.50	1.40	2.50	2.90	1.30	0.30
14	*Melochia corchorifolia*	3.30	2.60	2.00	2.20	–	–	1.10	3.80	4.90	4.40	4.10	3.90	3.00
15	*Murdannia nudiflora*	–	–	–	–	–	–	–	2.70	12.60	15.30	10.40	8.00	–
16	*Oxalis corniculata*	8.80	6.60	3.20	–	–	–	8.40	17.80	18.90	21.60	15.70	16.10	8.10
17	*Phyllanthus fraternus*	33.90	19.00	9.50	2.70	2.80	1.30	43.10	54.80	81.60	88.60	64.90	52.70	35.10
18	*Rungia pectinata*	166.00	48.00	23.00	6.60	–	2.80	25.10	85.40	153.50	217.80	220.00	222.40	167.10
19	*Sida cordifolia*	2.00	2.40	2.40	1.60	2.30	1.10	2.70	2.50	2.20	3.60	2.90	2.50	2.00
20	*Spermacoce ramanii*	5.10	1.60	–	–	–	8.40	15.80	17.00	18.10	17.50	11.80	11.10	4.90
21	*Zornia gibbosa*	19.80	7.70	–	–	–	–	8.60	18.80	36.10	51.40	59.60	42.30	20.40
	Non- grasses total	**388.20**	**176.30**	**80.90**	**15.70**	**5.10**	**44.70**	**285.50**	**528.30**	**743.70**	**871.60**	**764.60**	**646.90**	**389.90**
	Total	**1445.30**	**966.50**	**661.90**	**252.40**	**204.90**	**284.20**	**1385.40**	**2527.90**	**3176.10**	**3439.80**	**2975.10**	**2364.10**	**1496.00**

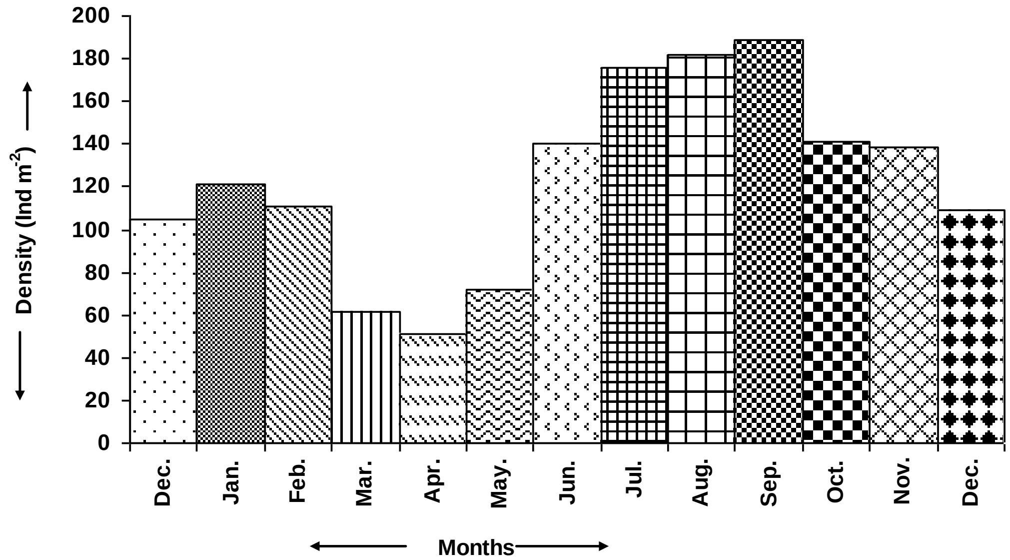

Fig. -5. Monthly variation in density values of *Cynodon dactylon* during the study period.

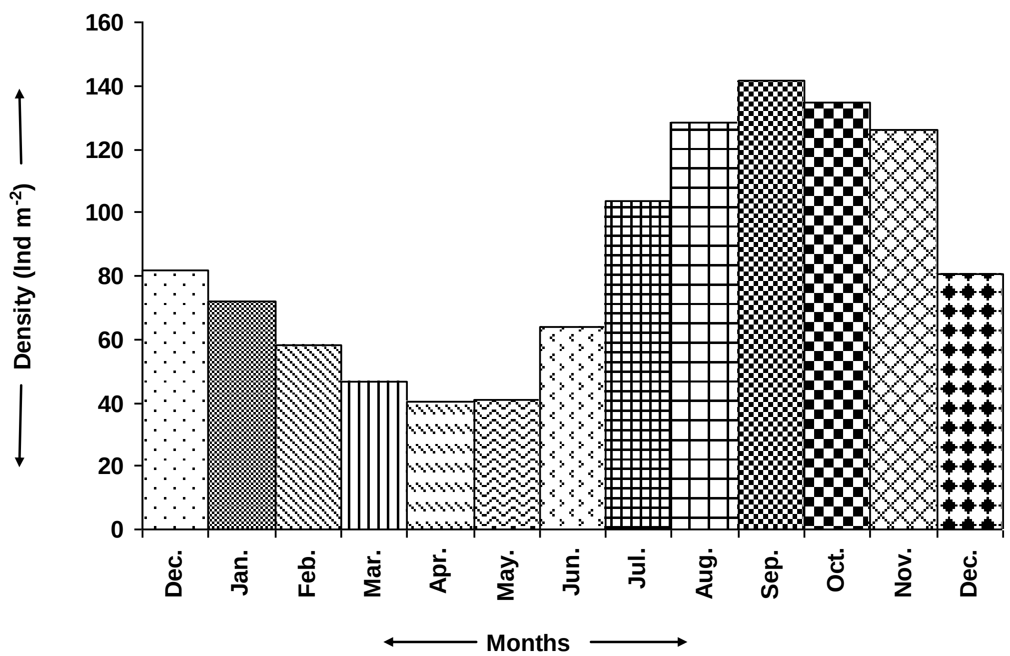

Fig.- 6. Monthly Variation in density value of *Digitaria abludens* during the study period.

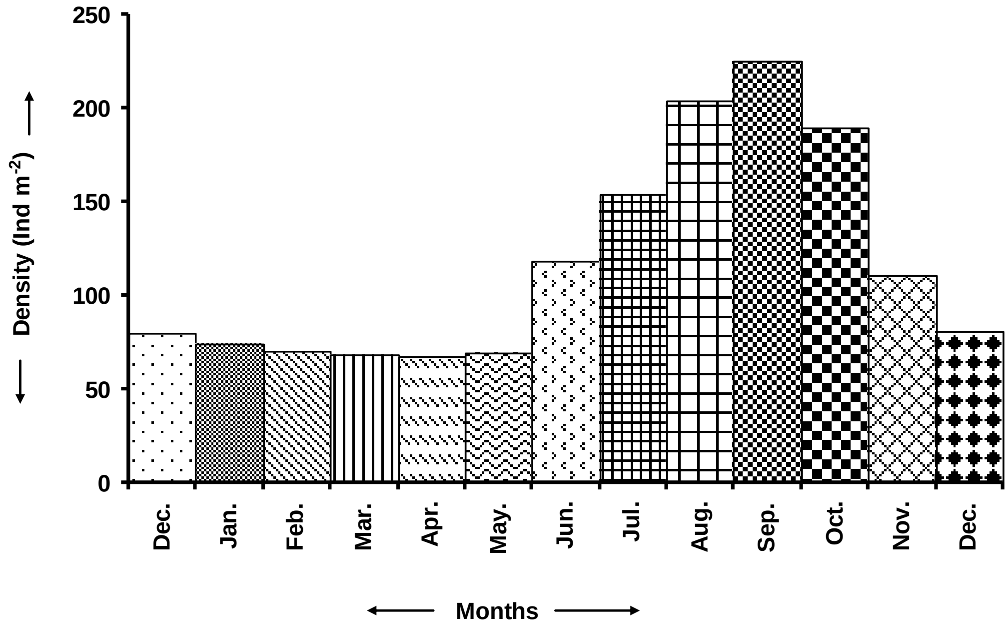

Fig.- 7. Monthly variation in density value of *Eleusine indica* during the study period.

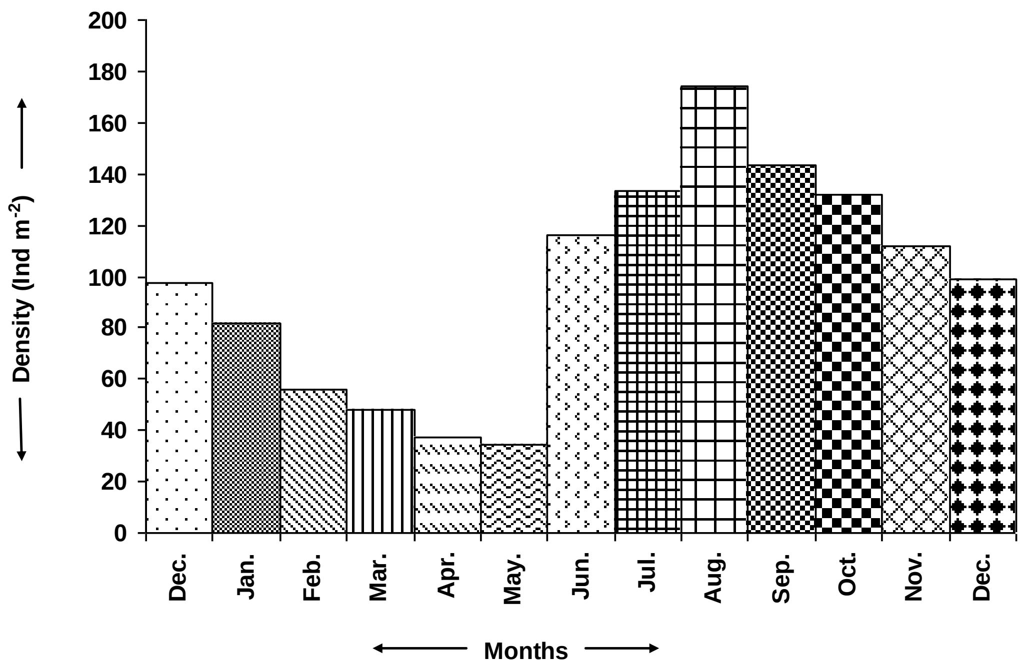

Fig.- 8. Monthly variation in density values of *Vetiveria zizanioides* during the study period.

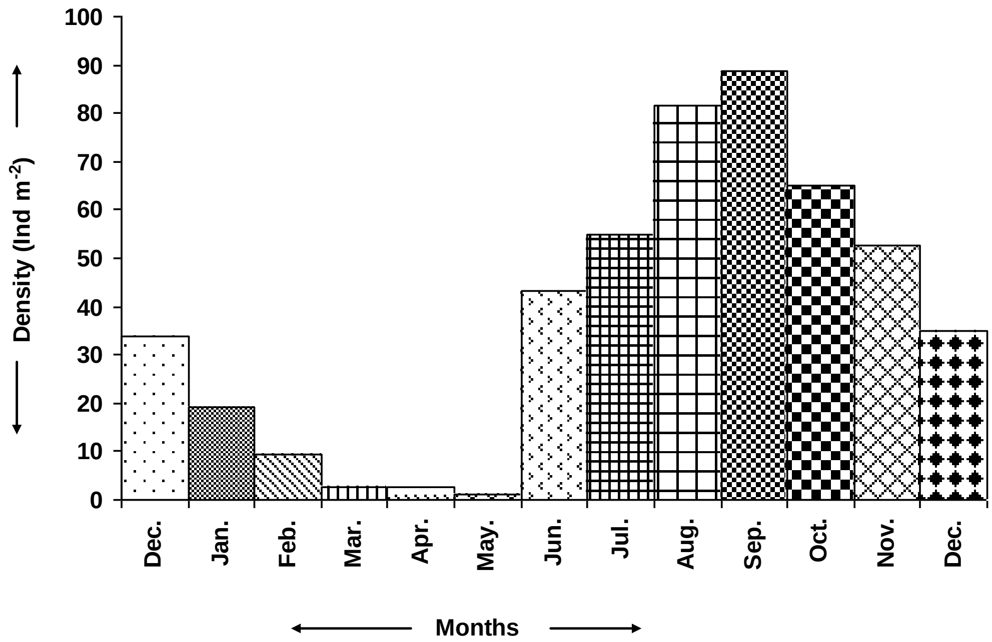

Fig.- 9. Monthly variation in density values of *Phylanthus fraternus* during the study period.

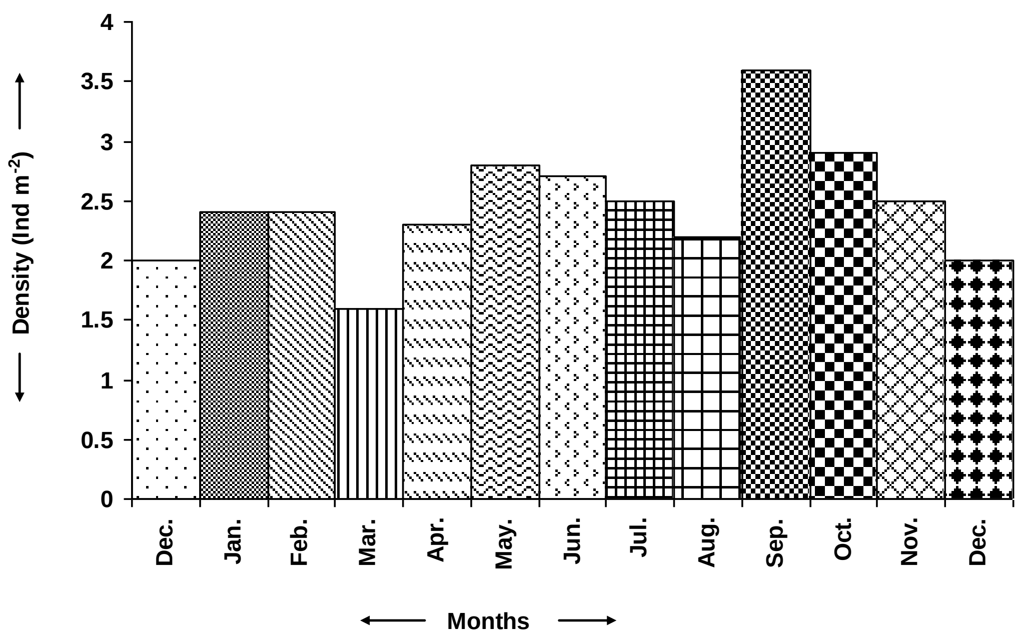

Fig.- 10. Monthly variation in density values of *Sida cordifolia* during the study period.

The IVI for grasses gradually increases from December to April and then it declined upto September and onwards it showed again an increasing trend till to the end of the sampling period. However, the IVI of non- grasses showed an opposite trend i.e. the value decreases from December to April, then an increasing trend of values were marked from April to September. Thereafter it decreases till to the end of the sampling period. The grasses exhibited peak IVI in the month of April (240.591) and non-grasses in the month of September (145.146).

4.2.5 SPECIES DIVERSITY AND DOMINANCE

The study of species diversity and dominance indices plays a vital role in the study of plant community. In fact, the term “diversity” is the richness (number) of species present. However, it also includes the distribution of individuals among the species. Diversity varies in different communities with the same richness, depending on the distribution of individuals among the species i.e. it is minimum when the individuals are of one species and maximum when individuals belong to large number of different species.

The stability of the community increases with the increase of species diversity. According to Margalef (1965) and Mc Naughton (1967) diversity controls the stability of community whereas dominance controls the community productivity. It is also reported that the diversity increases during succession and reaches its maximum at the climax. (Patten, 1966; Odum, 1971; Holland, 1971). Pielou (1975) was of the opinion that the purpose of measuring community diversity was to judge the relationship either to other community properties like productivity and stability or to the environmental factors that influence the plant community. Misra & Misra (1981) suggested that it is related to structural and functional units like productivity, niche structure, composition, stability and integration of the community.

Table - 6 Abundance (Ind m^{-2}) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	2.00	—	—	—	—	—	7.50	31.00	44.33	25.60	17.14	4.57	3.00
2	*Cynodon dactylon*	105.00	121.00	110.80	61.20	51.10	71.90	139.90	176.00	182.10	188.60	141.30	138.20	108.70
3	*Cyperus castaneus*	65.00	4.42					31.20	116.00	114.20	104.00	86.00	79.60	56.00
4	*Digitaria abludens*	81.50	72.00	58.20	46.90	40.20	41.10	63.70	103.40	128.60	141.50	134.70	126.30	80.50
5	*Digitaria longiflora*	412.00	329.60	250.00	—	—	—	265.00	512.90	559.30	819.20	789.20	629.70	460.10
6	*Eleusine indica*	79.60	74.10	70.20	68.40	67.60	69.00	118.60	154.20	203.70	225.00	189.60	110.30	80.80
7	*Eragrostis tenella*	11.50	8.20	2.75	—	—	—	45.70	99.20	100.70	81.50	71.60	51.60	11.20
8	*Eragrostis unioloides*	41.00	31.00	21.10	10.60	4.50	—	68.70	127.50	167.60	166.40	115.50	90.80	40.60
9	*Fimbristylis dichotoma*	44.50	22.00	11.10	3.20	—	—	40.77	103.20	114.50	81.20	72.00	71.00	45.00
10	*Fimbristylis ovata*	11.50	—	—	—	—	—	84.88	191.60	198.40	156.00	107.20	47.66	11.20
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	17.33	46.71	39.00	23.60	20.57	10.37	—
12	*Paspalum scrobiculatum*	31.50	3.60	—	—	—	22.80	61.10	130.70	191.50	188.50	136.00	85.50	31.20
13	*Scleria lithosperma*	63.00	45.00	3.12	—	—	—	45.00	73.44	139.40	147.60	132.70	110.80	61.60
14	*Setaria intermedia*	19.00	—	—	—	—	—	8.60	50.62	109.70	88.90	76.10	57.00	19.20
15	*Vetiveria zizanioides*	97.70	82.00	56.00	48.00	46.62	34.70	116.20	133.20	174.30	143.40	132.20	112.00	98.80
	Grasses total	**1064.80**	**792.92**	**583.27**	**238.30**	**210.02**	**239.50**	**1114.18**	**2049.67**	**2467.33**	**2581.00**	**2221.81**	**1725.40**	**1107.90**
	NON GRASSES													
1	*Aclisia secundiflora*	3.80	—	—	—	—	—	34.00	71.87	100.11	96.10	44.55	25.11	2.40
2	*Ageratum conyzoides*	1.33	—	—	—	—	—	3.00	5.66	3.00	13.50	3.40	3.00	1.50
3	*Alysicarpus vaginalis*	9.60	6.40	6.00	—	—	—	13.22	35.40	47.30	47.40	33.50	26.80	10.30
4	*Centranthera indica*	6.80	3.50	—	—	—		9.40	20.00	23.11	21.50	17.88	15.11	12.40
5	*Desmodium triflorum*	34.10	20.60	8.60	—	—	11.60	37.60	54.10	64.20	51.10	51.10	47.10	32.90
6	*Elephantopus scaber*	33.80	23.30	17.30	—	—		29.10	26.00	39.30	51.40	53.40	54.00	33.20
7	*Emilia sonchifolia*	5.66	1.70	0.80	2.88	—	3.00	7.70	14.80	24.60	27.50	14.90	12.20	5.33
8	*Evolvulus nummularius*	29.80	21.20	10.10	—	—	20.00	56.70	65.20	60.70	65.90	78.00	50.60	31.00
9	*Hedyotis herbacea*	13.10	5.50	—	—	—	—	16.55	26.60	35.00	42.30	45.60	30.50	16.00
10	*Lindernia anagllis*	4.40	1.30	—	—	—	—	5.50	15.50	6.22	8.55	5.87	11.00	4.33
11	*Lindernia crustacea*	11.00	5.60	3.20	—	—	—	7.50	16.00	12.00	19.80	19.60	17.20	11.87
12	*Ludwigia hyssopifolia*	2.60	—	—	—	—	—	—	4.42	26.60	15.50	13.60	9.33	3.50
13	*Mecardonia procumbens*	1.00	—	—	—	—	—	1.33	3.00	3.50	6.25	5.80	4.33	3.00
14	*Melochia corchorifolia*	3.66	2.60	2.50	3.14	—	—	2.20	3.80	5.44	5.50	4.10	4.87	5.00
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	6.75	14.00	15.30	14.85	13.33	—
16	*Oxalis corniculata*	11.00	6.60	8.00	—	—	—	10.50	19.77	18.90	21.60	26.16	20.12	11.57
17	*Phyllanthus fraternus*	33.90	19.00	9.50	3.30	3.50	2.60	43.10	54.80	81.60	88.60	64.90	52.70	35.10
18	*Rungia pectinata*	166.00	48.00	23.00	6.60	—	4.66	62.75	85.40	153.50	217.80	220.00	222.40	167.10
19	*Sida cordifolia*	4.00	3.42	3.00	2.28	3.83	2.75	3.37	3.12	4.40	3.60	4.14	5.00	2.50
20	*Spermacoce ramanii*	6.37	1.60	—	—	—	8.40	15.80	17.00	22.62	17.50	16.85	12.33	6.12
21	*Zornia gibbosa*	19.80	7.70	—	—	—	—	8.60	23.50	36.10	51.40	59.60	42.30	20.40
	Non - grasses total	**401.72**	**178.02**	**92.00**	**18.20**	**7.33**	**53.01**	**367.92**	**572.69**	**782.20**	**888.10**	**797.80**	**679.33**	**415.52**
	Total	**1466.52**	**970.94**	**675.27**	**256.50**	**217.35**	**292.51**	**1482.10**	**2622.36**	**3249.53**	**3469.10**	**3019.61**	**2404.73**	**1523.42**

Table - 7 Basal area ($cm^2\ m^{-2}$) of different species during the study period.

No	Species name	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
	GRASSES														
1	*Alloteropsis cimicina*	0.12	—	—	—	—	—	0.08	0.11	0.12	0.12	0.13	0.13	0.12	**0.12**
2	*Cynodon dactylon*	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.10	0.11	0.11	0.10	0.10	0.09	**0.09**
3	*Cyperus castaneus*	0.07	0.07	—	—	—	—	0.05	0.08	0.08	0.09	0.09	0.08	0.07	**0.08**
4	*Digitaria abludens*	0.28	0.28	0.27	0.27	0.26	0.26	0.13	0.22	0.28	0.29	0.30	0.30	0.29	**0.26**
5	*Digitaria longiflora*	0.14	0.12	0.11	—	—	—	0.08	0.11	0.13	0.13	0.15	0.15	0.14	**0.13**
6	*Eleusine indica*	0.27	0.27	0.26	0.25	0.25	0.24	0.21	0.22	0.26	0.27	0.28	0.28	0.27	**0.26**
7	*Eragrostis tenella*	0.13	0.12	0.11	—	—	—	0.08	0.10	0.13	0.13	0.14	0.14	0.13	**0.12**
8	*Eragrostis unioloides*	0.16	0.16	0.15	0.15	0.15	—	0.08	0.15	0.18	0.18	0.19	0.18	0.17	**0.16**
9	*Fimbristylis dichotoma*	0.12	0.09	0.06	0.05	—	—	0.08	0.12	0.14	0.15	0.15	0.14	0.14	**0.11**
10	*Fimbristylis ovata*	0.08	—	—	—	—	—	0.07	0.08	0.10	0.11	0.11	0.12	0.10	**0.10**
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	0.08	0.10	0.12	0.12	0.13	0.13	—	**0.11**
12	*Paspalum scrobiculatum*	0.23	0.22	—	—	—	0.08	0.15	0.25	0.28	0.28	0.28	0.27	0.25	**0.23**
13	*Scleria lithosperma*	0.16	0.15	0.15	—	—	—	0.14	0.18	0.19	0.20	0.20	0.21	0.20	**0.18**
14	*Setaria intermedia*	0.13	—	—	—	—	—	0.11	0.12	0.13	0.13	0.13	0.14	0.13	**0.13**
15	*Vetiveria zizanioides*	0.18	0.18	0.17	0.17	0.17	0.16	0.11	0.16	0.21	0.21	0.23	0.23	0.19	**0.18**
	Grasses total	**2.16**	**1.75**	**1.36**	**0.97**	**0.91**	**0.82**	**1.52**	**2.10**	**2.46**	**2.52**	**2.61**	**2.60**	**2.29**	**2.25**
	NON GRASSES														
1	*Aclisia secundiflora*	0.19	—	—	—	—	—	0.12	0.18	0.22	0.23	0.23	0.22	0.20	**0.20**
2	*Ageratum conyzoides*	0.28	—	—	—	—	—	0.23	0.28	0.30	0.32	0.32	0.31	0.29	**0.29**
3	*Alysicarpus vaginalis*	0.23	0.22	0.21	—	—	—	0.13	0.21	0.23	0.25	0.25	0.24	0.23	**0.22**
4	*Centranthera indica*	0.29	0.28	—	—	—	—	0.16	0.25	0.28	0.28	0.29	0.30	0.29	**0.27**
5	*Desmodium triflorum*	0.06	0.06	0.05	—	—	0.05	0.07	0.08	0.08	0.09	0.09	0.08	0.07	**0.07**
6	*Elephantopus scaber*	0.45	0.45	0.44	—	—	—	0.38	0.43	0.46	0.47	0.47	0.46	0.45	**0.45**
7	*Emilia sonchifolia*	0.28	0.27	0.27	0.11	—	0.20	0.26	0.26	0.28	0.30	0.30	0.29	0.28	**0.26**
8	*Evolvulus nummularius*	0.27	0.16	0.16	—	—	0.15	0.09	0.16	0.17	0.17	0.18	0.18	0.17	**0.17**
9	*Hedyotis herbacea*	0.10	0.09	—	—	—	—	0.06	0.08	0.08	0.10	0.11	0.11	0.10	**0.09**
10	*Lindernia anagllis*	0.10	0.10	—	—	—	—	0.08	0.10	0.12	0.12	0.13	0.13	0.11	**0.11**
11	*Lindernia crustacea*	0.08	0.08	0.07	—	—	—	0.06	0.08	0.09	0.09	0.08	0.08	0.07	**0.08**
12	*Ludwigia hyssopifolia*	0.26	—	—	—	—	—	—	0.16	0.22	0.28	0.28	0.27	0.26	**0.25**
13	*Mecardonia procumbens*	0.12	—	—	—	—	—	0.08	0.11	0.12	0.12	0.14	0.14	0.12	**0.12**
14	*Melochia corchorifolia*	0.15	0.14	0.13	0.13	—	—	0.08	0.12	0.16	0.18	0.18	0.17	0.16	**0.15**
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	0.09	0.12	0.12	0.13	0.13	—	**0.12**
16	*Oxalis corniculata*	0.07	0.07	0.06	—	—	—	0.06	0.07	0.08	0.08	0.09	0.09	0.07	**0.07**
17	*Phyllanthus fraternus*	0.18	0.18	0.17	0.17	0.16	0.16	0.08	0.12	0.18	0.20	0.20	0.19	0.19	**0.17**
18	*Rungia pectinata*	0.12	0.12	0.11	0.10	—	0.06	0.08	0.12	0.12	0.13	0.13	0.13	0.12	**0.11**
19	*Sida cordifolia .*	0.31	0.31	0.30	0.30	0.30	0.28	0.24	0.29	0.32	0.32	0.33	0.33	0.32	**0.30**
20	*Spermacoce ramanii*	0.15	0.24	—	—	—	0.08	0.23	0.26	0.26	0.27	0.27	0.26	0.25	**0.25**
21	*Zornia gibbosa*	0.11	0.11	—	—	—	—	0.06	0.09	0.11	0.12	0.12	0.13	0.12	**0.11**
	Non grasses total	**3.80**	**2.88**	**1.97**	**0.81**	**0.46**	**0.98**	**2.55**	**3.54**	**4.00**	**4.24**	**4.32**	**4.24**	**3.87**	**3.85**
	Total	**5.96**	**4.63**	**3.33**	**1.78**	**1.37**	**1.80**	**4.07**	**5.64**	**6.46**	**6.76**	**6.93**	**6.84**	**6.16**	**6.07**

Table - 8 Basal cover ($cm^2\ m^{-2}$) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	0.10	—	—	—	—	—	0.60	1.36	1.60	1.54	1.56	0.42	0.14
2	*Cynodon dactylon*	9.45	10.89	8.86	4.90	4.09	5.75	9.79	17.60	20.03	20.75	14.13	13.82	9.78
3	*Cyperus castaneus*	4.10	0.22	—	—	—	—	1.56	9.28	9.14	9.36	7.74	6.37	3.92
4	*Digitaria abludens*	22.82	20.16	15.71	12.66	10.45	10.69	8.28	22.75	36.01	41.04	40.41	37.89	23.35
5	*Digitaria longiflora*	57.68	39.55	27.50	—	—	—	21.20	56.42	72.71	106.50	118.38	94.46	64.41
6	*Eleusine indica*	21.49	20.01	18.25	17.10	16.90	16.56	24.91	33.92	52.96	60.75	53.09	30.88	21.82
7	*Eragrostis tenella*	1.50	0.98	0.12	—	—	—	3.66	9.92	13.09	10.60	10.02	7.22	1.46
8	*Eragrostis unioloides*	6.56	4.96	3.17	1.59	0.54	—	5.50	19.13	30.17	29.95	21.95	16.34	6.90
9	*Fimbristylis dichotoma*	5.34	1.98	0.67	0.08	—	—	2.94	12.38	16.03	12.18	10.80	9.94	6.30
10	*Fimbristylis ovata*	0.92	—	—	—	—	—	5.35	15.33	19.84	17.16	11.79	5.15	1.12
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	1.25	3.27	4.21	2.83	1.87	1.08	—
12	*Paspalum scrobiculatum*	7.25	0.48	—	—	—	1.82	9.17	32.68	53.62	52.78	38.08	23.09	7.80
13	*Scleria lithosperma*	10.08	6.75	0.38	—	—	—	6.30	11.90	26.49	29.52	26.54	23.27	12.32
14	*Setaria intermedia*	2.47	—	—	—	—	—	0.95	4.86	14.26	11.56	9.89	7.98	2.50
15	*Vetiveria zizanioides*	17.59	14.76	9.52	8.16	6.34	5.55	12.78	21.31	36.60	30.11	30.41	25.76	18.77
	Grasses total	**167.33**	**120.74**	**84.18**	**44.49**	**38.32**	**40.37**	**114.22**	**272.11**	**406.75**	**436.61**	**396.66**	**303.66**	**180.59**
	NON GRASSES													
1	*Aclisia secundiflora*	0.36	—	—	—	—	—	0.41	10.35	19.82	22.10	9.22	4.97	0.48
2	*Ageratum conyzoides*	0.11	—	—	—	—	—	0.07	0.48	0.45	0.86	0.54	0.28	0.09
3	*Alysicarpus vaginalis*	2.21	1.41	0.50	—	—	—	1.55	7.43	10.88	11.85	8.38	6.43	2.37
4	*Centranthera indica*	1.97	0.78	—	—	—	—	1.50	5.00	5.82	6.02	4.67	4.08	1.80
5	*Desmodium triflorum*	2.05	1.24	0.43	—	—	0.58	2.63	4.33	5.14	4.60	4.60	3.77	2.30
6	*Elephantopus scaber*	15.21	10.49	7.61	—	—	—	11.06	10.06	18.08	24.16	25.10	24.84	14.94
7	*Emilia sonchifolia*	1.43	0.46	0.22	0.29	—	0.30	2.00	3.85	6.89	8.25	4.47	3.54	1.34
8	*Evolvulus nummularius*	5.07	3.39	1.62	—	—	0.90	5.10	10.43	10.32	11.20	14.04	9.11	5.27
9	*Hedyotis herbacea*	1.31	0.50	—	—	—	—	0.89	2.13	2.80	4.23	5.02	3.36	1.44
10	*Lindernia anagllis*	0.22	0.13	—	—	—	—	0.26	0.62	0.67	0.92	0.61	0.72	0.29
11	*Lindernia crustacea*	0.88	0.45	0.11	—	—	—	0.36	1.28	1.08	1.78	1.57	1.38	0.67
12	*Ludwigia hyssopifolia*	0.34	—	—	—	—	—	0.00	0.50	2.93	4.34	3.81	1.51	0.36
13	*Mecardonia procumbens*	0.02	—	—	—	—	—	0.03	0.17	0.17	0.30	0.41	0.18	0.04
14	*Melochia corchorifolia*	0.50	0.36	0.26	0.29	—	—	0.09	0.46	0.78	0.79	0.74	0.66	0.48
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	0.24	1.51	1.84	1.35	1.04	—
16	*Oxalis corniculata*	0.62	0.46	0.19	—	—	—	0.50	1.25	1.51	1.73	1.41	1.45	0.57
17	*Phyllanthus fraternus*	6.10	3.42	1.62	0.46	0.45	0.21	3.45	6.58	14.69	17.72	12.98	10.01	6.67
18	*Rungia pectinata*	19.92	5.76	2.53	0.66		0.17	2.01	10.25	18.42	28.31	28.60	28.91	20.05
19	*Sida cordifolia .*	0.62	0.74	0.72	0.48	0.69	0.31	0.65	0.73	0.70	1.15	0.96	0.83	0.64
20	*Spermacoce ramanii*	1.28	0.38	—	—	—	1.51	3.63	4.42	4.71	4.73	3.19	2.89	1.23
21	*Zornia gibbosa*	2.18	0.85	—	—	—	—	0.52	1.69	3.97	6.17	7.15	5.50	2.45
	Non-grasses total	**62.38**	**30.82**	**15.81**	**2.17**	**1.14**	**3.98**	**36.72**	**82.23**	**131.34**	**163.06**	**138.81**	**115.44**	**63.46**
	Total	**229.71**	**151.56**	**99.98**	**46.66**	**39.46**	**44.35**	**150.94**	**354.33**	**538.09**	**599.67**	**535.47**	**419.11**	**244.05**

Table - 9 Relative frequency (%) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	1.370	3.876	—	—	—	—	3.460	1.278	0.926	1.479	2.141	2.222	1.434
2	*Cynodon dactylon*	3.425	2.713	6.061	10.415	16.667	10.101	3.460	3.195	3.086	2.959	3.058	3.175	3.584
3	*Cyperus castaneus*	3.082	3.876	—	—	—	—	3.460	3.195	3.086	2.959	3.058	3.175	3.584
4	*Digitaria abludens*	3.425	3.876	6.061	10.417	16.665	10.101	3.460	3.195	3.086	2.959	3.058	3.175	3.584
5	*Digitaria longiflora*	3.425	3.876	6.061	—	—	—	3.460	3.195	3.086	2.959	3.058	3.175	3.584
6	*Eleusine indica*	3.425	3.876	6.061	10.417	16.667	10.101	3.460	3.195	3.086	2.959	3.058	3.175	3.584
7	*Eragrostis tenella*	3.425	3.876	2.424	—	—	—	3.460	3.195	3.086	2.959	3.058	3.175	3.584
8	*Eragrostis unioloides*	3.425	3.876	6.061	10.417	13.333	—	3.460	3.195	3.086	2.959	3.058	3.175	3.584
9	*Fimbristylis dichotoma*	3.425	—	6.061	5.208	—	—	3.114	3.195	3.086	2.959	3.058	3.175	3.584
10	*Fimbristylis ovata*	3.425	—	—	—	—	—	3.114	3.195	3.086	2.959	3.058	2.855	3.584
11	*Lipocarpha sphacelata*	—	2.326	—	—	—	—	3.114	2.236	2.778	2.959	2.141	2.540	—
12	*Paspalum scrobiculatum*	3.425	3.876	—	—	—	10.101	3.460	3.195	3.086	2.959	3.058	3.175	3.584
13	*Scleria lithosperma*	3.425	—	4.845	—	—	—	3.460	2.875	3.086	2.959	3.058	3.175	3.584
14	*Setaria intermedia*	3.425	3.876	—	—	—	—	3.460	2.556	3.086	2.959	3.058	3.175	3.584
15	*Vetiveria zizanioides*	3.425	39.922	6.061	10.417	13.333	10.101	3.460	3.195	3.086	2.959	3.058	3.175	3.584
	Grasses total	**45.548**	**79.845**	**49.693**	**57.290**	**76.665**	**50.505**	**50.865**	**44.089**	**43.827**	**42.899**	**44.037**	**45.712**	**48.029**
	NON GRASSES													
1	*Aclisia secundiflora*	1.712	—	—	—	—	—	0.346	2.556	2.778	2.959	2.752	2.857	0.717
2	*Ageratum conyzoides*	1.027	—	—	—	—	—	0.346	0.958	1.543	0.592	1.525	0.952	0.717
3	*Alysicarpus vaginalis*	3.425	3.876	2.424	—	—	—	3.114	3.195	3.086	2.959	3.058	3.175	3.584
4	*Centranthera indica*	3.425	3.101	—	—	—	—	3.460	3.195	2.778	2.959	2.752	2.857	1.790
5	*Desmodium triflorum*	3.425	3.876	6.061	—	—	10.101	3.460	3.195	3.086	2.959	3.058	3.175	3.584
6	*Elephantopus scaber*	3.425	3.876	6.061	—	—	—	3.460	2.875	3.086	2.959	3.058	3.175	3.584
7	*Emilia sonchifolia*	3.080	3.876	2.424	9.375	—	5.051	3.460	3.195	3.086	2.959	3.058	3.175	3.226
8	*Evolvulus nummularius*	3.425	3.876	6.061	—	—	9.090	3.460	3.195	3.086	2.959	3.058	3.175	3.584
9	*Hedyotis herbacea*	3.425	3.876	—	—	—	—	3.114	3.195	3.086	2.959	3.058	3.175	3.226
10	*Lindernia anagllis*	1.712	3.876	—	—	—	—	2.076	1.278	2.778	2.663	2.446	1.587	2.151
11	*Lindernia crustacea*	3.425	3.876	3.030	—	—	—	2.768	3.195	3.086	2.959	3.058	3.175	2.867
12	*Ludwigia hyssopifolia*	1.712	—	—	—	—	—	—	2.236	1.543	2.959	3.058	1.905	1.434
13	*Mecardonia procumbens*	0.685	—	—	—	—	—	1.038	1.597	1.235	1.180	1.529	0.952	0.358
14	*Melochia corchorifolia*	3.082	3.876	4.848	7.292	—	—	1.730	3.195	2.775	2.367	3.058	2.540	2.151
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	1.275	2.778	2.959	2.141	1.905	—
16	*Oxalis corniculata*	2.740	3.876	2.424	—	—	—	2.768	2.875	3.086	2.959	1.835	2.540	2.505
17	*Phyllanthus fraternus*	3.425	3.876	6.061	8.333	13.333	5.051	3.460	3.195	3.086	2.959	3.058	3.175	3.584
18	*Rungia pectinata*	3.425	3.876	6.061	10.417	—	6.061	1.384	3.195	3.086	2.959	3.058	3.175	3.584
19	*Sida cordifolia*	1.710	2.710	4.848	7.292	10.000	4.040	2.765	2.556	1.543	2.959	2.141	1.587	2.867
20	*Spermacoce ramanii*	2.740	3.876	—	—	—	10.101	3.460	3.195	2.469	2.959	2.141	2.857	2.867
21	*Zornia gibbosa*	3.425	3.876	—	—	—	—	3.460	2.556	3.086	2.959	3.058	3.175	3.584
	Non - grasses total	**54.448**	**60.074**	**50.303**	**42.708**	**23.333**	**49.494**	**49.132**	**55.908**	**56.170**	**57.097**	**55.959**	**54.286**	**51.965**
	Total	**99.995**	**99.997**	**99.997**	**99.998**	**99.998**	**99.999**	**99.997**	**99.997**	**99.997**	**99.997**	**99.996**	**99.998**	**99.994**

Table - 10 Relative density (%) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	0.055	—	—	—	—	—	0.541	0.491	0.419	0.372	0.403	0.135	0.080
2	*Cynodon dactylon*	7.265	12.519	16.740	24.245	24.939	25.299	10.098	6.962	5.733	5.483	4.749	5.846	7.266
3	*Cyperus castaneus*	4.048	0.321	—	—	—	—	2.252	4.589	3.596	3.023	2.891	3.367	3.743
4	*Digitaria abludens*	5.639	7.450	8.793	18.582	19.615	14.462	4.598	4.090	4.049	4.114	4.528	5.342	5.381
5	*Digitaria longiflora*	28.506	34.102	37.770	—	—	—	19.128	20.290	17.610	23.815	26.527	26.636	30.755
6	*Eleusine indica*	5.508	7.667	10.606	27.100	32.992	24.279	8.561	6.100	6.414	6.541	6.373	4.666	5.401
7	*Eragrostis tenella*	0.796	0.848	0.166	—	—	—	3.299	3.924	3.171	2.369	2.407	2.183	0.749
8	*Eragrostis unioloides*	2.837	3.207	3.188	4.200	1.757	—	4.959	5.044	5.277	4.837	3.882	3.841	2.714
9	*Fimbristylis dichotoma*	3.079	2.276	1.677	0.634	—	—	2.649	4.082	3.605	2.361	2.420	3.003	3.008
10	*Fimbristylis ovata*	0.796	—	—	—	—	—	5.515	7.579	6.247	4.535	3.603	1.815	0.749
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	1.126	1.294	1.105	0.686	0.484	0.351	—
12	*Paspalum scrobiculatum*	2.179	0.228	—	—	—	8.023	4.410	5.170	6.029	5.480	4.571	3.615	2.086
13	*Scleria lithosperma*	4.359	4.656	0.375	—	—	—	3.248	2.615	4.389	4.291	4.460	4.687	4.118
14	*Setaria intermedia*	1.315	—	—	—	—	—	0.621	1.602	3.454	2.584	2.558	2.411	1.283
15	*Vetiveria zizanioides*	6.760	8.484	8.460	19.017	18.204	12.210	8.387	5.269	5.488	4.169	4.444	4.738	6.604
	Grasses total	**73.141**	**81.759**	**87.775**	**93.777**	**97.507**	**84.272**	**79.392**	**79.101**	**76.584**	**74.661**	**74.300**	**72.635**	**73.937**
	NON GRASSES													0.000
1	*Aclisia secundiflora*	0.131	—	—	—	—	—	0.245	2.275	2.837	2.794	1.348	0.956	0.160
2	*Ageratum conyzoides*	0.028	—	—	—	—	—	0.022	0.067	0.047	0.078	0.057	0.038	0.020
3	*Alysicarpus vaginalis*	0.664	0.662	0.363	—	—	—	0.859	1.400	1.485	1.378	1.126	1.134	0.689
4	*Centranthera indica*	0.470	0.290	—	—	—	—	0.679	0.791	0.655	0.625	0.541	0.575	0.410
5	*Desmodium triflorum*	2.359	2.131	1.299	—	—	4.082	2.714	2.140	2.021	1.486	1.715	1.992	2.199
6	*Elephantopus scaber*	2.339	2.411	2.614	—	—	—	2.100	0.926	1.237	1.494	1.795	2.284	2.219
7	*Emilia sonchifolia*	0.353	0.176	0.121	1.030	—	0.528	0.556	0.585	0.775	0.795	0.501	0.516	0.321
8	*Evolvulus nummularius*	2.062	2.193	1.526	—	—	6.330	4.093	2.575	1.911	1.916	2.622	2.140	2.072
9	*Hedyotis herbacea*	0.906	0.569	—	—	—	—	1.076	1.052	1.102	1.230	1.533	1.290	0.963
10	*Lindernia anagllis*	0.152	0.135	—	—	—	—	0.238	0.245	0.176	0.224	0.158	0.233	0.174
11	*Lindernia crustacea*	0.761	0.579	0.242	—	—	—	0.433	0.633	0.375	0.576	0.659	0.728	0.635
12	*Ludwigia hyssopifolia*	0.090	—	—	—	—	—	—	0.123	0.419	0.451	0.457	0.237	0.094
13	*Mecardonia procumbens*	0.014	—	—	—	—	—	0.029	0.059	0.044	0.073	0.097	0.055	0.020
14	*Melochia corchorifolia*	0.228	0.265	0.302	0.872	—	—	0.075	0.150	0.154	0.128	0.138	0.165	0.201
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	0.107	0.397	0.445	0.350	0.338	—
16	*Oxalis corniculata*	0.609	0.683	0.483	—	—	—	0.606	0.704	0.595	0.628	0.528	0.681	0.541
17	*Phyllanthus fraternus*	2.346	1.966	1.435	1.070	1.367	0.457	3.111	2.168	2.569	2.576	2.181	2.229	2.346
18	*Rungia pectinata*	11.486	4.966	3.475	2.615	—	0.985	1.812	3.375	4.833	6.332	7.395	9.407	11.170
19	*Sida cordifolia*	0.138	0.248	0.363	0.634	1.122	0.385	0.195	0.099	0.069	0.105	0.097	0.106	0.134
20	*Spermacoce ramanii*	0.350	0.166	—	—	—	2.956	1.140	0.672	0.570	0.509	0.397	0.470	0.328
21	*Zornia gibbosa*	1.370	0.797	—	—	—	—	0.621	0.744	1.135	1.494	2.003	1.789	1.364
	Non - grasses total	**26.857**	**18.237**	**12.222**	**6.220**	**2.489**	**15.723**	**20.603**	**20.891**	**23.407**	**25.334**	**25.697**	**27.363**	**26.058**
	Total	**99.997**	**99.996**	**99.997**	**99.998**	**99.996**	**99.994**	**99.996**	**99.992**	**99.991**	**99.996**	**99.997**	**99.998**	**99.996**

Table - 11 Relative dominance (%) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	2.013	—	—	—	—	—	—	1.950	1.858	1.775	1.876	1.901	1.948
2	*Cynodon dactylon*	1.510	1.944	2.402	4.494	5.839	4.444	1.720	1.773	1.703	1.627	1.443	1.462	1.461
3	*Cyperus castaneus*	1.174	1.512	—	—	—	—	1.225	1.418	1.238	1.331	1.299	1.170	1.136
4	*Digitaria abludens*	4.698	6.048	8.108	15.169	18.978	14.444	3.194	3.901	4.334	4.290	4.329	4.386	4.708
5	*Digitaria longiflora*	2.349	2.592	3.303	—	—	—	1.966	1.950	2.012	1.923	2.165	2.193	2.273
6	*Eleusine indica*	4.530	5.832	7.808	14.045	18.248	13.333	5.160	3.901	4.025	3.994	4.040	4.094	4.383
7	*Eragrostis tenella*	2.181	2.592	3.303	—	—	—	1.966	1.773	2.012	1.923	2.020	2.047	2.110
8	*Eragrostis unioloides*	2.685	3.456	4.505	8.427	10.949	—	1.966	2.660	2.786	2.663	2.742	2.632	2.760
9	*Fimbristylis dichotoma*	2.013	1.944	1.802	2.809	—	—	1.720	2.128	2.167	2.219	2.165	2.047	2.273
10	*Fimbristylis ovata*	1.342	—	—	—	—	—	1.966	1.418	1.548	1.627	1.587	1.754	1.623
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	1.966	1.773	1.858	1.775	1.876	1.901	—
12	*Paspalum scrobiculatum*	3.859	4.752	—	—	—	4.444	3.686	4.433	4.334	4.142	4.040	3.947	4.058
13	*Scleria lithosperma*	2.685	3.240	4.505	—	—	—	3.440	3.191	2.941	2.959	2.886	3.070	3.245
14	*Setaria intermedia*	2.181	—	—	—	—	—	2.703	2.128	2.012	1.923	1.876	2.047	2.110
15	*Vetiveria zizanioides*	3.020	3.888	5.105	9.551	12.405	8.885	2.703	2.837	3.251	3.107	3.319	3.363	3.084
	Grasses total	**36.242**	**37.797**	**40.841**	**54.494**	**66.420**	**45.552**	**35.377**	**37.234**	**38.080**	**37.278**	**37.662**	**38.012**	**37.174**
	NON GRASSES													
1	*Aclisia secundiflora*	3.188	—	—	—	—	—	2.948	3.191	3.406	3.402	3.319	3.216	3.247
2	*Ageratum conyzoides*	4.698	—	—	—	—	—	5.651	4.965	4.644	4.734	4.618	4.532	4.708
3	*Alysicarpus vaginalis*	3.855	4.752	6.306	—	—	—	3.194	3.723	3.560	3.698	3.608	3.509	3.734
4	*Centranthera indica*	4.866	6.048	□	—	—	—	3.931	4.433	4.334	4.142	4.185	4.386	4.708
5	*Desmodium triflorum*	1.007	1.296	1.502	—	—	2.778	1.720	1.418	1.238	1.331	1.299	1.170	1.136
6	*Elephantopus scaber*	7.550	9.715	13.213	—	—	—	9.337	7.624	7.121	6.953	6.782	6.725	7.305
7	*Emilia sonchifolia*	4.698	5.832	8.108	6.180	—	11.111	6.388	4.610	4.334	4.438	4.329	4.240	4.545
8	*Evolvulus nummularius*	2.852	3.456	4.805	—	—	2.778	2.211	2.837	2.632	2.515	2.597	2.632	2.760
9	*Hedyotis herbacea*	1.678	1.944	—	—	—	—	1.474	1.418	1.238	1.479	1.587	1.605	1.623
10	*Lindernia anagllis*	1.678	2.160	—	—	—	—	1.966	1.773	1.858	1.775	1.876	1.901	1.786
11	*Lindernia crustacea*	1.342	1.728	2.102	—	—	—	1.474	1.418	1.393	1.331	1.154	1.170	1.136
12	*Ludwigia hyssopifolia*	4.362	—	—	—	—	—	—	2.837	3.406	4.142	4.040	3.947	4.221
13	*Mecardonia procumbens*	2.013	—	—	—	—	—	1.966	1.950	1.858	1.775	2.020	2.047	1.948
14	*Melochia corchorifolia*	2.517	3.024	3.904	7.303	—	—	1.966	2.128	2.477	2.660	2.597	2.485	2.597
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	1.596	1.855	1.775	1.876	1.901	—
16	*Oxalis corniculata*	1.174	1.512	1.802	—	—	—	1.474	1.241	1.238	1.183	1.295	1.316	1.136
17	*Phyllanthus fraternus*	3.020	3.888	5.105	9.551	11.679	8.885	1.966	2.125	2.786	2.959	2.886	2.778	3.080
18	*Rungia pectinata*	2.013	2.592	3.303	5.615	—	3.333	1.966	2.128	1.855	1.923	1.876	1.901	1.948
19	*Sida cordifolia*	5.201	6.695	9.005	16.854	21.895	15.556	5.897	5.142	4.950	4.734	4.762	4.825	5.195
20	*Spermacoce ramanii*	4.195	5.184	—	—	—	10.000	5.651	4.610	4.025	3.990	3.896	3.801	4.058
21	*Zornia gibbosa*	1.846	2.376	—	—	—	—	1.474	1.596	1.703	1.775	1.732	1.901	1.948
	Non - grasses total	**63.754**	**62.199**	**59.155**	**45.503**	**33.574**	**54.441**	**62.654**	**62.764**	**61.911**	**62.715**	**62.334**	**61.985**	**62.820**
	Total	**99.996**	**99.996**	**99.996**	**99.997**	**99.993**	**99.992**	**98.031**	**99.998**	**99.991**	**99.993**	**99.996**	**99.997**	**99.994**

Table - 12 Importance Value Index (IVI) of different species during the study period.

No.	Species name	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	GRASSES													
1	*Alloteropsis cimicina*	3.439	—	—	—	—	—	5.967	3.719	3.202	3.627	4.420	4.258	3.462
2	*Cynodon dactylon*	12.200	18.339	25.203	39.154	47.445	39.845	15.278	11.930	10.523	10.069	9.251	10.482	12.311
3	*Cyperus castaneus*	8.304	4.546	—	—	—	—	6.937	9.202	7.920	7.313	7.247	7.711	8.464
4	*Digitaria abludens*	13.762	17.373	22.962	44.167	55.258	39.007	11.252	11.186	11.470	11.362	11.915	12.903	13.673
5	*Digitaria longiflora*	34.280	40.570	47.134	—	—	—	24.554	25.435	22.708	28.697	31.749	32.004	36.612
6	*Eleusine indica*	13.462	17.374	24.474	51.561	67.907	47.713	17.181	13.196	13.525	13.494	13.471	11.934	13.368
7	*Eragrostis tenella*	6.402	7.316	5.894	—	—	—	8.724	8.892	8.269	7.251	7.485	7.404	6.443
8	*Eragrostis unioloides*	8.946	10.539	13.753	23.043	26.039	—	10.385	10.898	11.150	10.459	9.682	9.647	9.058
9	*Fimbristylis dichotoma*	8.517	8.096	9.539	8.651	—	—	7.483	9.405	8.859	7.538	7.643	8.225	8.865
10	*Fimbristylis ovata*	5.563	—	—	—	—	—	10.594	12.193	10.881	9.121	8.249	6.424	5.956
11	*Lipocarpha sphacelata*	—	—	—	—	—	—	6.206	5.303	5.740	5.420	4.501	4.791	—
12	*Paspalum scrobiculatum*	9.463	7.305	—	—	—	22.568	11.556	12.798	13.450	12.581	11.670	10.737	9.728
13	*Scleria lithosperma*	10.468	11.772	9.725	—	—	—	10.148	8.682	10.417	10.208	10.404	10.932	10.947
14	*Setaria intermedia*	6.920	—	—	—	—	—	6.784	6.286	8.553	7.466	7.492	7.632	6.978
15	*Vetiveria zizanioides*	13.205	16.248	19.626	38.985	43.942	31.196	14.550	11.301	11.825	10.234	10.821	11.275	13.273
	Grasses total	**154.930**	**159.478**	**178.309**	**205.562**	**240.591**	**180.328**	**167.600**	**160.425**	**158.492**	**154.839**	**155.999**	**156.359**	**159.139**
	NON GRASSES													
1	*Aclisia secundiflora*	5.032	—	—	—	—	—	3.540	8.022	9.020	9.155	7.419	7.029	4.124
2	*Ageratum conyzoides*	5.753	—	—	—	—	—	6.019	5.990	6.234	5.404	6.200	5.523	5.445
3	*Alysicarpus vaginalis*	7.944	9.290	9.093	—	—	—	7.167	8.319	8.132	8.035	7.792	7.817	8.006
4	*Centranthera indica*	8.761	9.438	—	—	—	—	8.070	8.419	7.767	7.726	7.478	7.818	6.908
5	*Desmodium triflorum*	6.791	7.303	8.861	—	—	16.960	7.894	6.753	6.346	5.775	6.072	6.336	6.920
6	*Elephantopus scaber*	13.314	16.002	21.888	—	—	—	14.897	11.425	11.445	11.406	11.635	12.184	13.109
7	*Emilia sonchifolia*	8.131	9.883	10.653	16.585	—	16.689	10.404	8.390	8.195	8.191	7.888	7.930	8.092
8	*Evolvulus nummularius*	8.339	9.525	12.391	—	—	18.198	9.764	8.607	7.629	7.389	8.277	7.947	8.416
9	*Hedyotis herbacea*	6.009	6.389	—	—	—	—	5.664	5.666	5.427	5.668	6.178	6.070	5.812
10	*Lindernia anagllis*	3.542	6.170	—	—	—	—	4.280	3.296	4.812	4.662	4.480	3.721	4.110
11	*Lindernia crustacea*	5.528	6.183	5.374	—	—	—	4.675	5.246	4.855	4.866	4.871	5.072	4.639
12	*Ludwigia hyssopifolia*	6.165	—	—	—	—	—	—	5.196	5.368	7.551	7.556	6.089	5.748
13	*Mecardonia procumbens*	2.712	—	—	—	—	—	3.033	3.607	3.136	3.028	3.647	3.054	2.327
14	*Melochia corchorifolia*	5.827	7.165	9.055	15.467	—	—	3.771	5.473	5.406	5.155	5.793	5.190	4.948
15	*Murdannia nudiflora*	—	—	—	—	—	—	—	2.978	5.029	5.179	4.366	4.144	—
16	*Oxalis corniculata*	4.523	6.071	4.710	—	—	—	4.849	4.821	4.920	4.770	3.658	4.536	4.183
17	*Phyllanthus fraternus*	8.790	9.730	12.601	18.954	26.379	14.393	8.537	7.488	8.442	8.493	8.126	8.182	9.010
18	*Rungia pectinata*	16.924	11.434	12.839	18.647	—	10.379	5.161	8.698	9.774	11.213	12.329	14.483	16.702
19	*Sida cordifolia*	7.050	9.654	14.216	24.780	33.017	19.981	8.857	7.797	6.562	7.797	7.000	6.518	8.196
20	*Spermacoce ramanii*	7.284	9.225	—	—	—	23.057	10.252	8.477	7.064	7.457	6.433	7.128	7.253
21	*Zornia gibbosa*	6.640	7.048	—	—	—	—	5.555	4.895	5.924	6.228	6.793	6.864	6.896
	Non grass total	**145.058**	**140.510**	**121.681**	**94.431**	**59.396**	**119.657**	**132.389**	**139.562**	**141.487**	**145.146**	**143.991**	**143.634**	**140.844**
	Total	**299.988**	**299.989**	**299.990**	**299.993**	**299.987**	**299.986**	**299.989**	**299.987**	**299.980**	**299.985**	**299.989**	**299.993**	**299.983**

Work on diversity was done on animal or planktonic communities in the past, where the individuals were easily distinguished and were of more or less equal weight. Though the plants are more plastic, it is difficult to distinguish the individuals and hence biomass value was used for the estimation of diversity index by many workers (Whittaker, 1965; Wilhm, 1968; Tramer, 1975). Besides, a lot of work on grassland species diversity has been done taking density or biomass or both into account by Singh & Misra (1969), Precsenyi (1969,1973), Singh & Ambasht (1975), Misra (1978), Naik (1985), Pradhan (1994) and Barik & Misra (1997).

The present study deals with the measurement of diversity and dominance indices basing on the density of the community. The density based species diversity and dominance indices are presented in Figure-11. The highest diversity index value was observed during August (1.325) and lowest in the month of April (0.661). The value gradually decreased from January to April, and then it started increasing till August. Thereafter the value exhibited a declined trend till to the end of the sampling period.

The dominance index based on density value on the other hand showed an opposite trend compared to diversity index value. The dominance value was maximum in April (0.243) and minimum in August (0.066). The density based dominance index value gradually increased from December to April, then it decreased till August and thereafter the value showed an increasing trend till to the end of the sampling period.

The correlation between the diversity and dominance indices was also calculated. The dominance index (C) and diversity index (H') were negatively correlated, where the correlation co-efficient $r = -0.983$ significant at $p = 0.001$ level was observed, (Fig. - 12).

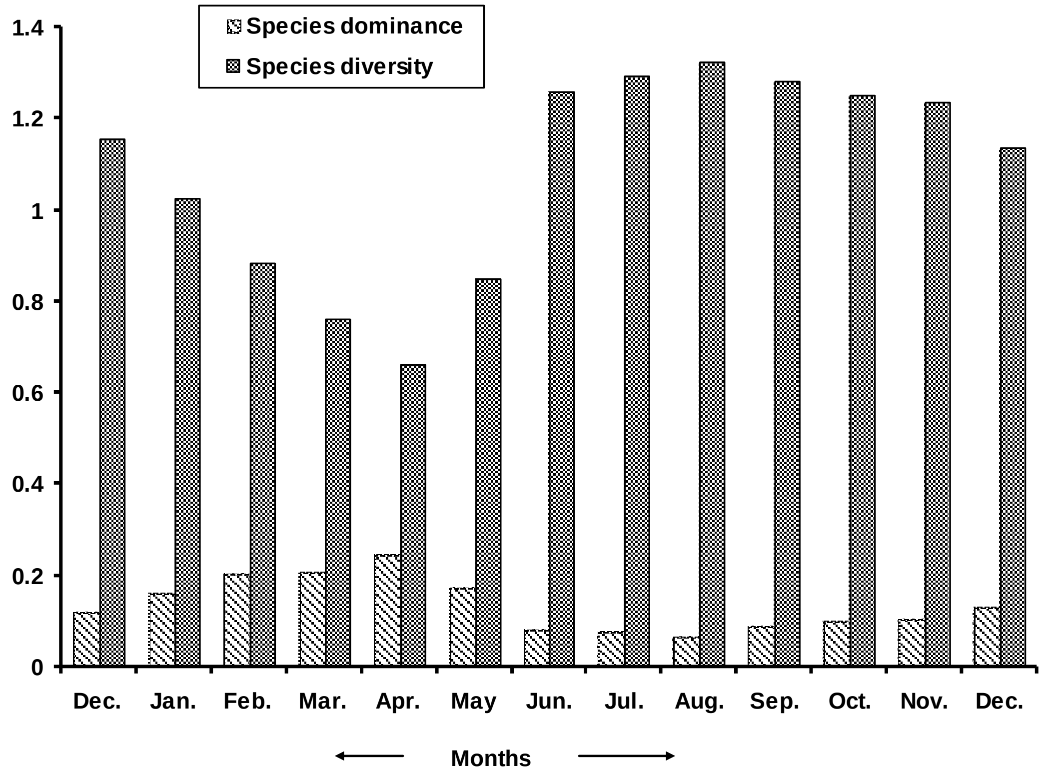

Fig. - 11. Monthly variation in species diversity (H') and dominance (C) based on density value during the study period.

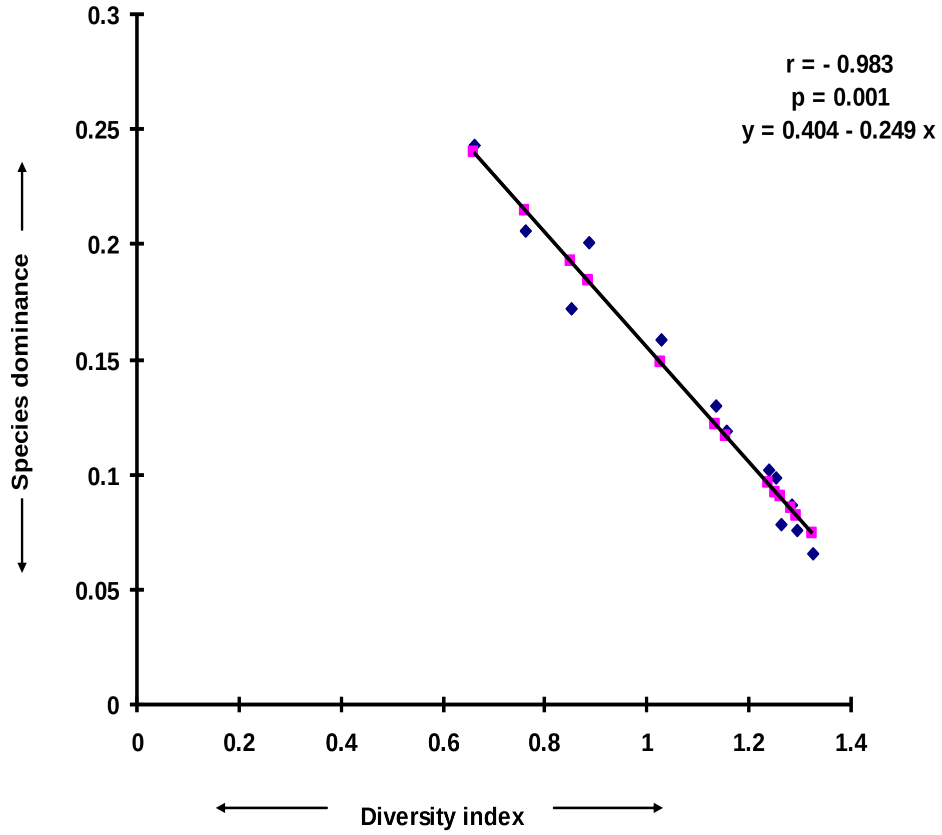

Fig - 12. Relationship between diversity index and dominance index based on density value during the study period.

4.3 DISCUSSION

FLORISTIC COMPOSITION

The floristic composition of the experimental site was not so different as in other grassland types of India (Rao, 1968; Singh & Ambast, 1975; Misra & Misra, 1979; Malana & Misra, 1980; Rath & Misra, 1980; Naik, 1985; Patnaik, 1993; Behera & Misra, 1993; Pradhan, 1994; Barik & Misra, 1997).The community comprises with 36 species (15 species were grasses and 21 species were non-grasses) of both annual and perennials. Mostly the annuals appeared with the onset of monsoon and completed their life-cycle till the end of winter season (Misra & Misra, 1979; Naik, 1985; Misra, 1992; Behera & Misra, 1993; Pradhan,1994; Barik & Misra, 1997). A maximum of seven species were found to survive in the month of April in very dispirited condition. Most of the species completed their life-cycles during summer with adverse climatic condition. *Cynodon dactylon, Digitaria abludens, Eleusine indica, Vetiveria zizanoides* among the grasses and *Phyllanthus fraternus* and *Sida cordifolia* among the non -grasses were found dominant during the study period because of well organized rhizoidal system to protect wind and irrespective (loss) of water requirement proficiency of the experimental grassland community.

LIFE- FORMS

The life form of all species of the study site showed maximum percentage of therophytes (30.55%) followed by chamaephytes (27.78%), hemicryptophytes (25%) and geophytes (16.67%). The class phanerophytes was found to be absent. Maximum therophytic percentage contribution was also reported in the grassland of Varanasi (Rao, 1968; Sing & Ambast,1975), Berhampur (Misra & Misra,1979 ; Malana & Misra, 1980 ; Rath & Misra, 1980; Barik & Misra, 1997), Western Orissa (Naik, 1985), South Orissa (Patnaik,1993), Phulbani (Behera & Misra,1993) and Bhubaneswar (Pradhan,1994). Species association studies in grasslands of Varanasi by Singh and Ambast (1975) and Berhampur by Barik and Misra (1997) did not show any phanerophytic species. In this study also no phanerophytic species was found. Bharucha & Dave (1944) while studying the grassland in Bombay noticed higher degree in the percentage of therophyte because of the influence of human being and animals. According to Pandeya (1964) over grazing was one of the important factors for getting maximum percentage of therophytic species. Cain (1950) also pointed out the same, that the higher therophytic percentage in grassland was due to intense grazing. However in this grassland community the greater percentage of therophytes and absence of phanerophytes may be due to the influence of periodicity of soil characteristic, climatic condition as well as the biotic interference. Since the experimental grassland was well protected grazing was not possible. However, there was no restriction before the study period. Present findings when compared to normal biological spectrum of Raunkiaer (1934) showed near about 3.09 times higher than the percentage of chamaephyte, 2.78 times in case of geophytes and 2.35 times in case of therophytes whereas the percentage of hemicryptophytes was nearly 0.96 times less than the normal spectrum. Table - 13 showed in detail the biological spectra of the study site and other climatological region along with the Raunkiaer's normal spectrum.

STRATIFICATION

Stratification or layering is the occurrence of organisms (plants) at different level in community ecology. It depends on the type of community. In forest ecosystem five to seven strata may be found, however a grassland community comprises with a maximum of three strata. The plant height ranges from 50cm to 1m considered as highest or top strata, 25cm to 50cm is the middle strata and the plant height bellow 25cm are placed in lower strata. Almost all runners are considered under lower strata. In this investigation the stratification of the study site revealed all the 3 strata in the grassland community (Appendix-3). Similar findings were also reported by Misra (1978), Naik (1985), Pattnaik (1993), Pradhan (1994), Behera (1994) and Barik & Misra (1997). The occurrence of 3 strata in the present grassland community under study, attributed to favourable climatic conditions, responsible for the growth and development of flora in the grassland community.

Table-13 Biological spectra of the study site as compared to other grassland types of India.

Region	Pha%	Cha%	Hem%	Geo%	The%
Raunkiaer's normal spectrum (Raunkiaer, 1934)	46.0	9.0	26.0	6.0	13.0
Varanasi (Rao, 1968)	40.0	6.0	1.0	10.0	43.0
Varanasi (Singh & Ambasht, 1975)	-	4.2	19.2	6.3	70.2
Berhampur (Misra & Misra, 1979)	5.7	25.7	14.3	5.7	48.6
Berhampur (Malana & Misra, 1980)	10.00	26.66	23.33	3.33	36.33
Berhampur (Rath & Misra, 1980)	5.4	21.6	18.9	2.7	51.3
Western Orissa (Naik, 1985)	3.00	21.20	18.20	6.00	51.50
South Orissa (Patnaik, 1993)	3.58	17.86	25.00	10.71	42.86
Phulbani (Behera & Misra, 1993)	5.71	20.00	11.42	8.57	54.28
Bhubaneswar (Pradhan, 1994)	5.88	29.42	11.76	5.88	47.05
Berhampur (Barik & Misra, 1997)	-	25.81	12.90	9.68	51.61
Present study	-	27.78	25.00	16.67	30.55

Pha = Phanerophytes, Cha = Chamaephytes, Hem = Hemicryptophytes

Geo = Geophytes,The = Therophytes.

FREQUENCY, DENSITY, ABUNDANCE, BASAL COVER, RELATIVE FREQUENCY, RELATIVE DENSITY, RELATIVE DOMINANCE AND IMPORTANCE VALUE INDEX (IVI) OF VARIOUS SPECIES:

The study of frequency, density, abundance, basal cover and IVI of various species in the experimental site were determined. It was observed that the *Cynodon dactylon, Digitaria abludens, Eleusine indica* and *Vetiveria zizanioides* showed high frequency percentage through out the sampling period. Whereas *Ageratum conyzoides* and *Mecardonia procumbens* exhibited lower percentage of frequency among all the grasses and non-grasses.

The density of all species in the community was found to high in the month of September (The grasses contributed 74.7% to the total community where as non-grasses contributed only 25.3%) and less during April (Grasses 97.5% and non-grasses 2.5%). The density value of the community showed gradual declined in trend from December to January, February, March and then to April. There after the value started increasing from April to September. Again a declined trend of density value was observed from September onwards till to the end of sampling period (December).

The dominated species of grasses i.e. *Cynodon dactylon, Digitaria abludens, Eleusine indica and Vetiveria zizanioides* in the community showed decline in their density values from December / January to February, then to March and exhibited lower value during April / May. The values were then increased and attained peak during September expect *Vetiveria zizanioides* which showed peak value during August.

Again a declined trend in density values was marked till to the end of the sampling period. Besides, among the non-grasses the dominated species i.e. *Phyllanthus fraternus* and *Sida cordifolia* exhibited minimum density value in the month of May and March respectively and maximum in the month of September. The total density value of grasses and non-grasses on the other hand gradually declined from the beginning i.e. from the month of December to January, February, March and April which showed the lowest value. May onwards the value exhibited gradual increased in trend and attained peak during September. Then the value showed a declined trend till to the end of the sampling period.

The abundance of various species followed similar trend to that observed in density value of concerned species throughout the sampling period. The total basal area of all species was found to be maximum in the month of October and minimum in the month of April. The value exhibited gradual decline in trend from December to January, February, March and lowest in the month of April. Then an increasing trend in value was observed from April onwards and attained peak during October. The basal area later on showed a decline trend till to the end of the sampling period. The total basal cover of the species on the other hand exhibited minimum during April and maximum in the month of September. The basal cover gradually decreases from December to April and then it increased till September and onwards the value showed a declined trend till to the end of the sampling period (December).

The calculated Importance Value Index (IVI) of grasses was found to be high than that of the non-grasses in each month. The grasses contributed lowest IVI in the month of September and non-grasses in the month of April. The IVI of grasses gradually increases from December to April and then it declined till September. Onwards the value showed an increasing tends till to the end of the sampling period. However the IVI of non-grasses revealed an opposite trend i.e., the value decreases from December to April, then an increasing trend of value was marked from April to September. Thereafter it decreases till to the end of the sampling period. The grasses showed peak IVI in the month of April and non-grasses in the month of September. The increasing and decreasing trend of result in frequency, density, abundance, basal cover as well as in IVI of various grasses and non-grasses attributed to be due to variation in species composition, inter and intra specific competition among the species, micro and macro climatic fluctuation, physicochemical characteristic of the soil as well as the photosynthetic efficiency of the species concerned. Similar findings were also reported by Gupta & Misra (1978), Singh & Ambasht (1980), Bharadwaj (1981), Ambasht & Pandey (1981), Naik (1985), Borman ***et al.*** 1990, Misra (1992), Pradhan(1994) and Barik & Misra(1996).

SPECIES DIVERSITY AND DOMINANCE

The density based species diversity was maximum in August and minimum in the April. The value gradually declined from January to April and then it started increasing trend till August. Thereafter the value exhibited a declined trend till to the end of the sampling period. The dominance index showed an opposite trend compared to that of diversity index value. The dominance value was maximum in April and minimum in August. The density based dominance index value gradually increased from January to April, then it decreased till August and onwards the value showed an increasing trend till to the end of sampling period.

Maximum diversity index in the month of August may be due to the emergence of maximum number of tillers / seedlings during the month. The seedling performance was gradually checked because of the decreasing amount of rainfall. Only those plants could be noticed which were sturdy and strong. As a result of which law diversity values were recorded in April. It was also noticed that if the tillering of species was high the density based dominance decreased and when the tillering (including seedling) was low the dominance index increased. Accordingly the dominance index value was found to be maximum in the month of April and less during August.

Margalef (1965) was of the view that, “the more dominant of the species, the smaller is the diversity index and vice-versa”. Singh (1967), Singh & Misra (1969), Precsenyi (1973) reported that increased in diversity of species minimised the dominance. Singh & Ambasht (1975), Misra (1978), Patnaik (1993),Pradhan (1993) and Barik (2006) also had the similar view. In this study also, the dominance index of the species based on density was found inversely related to its diversity index. The species diversity and dominance are in true sense dependent on the type of species, their photosynthetic performance, productivity, biotic interference and also the climatic condition of that area.

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5.1 INTRODUCTION

Living organisms (green plants) have the tendency to synthesize their own food from the organic material for their growth and maintenance. Thus the quantity of live organic material of a given area in an ecosystem is the biomass of the same locality and when it is referred to a particular time it is known as "standing crop biomass". It can be represented more appropriately in term of dry weight. Biomass values of different ecosystems are of great structural and functional importance though the quantity of biomass indicates the size of organisms and also refers to the nutrient level. Primary productivity is the amount of organic matter incorporated in the plant body by the green plants per unit area per unit time. It includes both the photosynthetic product and the mineral elements present in the plant tissue. When the respiratory losses are taken into account in the process it is termed as "Gross primary production" and the net organic matter stored in the tissues before respiratory loss is referred as "Net primary production". Estimation of primary production in an ecosystem is usually hampered due to lack of basic information about the species in the ecosystem (Bernard, 1974). Thus, the species in the ecosystem are considerably very important. The net production of individual species generally regulates the net community primary production. The summation of individual production values is the primary production of the community. Productivity is a rate fraction and can be expressed as change in dry weight or energy content per unit area per unit time.

Literature referred reveals plenty of work on functional attributes like biomass and primary productivity in different climatic zones (Odum, 1960; Ovington ***et al.*** ,1963; Iwaki ***et al.*** , 1964; Dahlman & Kucera, 1965; Golley, 1965; Bliss, 1966, 1969; Porter, 1967; Precsenyi, 1969, 1973; Bazaz & Bliss, 1971; Vershney, 1972; Ambasht et al. ,1972; Singh &Yadava , 1972, 1974; Gorham & Somers, 1973; Traczyk & Kochev, 1974; Bernard, 1974; Dash ***et al.***, 1974; Redmann, 1975, Kjelvik & Karenlampi, 1975; Shrimal & Vyas, 1975; Billore & Mall, 1977; Misra 1978; Kumar ***et al.*** , 1980; Rath, 1980; Malana, 1981; Misra & Misra, 1984, 1986, 1989; Pradhan & Das, 1984; Naik, 1985; Pandya & Sidha, 1987; Ramakrishnan & Ram, 1988; Tripathy, 1989; Pandey &

Sidha, 1989;Bobbink ***et al.*** , 1989; Bobbink & Willems, 1991; Sinha ***et al.***, 1991; Patnaik, 1993; Pradhan & Mohanty, 1993 and Pradhan, 1994). Here also an attempt was made to measure the monthly biomass and primary productivity of various components of the grassland community.

5.2 RESULTS

5.2.1 BIOMASS

The biomass of the community was the sum total of the above ground and below ground biomass values and was expressed as g m^{-2} on dry weight basis. To study the structure and dry matter dynamics of a community, it was felt necessary to deal with the various components i.e. live green, standing dead, total above ground and below ground of the community.

Live green biomass

Figure- 13, 14 and 15 represents the monthly variation in biomass values of live green grasses, non grasses and total live green biomass respectively of the experimental site.

The live green biomass (grasses, non grasses and total live green) of the study site showed gradual declined in trend from December to January, February, March and lowest in the month of April. Thereafter it increased and attained a peak during September and onwards a gradual decreased in trend was observed till to the end of the sampling period.

Standing dead biomass

Figure-16 showed the monthly variation in standing dead biomass of the experimental site. It was observed that the standing dead biomass gradually decreased from December to June and showed minimum value (5.5 g m^{-2}). Thereafter, the value started an increasing trend and showed the peak in the month of December (181.56 g m^{-2}).

Litter biomass

The litter biomass of the community exhibited an increasing trend from December to January, February, March, April and May (77.84 g m^{-2}).Thereafter the value showed a declined trend till August (65.08 g m^{-2}).The litter biomass again showed an increasing trend showing a maximum of 108.08 g m^{-2}during the last sampling period i.e. in the month of December (Fig.-17).

Above ground biomass

Total above ground biomass is the sum total of live green biomass and standing dead biomass. It was found to be minimum in the month of April (423.35 g m^{-2}) and maximum during September (6005.68 g m^{-2}). The sequence of monthly above ground biomass values showed similar trend to that observed in case of live green biomass values in the present study (Fig. - 18).

Below ground biomass

It showed similar trend like live green and above ground biomass. The below ground biomass values decreased from December (274.76 g m^{-2}) to April (46.42 g m^{-2}) and onwards the values showed gradual increased in trend till September (737.8 g m^{-2}) and then decreased thereafter (Fig. -19).

Total biomass

It is the sum total of above ground and below ground biomass of the concerned months. The total biomass of the community ranges from 469.77 g m^{-2} to 6743.48 g m^{-2}. The maximum biomass was observed in September and minimum in the month of April. A gradual decrease in total biomass value was found from December to April, then the value started increasing up to September and onwards the value again followed a decreasing trend till to the end of the sampling period (Fig.-20).

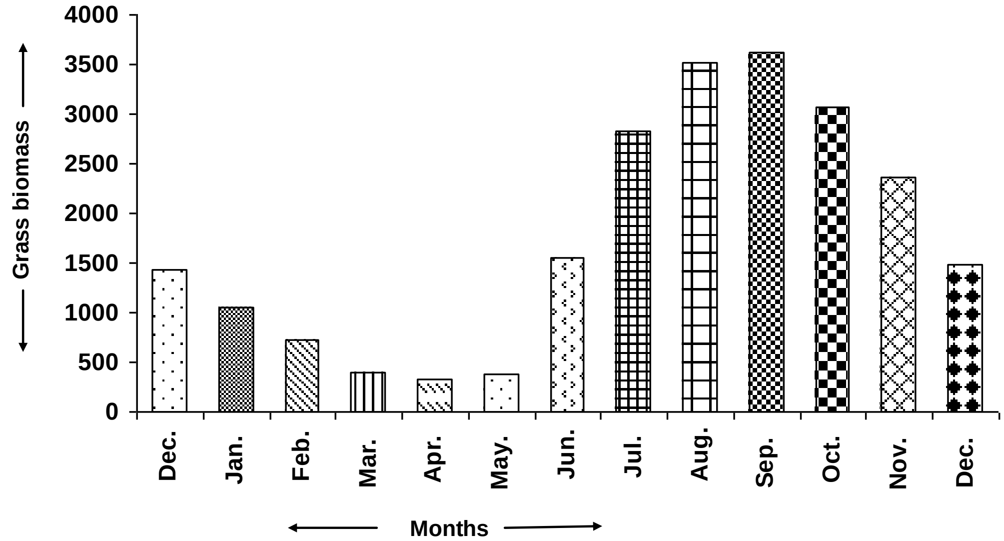

Fig. - 13. Monthly variation in grass biomass (g m^{-2}) during the study period.

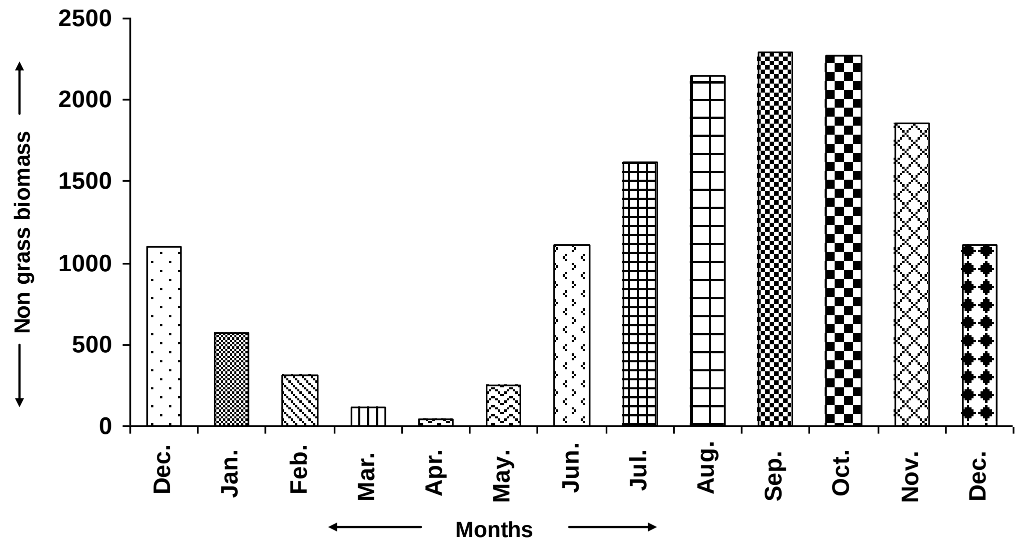

Fig. - 14. Monthly variation in non grass biomass (g m^{-2}) during the study period.

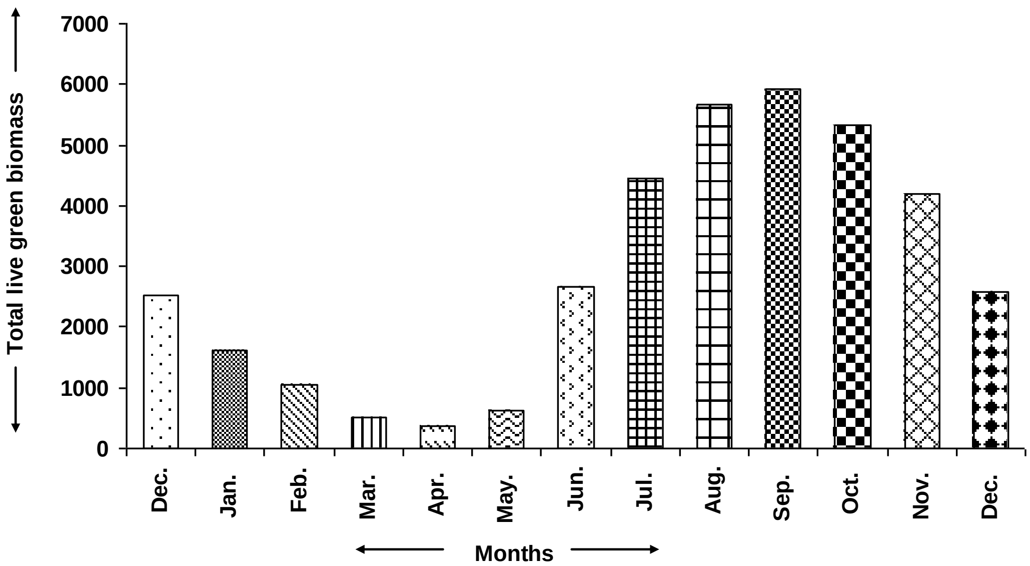

Fig. - 15. Monthly variation in total live green biomass (g m^{-2}) during the study period.

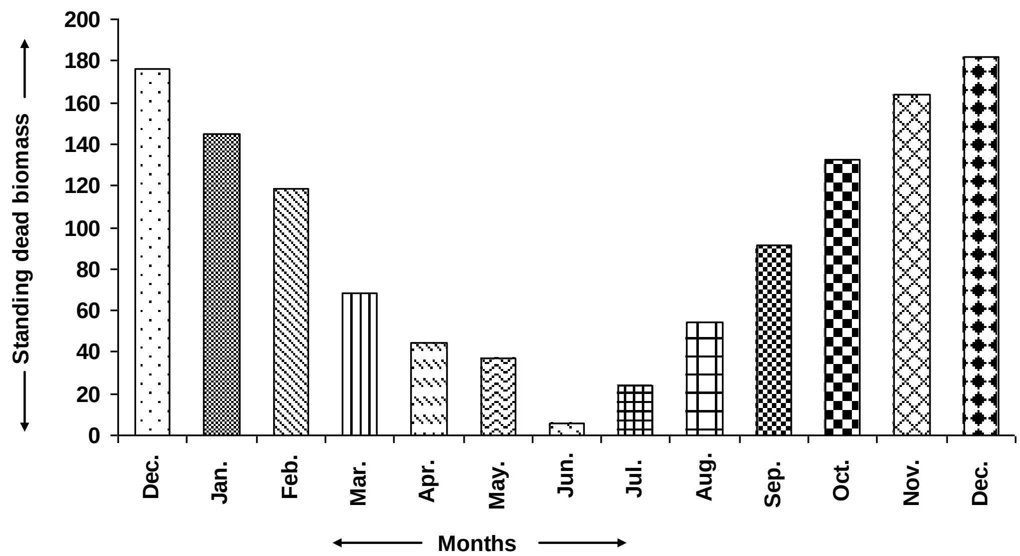

Fig. - 16. Monthly variation in standing dead biomass (g m^{-2}) during the study period.

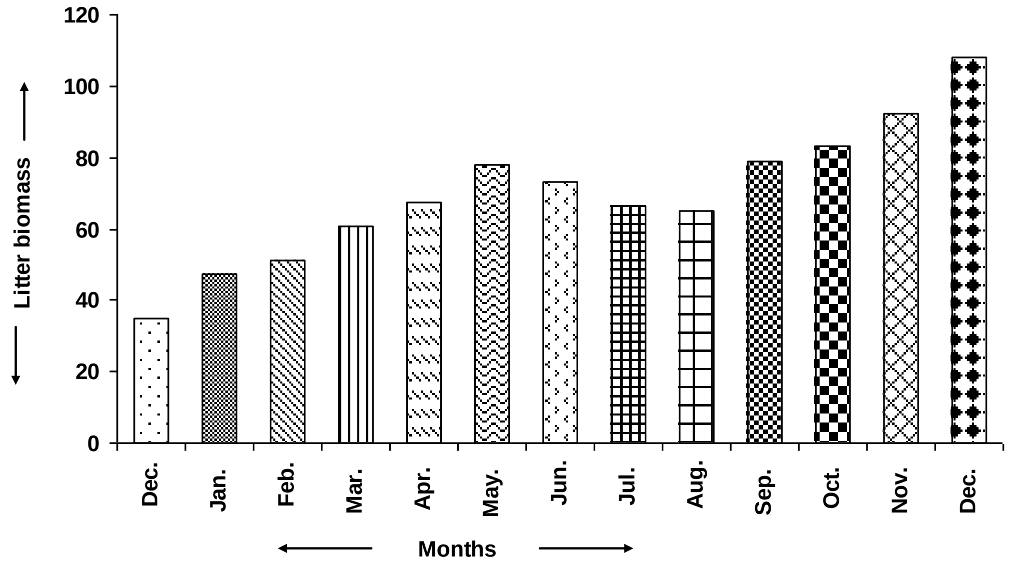

Fig. - 17. Monthly variation in litter biomass (g m^{-2}) during the study period.

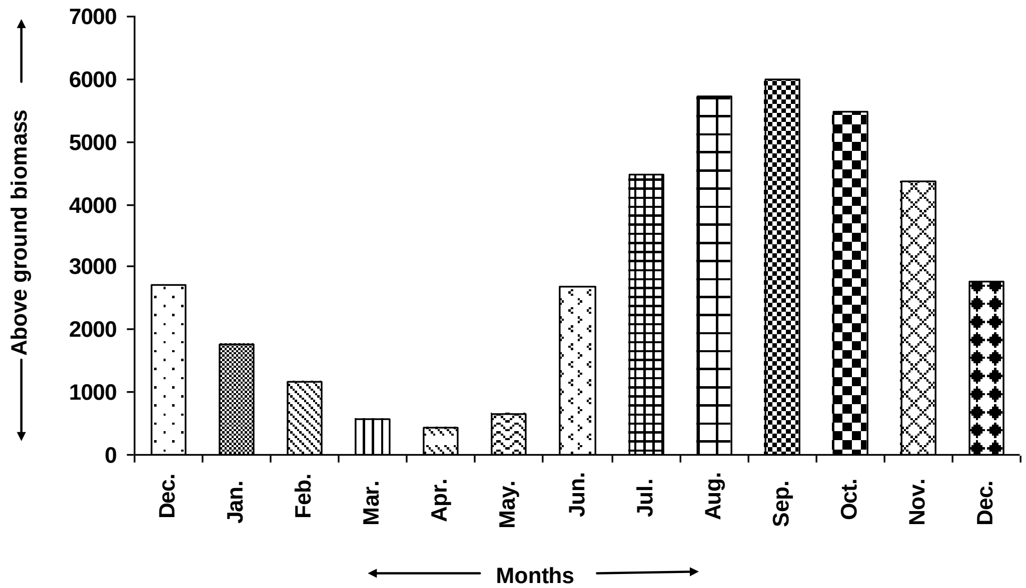

Fig. - 18. Monthly variation in above ground biomass (g m^{-2}) during the study period.

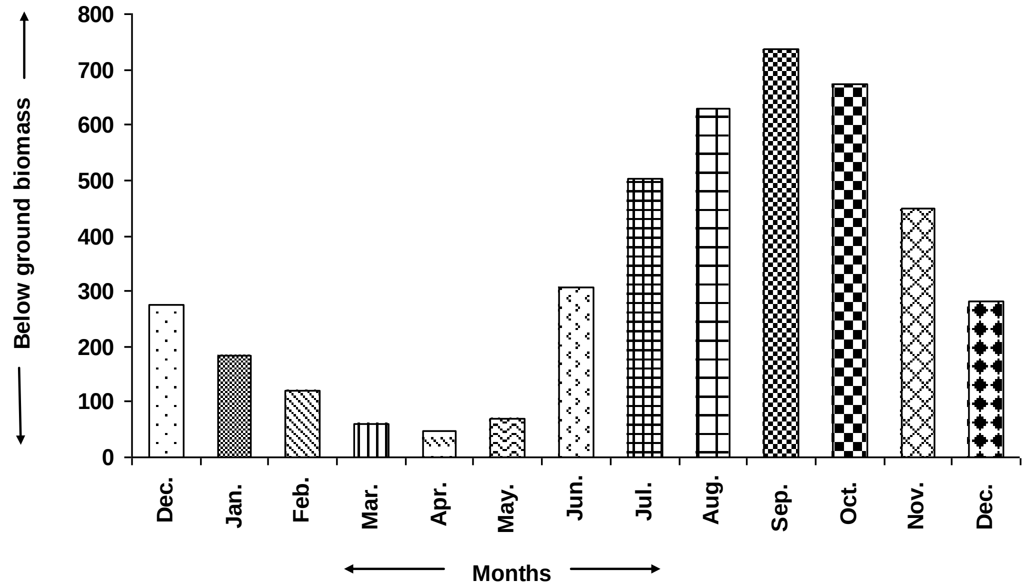

Fig. 19 - Monthly variation in below ground biomass (g m^{-2}) during the study period.

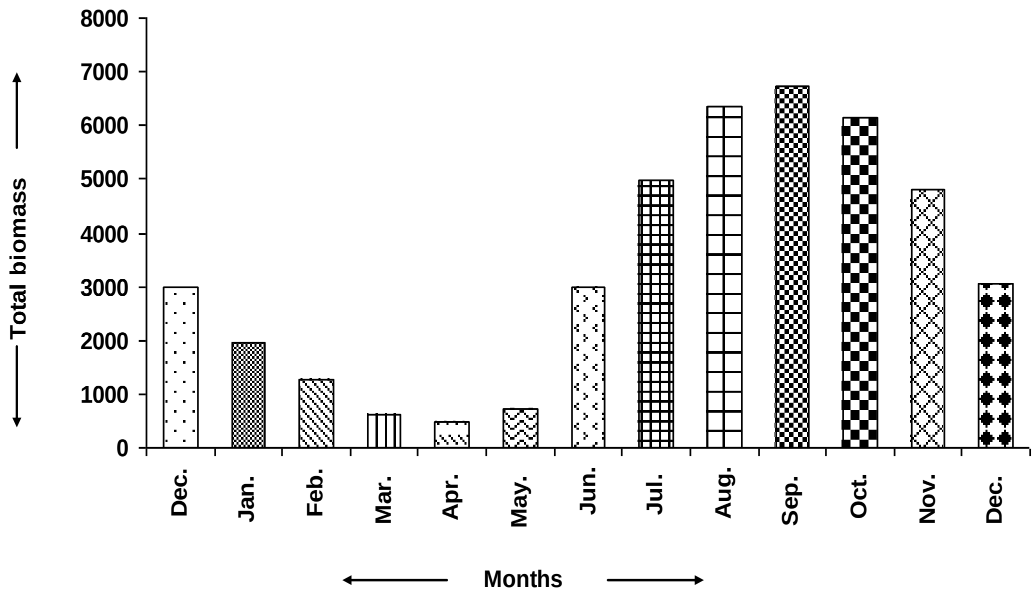

Fig. - 20. Monthly variation in total biomass (g m^{-2}) during yhe study period.

5.2.2 PRIMARY PRODUCTIVITY

The productivity of each category of plant materials i.e. live green, standing dead, litter and below ground parts was calculated by summing up of the positive increments of concerned biomass during the study period.

Live green production

It includes both grass and non-grass production. Grass production was found to be minimum during May (49.57 g m^{-2}) and maximum in the month of July (1274.09 g m^{-2}). The production of grass exhibited an increasing trend from May to June and then to July. Thereafter the value declined till September. This compartment showed no production value during rest of the months (Fig. - 21). The annual grass production was found to be 3289.53 g m^{-2} yr^{-1}.

The non-grass production on the other hand showed maximum in the month of June (868.55 g m^{-2}) and minimum in the month of September (141.11 g m^{-2}). No such increasing / decreasing trend of non grass production was observed as found in case of grass production. The production was nil during the month of December, January, February, March, April, October and November (Fig.- 22). The annual non-grass production was found to be 2246.10 g m^{-2} yr^{-1}.

Figure-23 represents the monthly variation in total live green production during the study period. The total live green production (grass and non-grass) showed their minimum and maximum value during May (249.00 g m^{-2}) and June (2041.89 g m^{-2}). Out of the total annual net live green production (5535.63 g m^{-2} yr^{-1}), 59.42% was contributed by grasses and 40.58% by non-grasses.

Standing dead production

Total standing dead production was found to be 176.06 g m^{-2} yr^{-1} during the sampling period. The rate of production was nil during December to June. From July and continuous production of standing dead was observed showing a maximum of 40.81 g m^{-2} during October. The standing dead production exhibited a gradual increased in value from July to October and then a decreasing trend in value was observed till to the end of the sampling period (Fig. - 24).

Litter production

Figure-25 showed the monthly variation in litter production during the study period. Litter production was found to be nil during June, July and August. No such increasing / decreasing trend of litter production was noticed through out the sampling period. The net annual litter production was 85.72 g m^{-2} yr^{-1}.

Above ground production

It includes the sum total of positive increments of both above ground live green (grass + non-grass) and standing dead of the community. Net above ground production was found to be 5711.69 g m^{-2} yr^{-1} during the sampling period of which June showed a maximum of 2041.89 g m^{-2}.The production was found to be nil in the month of January, February, March and April. The net above ground production exhibited a gradual declined in trend from June to July, then to August, September, October, November and December showing a minimum production of 17.44 g m^{-2} (Fig.- 26).

Below ground production

Like total live green production, the below ground production was found to be nil during January, February, March, April, October, November and December. A maximum of 236.55 g m^{-2} of below ground production was observed during June. Thereafter the rate of production gradually decreased till September. A minimum production of 23.71 g m^{-2} was observed in the month of May (Fig.-27). Total below ground production was found to be 691.38 g m^{-2} during the study period.

Net primary production

Following the procedure of Odum (1960), Golley (1965), Golley & Lieth (1972), the positive increments of live green grass, non-grass and standing dead biomass were summed up together to asses the above ground net production and the total net production was derived by adding the above ground and below ground net production values. Table -14 shows the net primary production of various components during the study period.

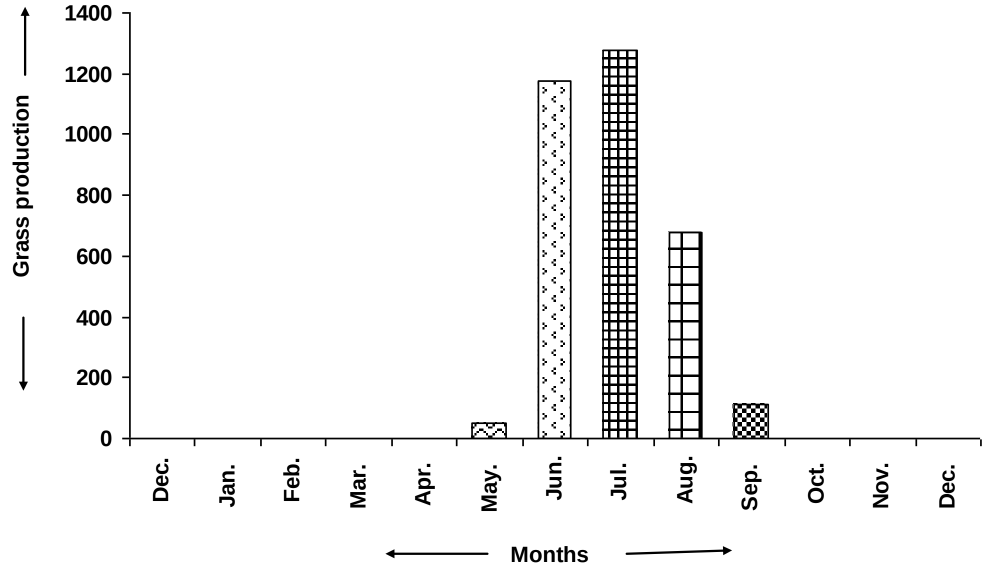

Fig. - 21. Monthly variation in live green grass production (g m^{-2}) during the study period.

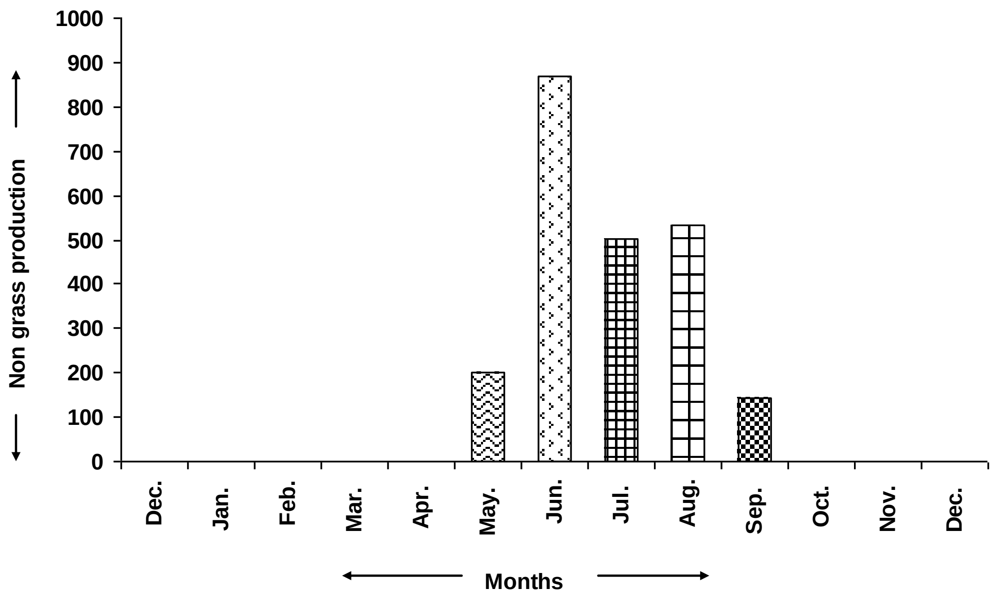

Fig. - 22. Monthly variation in live green non grass production (g m^{-2}) during the study period.

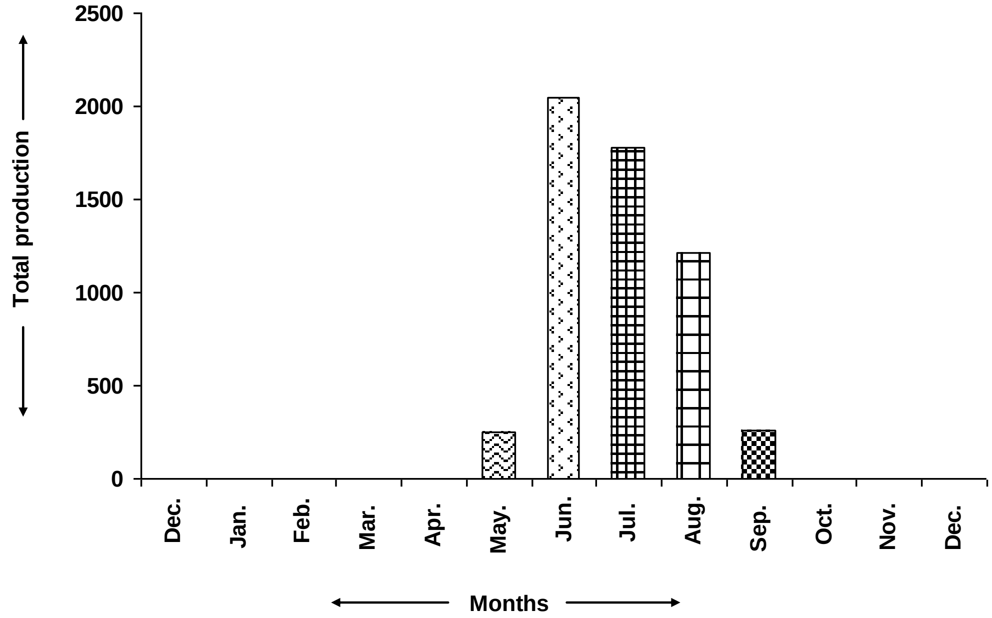

Fig. - 23. Monthly variation in total live green production (g m^{-2}) during the study period.

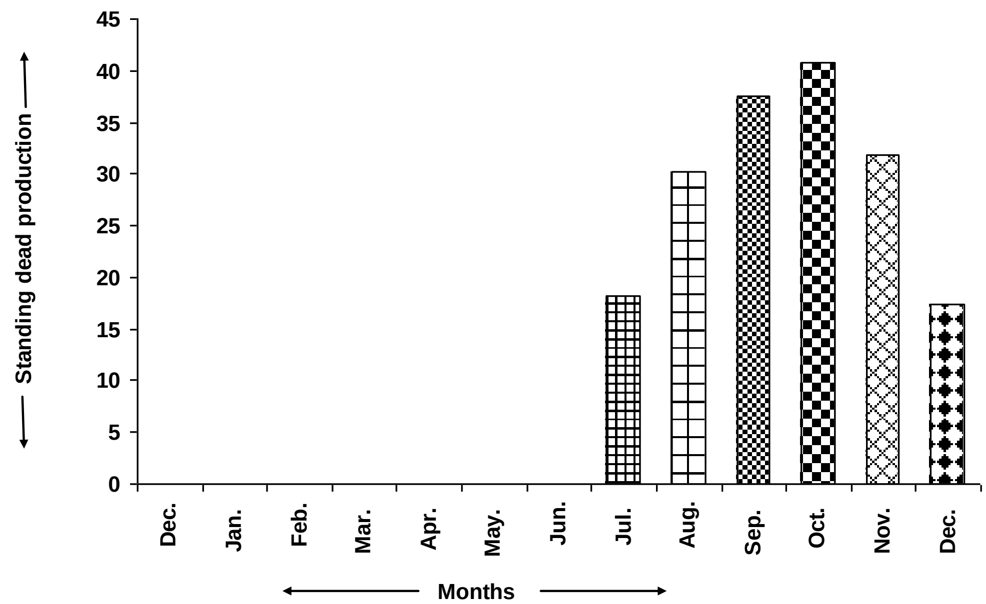

Fig. - 24. Monthly variation in standing dead production (g m^{-2}) during the study period.

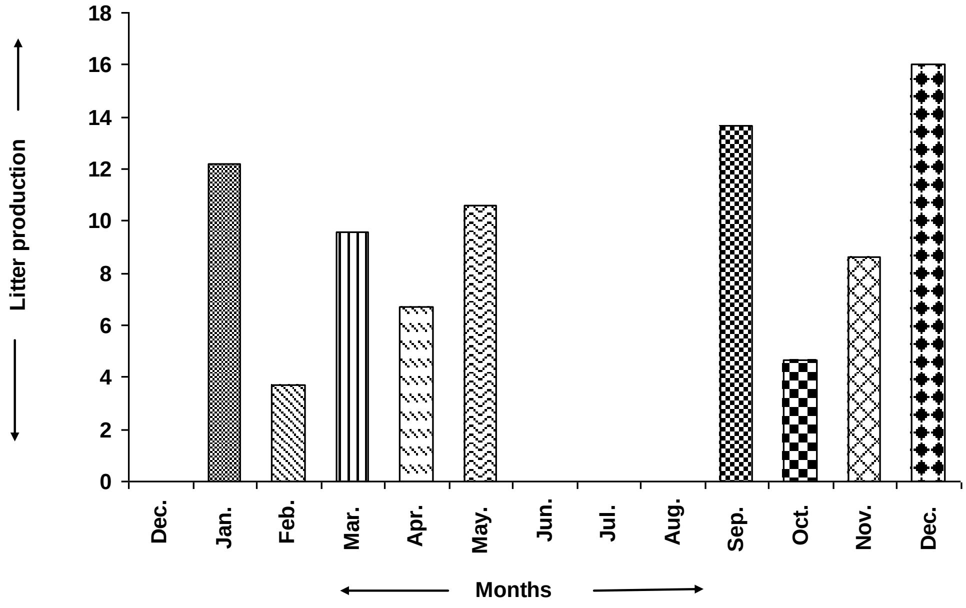

Fig. - 25. Monthly variation in litter production (g m^{-2}) during the study period.

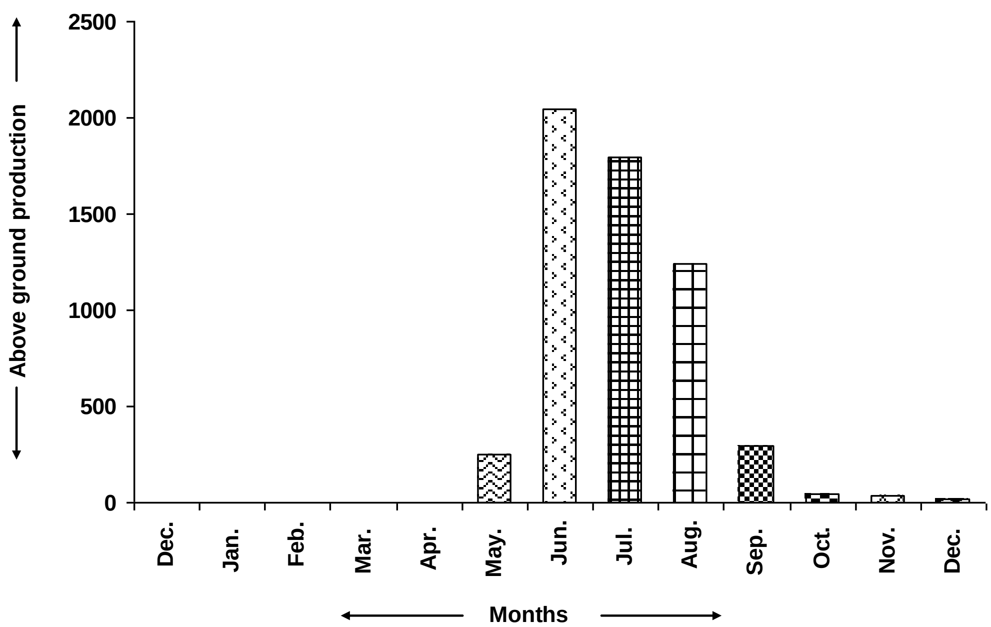

Fig. - 26. Monthly variation in above ground production (g m^{-2}) during the study period.

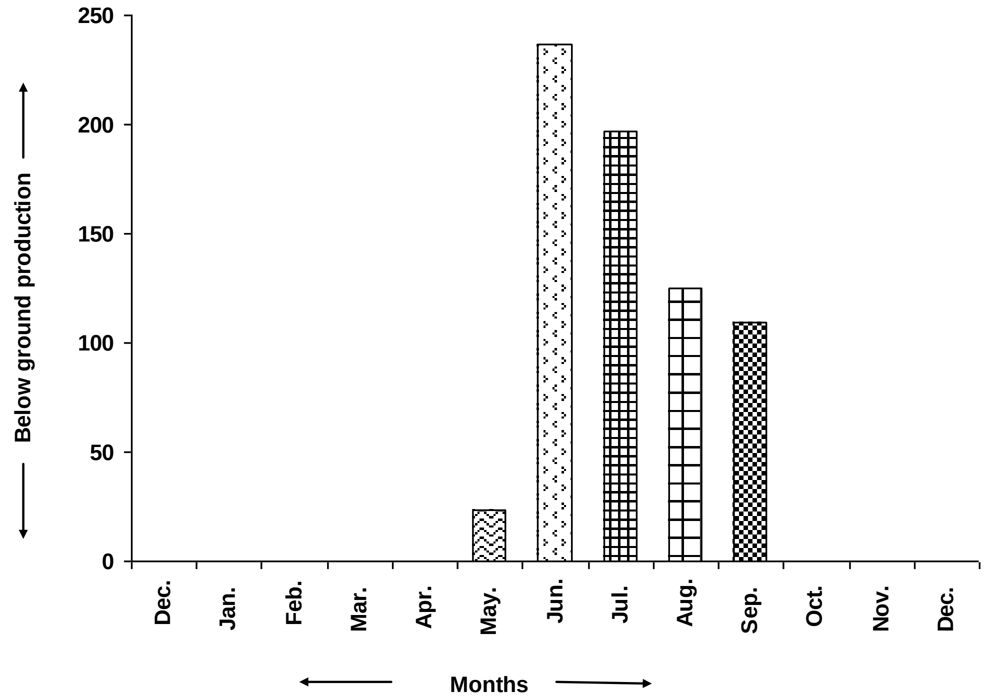

Fig. - 27. Monthly variation in below ground production (g m^{-2}) during the study period.

5.2.3 COMPARTMENTAL TRANSFER

Different compartments along with their accumulation (productivity) are shown in table -15 and the transfer rate of dry matter dynamics is shown in block and arrow diagram (Fig.-28). The block represents the annual net production of respective compartments which is considered as an independent compartment showing inputs and outputs whereas the arrow showed the respective transfer rates.

The net production of different compartments was taken from Table - 14. The litter disappearance (LD) was calculated following the method of Golley (1965) whereas the below ground (BD) was derived as per the method of Sims & Singh (1971). Total disappearance was calculated by adding litter disappearance and below ground disappearance values.

The rate of respiration was not measured in the present investigation but was calculated by multiplying the total net production with a factor 0.3, which was the median ratio of respiration to net production for different types of vegetation (Odum, 1960). The respiratory loss thus obtained when added to total net production gave the gross production (GP) of the community.

The total net production of 6403.07 g m^{-2} yr^{-1} when added to respiratory loss 1920.92 g m^{-2} yr^{-1} gave the gross production of 8323.99 g m^{-2} yr^{-1}. The rate of synthesis of organic matter was observed to be 17.54 g m^{-2} yr^{-1}, out of which 1.89g m^{-2} day^{-1} was directed towards below ground parts and the remaining 15.65 g m^{-2} day^{-1} was locked in the above ground parts. This showed that about 89.22% of the total net production remained in the above-ground parts and about 10.78% directed towards below ground parts. From the above ground net production 0.48 g m^{-2} day^{-1} was transferred to standing dead. The transfer rate from standing dead to litter was 0.23 g m^{-2} day^{-1}. The rate of litter disappearance was less compared to the rate of below ground disappearance (the rate of disappearance of litter and below ground was 0.03 g m^{-2} day^{-1} and 1.25 g m^{-2} day^{-1}, respectively). The total disappearance of organic matter was at the rate of 1.28 g m^{-2} day^{-1} or in other words about 7.34% of the total net production was lost annually.

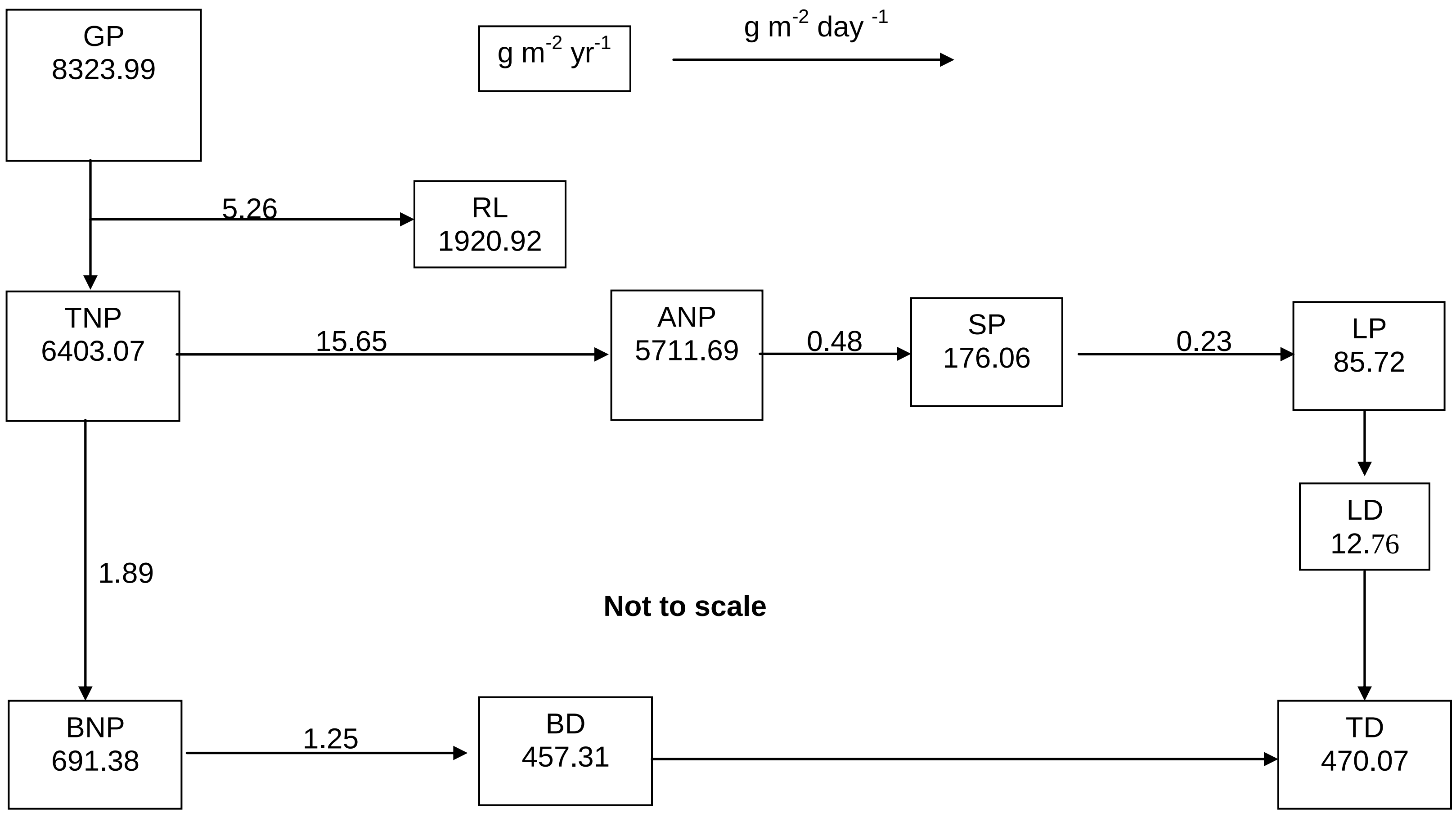

Fig. 28: Block and arrow diagram showing the transfer of organic matter in different compartments of the grassland community (GP = Gross Production, TNP = Total Net Production, ANP = Above ground Net Production, SP = Standing dead Production, LP = Litter Production, LD = Litter Disappearance, BNP = Below ground Net Production, BD = Below ground Disappearance, TD = Total Disappearance, RL = Respiratory Loss).

Table- 14. Net primary production (g m^{-2} yr^{-1}) of the grassland community.

Grass production (Positive increment of live green grass)	3289.53
Non-grass production (Positive increment of live green non-grass)	2246.10
Total live green production	5535.63
Standing dead production (Positive increment of standing dead)	176.06
Total Above ground Net Production (ANP)	5711.69
Litter production	85.72
Below ground Net Production (BNP)	691.38
Total Net Production (TNP)	6403.07

Table-15. Dry matter dynamics of different compartments of the grassland community (g m^{-2} yr^{-1})

Gross production (GP)	8323.99
Respiration (R)	1920.92
Total Net Production (TNP)	6403.07
Above ground Net Production (ANP)	5711.69
Above ground live green production (Lg P)	5535.63
Standing dead production (SP)	176.06
Litter production (LP)	85.72
Below ground Net Production (BNP)	691.38
Litter Disappearance (LD)	12.76
Below ground Disappearance (BD)	457.31
Total Disappearance (TD)	470.07

5.2.4 SYSTEM TRANSFER FUNCTION

Grodins (1963) was of the opinion that the system transfer function was the quantity by which the system block multiplies in input to generate the output i.e. the ratio of output to input and is regarded as a good measures to express the changes in the concerned ecosystem functioning in the different periods of the year (Singh & Yadav,1972).

Table-16 gives an account of the system transfer function between various compartments of the community. This indicates that the transfer function of above ground net production (0.89) was 8.09 times higher than that of below ground net production (0.11). It was also observed that the transfer function of above ground net production to live green production and standing dead production were 0.97 and 0.03 respectively. The system transfer function of standing dead to litter production was found to be 0.49. The disappearance of belowground (0.66) was high compared to litter disappearance (0.15). The above ground net live green productions to standing dead production (0.03) were found to be very less among the other components of the community.

5.2.5 TURNOVER OF ORGANIC MATTER

"The ratio of through put to content" is termed as turnover and is expressed either as a rate fraction or as a turnover time (Odum, 1971). Determination of turnover rate and time of the vegetation will give an idea on the functioning of the ecosystem. Moreover, it will also help to understand the relationship of turnover of plant material with that of biogeochemical cycle in the ecosystem. Turnover rate and time of the vegetation of various terrestrial and aquatic ecosystems have also been worked out in different climatic zones of the world. In this work an attempts was made to determine the turnover rate and time of different components of the grassland community and are presented in Table-17.

It is evident from the Table-17, that the turnover rate of non-grass was found to be maximum (98.01%) compared to that of grasses (90.81%). Among the component of the community i.e. livegreen, standing dead and below ground, the turnover rate was not significantly different from each other (93.60%, 96.97% and 93.71% respectively).The litter component showed less turnover rate (79.31%) in the community.

The turnover time of live green non-grass on the other hand exhibited one month less compared to live green grasses i.e. grasses showed turnover time of 13 - 14 months and the non-grass showed 12 - 13 months. If we compare the turnover time of live green non - grass, total live green, standing dead and below ground did not show any differences (i.e. 12 - 13 months in each).The litter component exhibited a maximum turnover time (15 - 16 months) among the components of the community.

Table-16. System transfer function of dry matter dynamics of the community.

Compartments	System transfer function
TNP to ANP	0.89
TNP to BNP	0.11
ANP to LgP	0.97
ANP to SP	0.03
LgP to SP	0.03
SP to LP	0.49
LP to LD	0.15
BNP to BD	0.66

Table-17. Turnover rate (%) and time (months) of biomass for different compartments of the plant community.

Compartments	Turnover rate (%)	Turnover time (months)
Livegreen grass	90.81	13 - 14
Livegreen non-grass	98.01	12 - 13
Total livegreen	93.60	12 - 13
Standing dead	96.97	12 - 13
Litter	79.31	15 - 16
Below ground	93.71	12 - 13

5.3 DISCUSSION

Live green biomass

The live green biomass (Fig.13, 14 and 15) of the community gradually declined from December to April and subsequently increased till September. Again there was a decreasing trend from September to December. It indicates that with the increase in atmospheric temperature the live green parts of the flora dry up and turn yellow and hence April showed less live green biomass. During May to September the rain fall, atmospheric temperature and soil condition were found to be suitable for the growth and development of all species so that September exhibited peak value. Onwards the amount of rain fall, atmospheric temperature along with the soil condition might not be favorable for the growth of vegetation as a result of which a gradual declined in green biomass was observed till to the end of the sampling period.

Standing dead biomass

Standing dead biomass (Fig.-16) was found to decrease from December to June. Then it increased gradually and attained peak again in December. This indicated that the low rain fall followed by atmospheric temperature were not the factors responsible for decrease or increase in standing dead biomass. The wind velocity, soil characteristics, soil organisms, species density and species interaction do play a vital role for such decrease and increase in standing dead biomass.

Litter biomass

Litter biomass (Fig.-17) exhibited a gradual increase in trend from December to May. Then it showed a decreasing trend till August. Onwards an increasing trend of litter biomass was observed till December. This was perhaps due to the litter decomposition. The factors i.e. rainfall , atmospheric temperature, wind velocity, soil characteristics as well as presence of soil organisms might be the reasons for such increase and decrease in litter biomass value.

Above ground biomass

The above ground biomass of the community was found to be minimum in the month of April and maximum during September. The biomass value gradually declined from December to April and then it showed an increasing trend till September. Thereafter, the value decreased till to the end of the sampling period .The atmospheric temperature, rainfall and soil condition may not be suitable for the growth of vegetation so that declined trend in biomass values were observed during December to April and September to December. The value started increasing from April to September. Perhaps due to the atmospheric temperature, rainfall and the soil condition which initiate the growth and development of plant species occurring in the community.

Below ground biomass

The below ground biomass showed an increasing trend from April to September. This might be due to gradual formation of adventitious root system. The soil condition particularly the moisture content of the soil might have decreased so that declined trend in below grow biomass from September to December and December to April were observed. During this period the adventitious roots were gradually dried up and finally cut off from the tap root. Thus the biomass decreased to its minimum in April.

Table-18, 19 and 20 showed the mean values of live green, standing dead and litter biomass respectively for different communities reported by various workers in specific climatic regions. Comparisons of these data showed that, in the present findings live green biomass and did not show any similarity with the data of others. It was found to be very high compared to the finding of most of the workers (Golley, 1968; Porter, 1967; Kelly ***et al.***1969; Vershney, 1972; Mall & Billore, 1974; Misra, 1978; Trivedi & Misra, 1979; Naik,1985; Behera, 1994 and Barik, 2006). Standing dead biomass was found to be less to that of grasslands of South Carolina(Golley,1965),Tennessee (Kelly ***et al.***1969), Varanasi (Choudhury,1972),Ujjain(Misra,1973),Ratlam(Mall& Billore,1974), Berhampur (Misra,1978 and Barik, 2006), Jhansi (Trivedi&Misra, 1979), and Phulbani (Behera,1994). However, it was high than the value reported by

Patnaik (1993). Litter biomass, on the other hand showed some what similar to the *Heteropogen* grassland of chakia (Singh & Ambasht, 1975) and *Aristida grassland* of Berhampur studied by Barik (2006).

Table-21 showed the maximum belowground biomass of various communities in different climatic regions. Here also an attempt was made to compare the present findings with that of other grassland types. The value showed some what similarity with the grassland of Berhampur (Misra, 1978; Malana, 1981) and Bhubaneswar (Pradhan, 1994). The maximum biomass value was found to be less than the value obtained by Dahlman & Kucera (1965), Jain & Misra (1972), Choudhury(1972) ,and Misra(1973)and high from the findings of Ovington ***et al.*** (1963), Sing & Ambasht(1975), Pandey (1978), Pradhan & Das (1984), Behera(1994) and Barik (2006).

Table - 18. Mean above-ground live green biomass (g m^{-2}) of different herbaceous communities.

Author (s)	**Year of Study**	**Location**	**Type of community (dominated)**	**Mean live green biomass**
Golley	1965	South Carolina	*Andropogon*	90.95
Porter	1967	South Florida	*Muhlenbergia*	119.40
Kelly ***et. al.***	1969	Tennessee	*Andropogon*	219.10
Vershney	1972	New Delhi	*Heteropogon*	333.80
Mall & Billore	1974	Ratlam	Sehima	104.10
Misra	1978	Berhampur	*Aristida*	342.70
Trivedi & Misra	1979	Jhansi	Sehima	197.60
Naik	1985	Rourkela	Mixed type	516.90
Behera	1994	Phulbani	*Heteropogon*	333.50
Barik	2006	Berhampur	*Aristida*	441.30
Present study		Rangamatia	Mixed type	2886.20

Table - 19. Mean above ground standing dead biomass (g m $^{-2}$) of different herbaceous communities.

Author(s)	Year of study	Location	Type of community (dominated)	Mean standing dead biomass.
Golley	1965	South Carolina	*Andropogon*	335
Kelly *et al.*	1969	Tennessee	*Andropogon*	650
Choudhury	1972	Varanasi	*Dichanthium*	129
Misra	1973	Ujjain	*Dichanthium*	164
Mall&Billore	1974	Ratlam	Sehima	190
Jain	1976	Sagar	*Heteropogon*	338
Pandey	1978	Varanasi	*Aristida*	845
Misra	1978	Berhampur	*Aristida*	232
Trivedi& Misra	1979	Jhansi	Sehima	104
Patnaik	1993	South Orissa	*Heteropogon*	073
Behera	1994	Phulbani	*Heteropogon*	179
Barik	2006	Berhampur	*Aristida*	272
Present study		Rangamatia	Mixed type	095

Table- 20. Mean litter biomass of different herbaceous communities ($g\ m^{-2}$).

Author (s)	Year of study	Location	Type of community (dominated)	Mean litter biomass
Odum	1960	South Carolina	Forb	300
Ovington ***et al.***	1963	Minnesota	Prairie	279
			Savana	1,365
Wiegert&Evans	1964	Michigan	Poa,Upland	202
Golley	1965	South Carolina	*Andropogon*	250
Choudhury	1972	Varanasi	*Dichanthium*	098
Misra	1973	Ujjain	*Dichanthium*	225
Singh&Ambasht	1975	Chakia	*Heteropogon*	065
Misra	1978	Berhampur	*Aristida*	057
Trivedi &Misra	1979	Jhansi	Sehima	044
Rath	1980	Berhampur	*Aristida*	055
			Aristida (Grazed)	034
Patnaik	1993	South Orissa	*Heteropogon*	062
Behera	1994	Phulbani	*Heteropogon*	049
Barik	2006	Berhampur	*Aristida*	065
Present study		Rangamatia	Mixed type	068

Table- 21. Maximum belowground biomass (g m^{-2}) of different herbaceous communities.

Author (s)	Year of study	Location	Type of community (dominated)	Maximum belowground biomass
Ovington ***et al.***	1963	Cedar Creek	Prairie	669.5
Dahlaman &Kucera	1965	Missouri	Prairie	1,901.0
Singh	1967	Varanasi	*Dichanthium*	583.0
Kelly ***et al.***	1969	Tennessee	*Andropogon*	804.0
Jain & Misra	1972	Sagar	*Heteropogon*	1,537.3
Choudhury	1972	Varanasi	*Dichanthium*	1,008.0
Misra	1973	Ujjain	*Dichanthium*	925.0
Singh&Ambasht	1975	Varanasi	*Heteropogon*	184.1
Misra	1978	Berhampur	*Aristida*	743.2
Malana	1981	Berhampur	*Heteropogon*	727.0
Pradhan & Das	1984	Sambalpur	Savana	256.0
Pradhan	1994	Bhubaneswar	*Aristida*	736.4
Behera	1994	Phulbani	*Heteropogon*	688.9
Barik	2006	Berhampur	*Aristida*	644.1
Present study		Rangamatia	Mixed type	737.8

Live green production

Live green production includes both grass and non-grass production .Figure-23 shows the total live green production of the experimental site. It indicates that the total live green production attained peak during the month of June (2041.9 g m^{-2}) this might be due to favourable climatic condition. Live green grass production (Fig. -21) and live green non grass production (Fig. -22) were found to be maximum during July and June respectively. This variation was due to physiological and phenological differences of the species of the community. The total live green production of the community gradually declined from June to July, then to August and lowest in the month of September. October and onwards no production was evident, might be due to adverse climatic conditions and higher rate of standing dead production.

Standing dead production

Standing dead production was nil from December to June and thereafter the production was observed in July. It indicates that the climatic condition as well as the soil nutrient during December to June was not suitable for the standing dead production. From July, the dead production started increasing showing a peak in the month of October (40.81 g m^{-2}) might be due to gradual drying of live green parts of the grass and non grass species of the community. October onwards a declined trend of standing dead production was evident perhaps due to higher rate of litter decomposition. Accordingly the above ground net production in the community showed a maximum of 2041.89 g m^{-2} during June. Thereafter the value exhibited a declined trend till to the end of the sampling period. The annual net above ground production of the community was found to be 5711.69 g m^{-2} yr^{-1}. On composition of the annual net above ground production of this grassland, with the production of other grasslands it was observed that the present value showed higher production than the values reported for other Indian grassland (Table -22).

Litter production

Litter production of the community was evident from January to May and from September to December. No litter production was observed during June, July and August. This may perhaps be due to rapid decomposition of litter which subsequently mixed with the soil. The atmospheric temperature, rainfall and soil condition might be favourable for such litter decomposition. Besides, wind factor may create a serious problem for litter production as it washes out the litter component from the community causing reduction in litter production.

Below ground production

The below ground production was observed during the month of May, June, July, August & September. No production of below ground parts was recorded during rest of the sampling period. A maximum of 236.55 g m^{-2} below ground production was evident during June which gradually declined in subsequent months till September. Peak below ground production during June was perhaps due to suitable climatic condition. In the succeeding months the climatic condition of the site may be not in favour of below ground production as a result of which a gradual decline in below ground biomass was observed from June to September. The annual net belowground production(691.38 g m^{-2} yr^{-1})of the present study when compared with the findings of other workers(Table-23)it shows that, the value was much less than that of Jain & Misra (1972) and Rath (1980)and much higher than most of the workers (Choudhury,1972; Misra,1973; Singh & Ambasht,1975; Billore &Mall, 1977;Misra, 1978;Malana, 1981; Pandya&Sidha,1987;Patnaik,1993; Pradhan, 1994;Behera,1994 and Barik, 2006). This fluctuation in the belowground production was mainly due to the variation in soil characteristics, amount of precipitation and variable temperature of the locality.

Net primary production

In the present grassland community the net primary production was calculated to be 6403.07 g m^{-2} yr^{-1}, of which above ground parts contributed 5797.41 g m^{-2} yr^{-1} and the below ground parts contributed 691.38 g m^{-2} yr^{-1}.

Table-24 gives the annual, net primary production of some Indian grassland. It indicates that the net production in this study was no way similar to the findings of other workers as reported earlier. It showed marked higher value compared to the findings of Ambasht ***et al***. (1972), Varshney (1972), Singh & Yadava (1972), Misra (1973), Billore & Mall (1977), & Misra (1978), Malana (1981), Pradhan (1994), Behera (1994) and Barik (2006). It was observed that rain fall was not a single factor responsible for this variation. There were some other factors including rain fall that influenced the net production in the community. It might be due to phenology of the species, rate of evaporation, temperature variability, fertility of soil etc.

Dry matter transfer/System transfer function

Table-15 reveals the dry matter transfer of different components. The net production of the community was found to be 6403.07 g m^{-2} yr^{-1}.Out of which about 89.22% remained in the above ground parts and 10.78% directed towards the below ground parts. The rate of litter disappearance (12.76 g m^{-2} yr^{-1}) was much less compared to the rate of below ground disappearance (457.31g $m^{-2}yr^{-1}$) and about 7.34% of the total net production was disappear annually.

Table -25 shows the system transfer function of dry matter dynamics of few grassland types in various climatological region. In contrast to the present findings, the values reported by others, TNP to ANP was high to those reported by Singh & Yadav (1974), Misra (1973), Billore & Mall (1977), Rath (1980), Malana (1981), Misra & Misra (1984), Naik (1985), Pandya & Sidha (1987), Pradhan (1994), Behera (1994) and Barik (2006).The system transfer function of total net production to below ground net production, above ground net production to standing dead production and litter to litter decomposition were found less in comparison to most of the workers. Below ground to below ground disappearance was found to be same (approx.) with the result of Malana (1981) and Naik (1985).

Turnover of Organic matter

In the present investigation the turn over rate of litter was found to be less to that observed in case of live green and below ground parts (Table-17). Compared to other grasslands, the turn over rate of live green of the community showed lower value to that of *Aristida* grasslands as reported by Rath (1980) and Pradhan (1994). It exhibited higher value compared to the findings of Precsenyi (1971), Misra & Misra (1979), Malana (1981), Naik (1985), Behera(1994) and Barik (2006). However it showed some how similarities with the findings of Golley (1965). The turn over rate of litter was found less to that of Precsenyi (1971), Billore (1973), Misra & Misra (1979), Rath (1980), Malana (1981), Patnaik (1993), Pradhan (1994), Behera (1994) and high to that of Ovington ***et al.*** (1963), Iwaki ***et al.*** (1964), Naik (1985) and Barik (2006) It showed nearly same value to that reported by Misra (1973).The turnover of below ground parts of the community on the other hand exhibited much higher value compared to most of the worker(Table-26).This difference in the turnover rates of various plant communities may be attributed to prevailing climatic conditions (i.e. the micro and macroclimatic fluctuation) and interaction among the species of the community.

Table- 22. Annual net above- ground production (g $m^{-2}yr^{-1}$) in different herbaceous community.

Author(s)	Year	Location	Type of community (Dominated)	Amount (g m^{-2} yr^{-1})
Singh	1968	Varanasi	*Dichanthium*	433-515
Choudhury	1972	Varanasi	*Dichanthium*	310-504
Singh &Yadava	1972	Kurukhetra	Mixed	2300
Varshney	1972	New Delhi	*Heteropogon*	798
Misra	1973	Ujjain	*Dichanthium*	564
Singh & Ambasht	1975	Varanasi	*Heteropogon*	1074-3849
Billore & Mall	1977	Ratlam	Sehima	429
Misra	1978	Berhampur	*Aristida*	956
Trivedi & Misra	1979	Jhansi	Sehima	689-912
Rath	1980	Berhampur	*Aristida*	601
Malana	1981	Berhampur	*Aristida*	527
Patnaik	1993	South Orissa	*Heteropogon*	457
Pradhan	1994	Bhubanewar	*Aristida*	979
Behera	1994	Phulbani	*Heteropogon*	469
Barik	2006	Berhampur	*Aristida*	640
Present study		Rangamatia	Mixed type	5712

Table-23. Annual net below ground production ($gm^{-2}yr^{-1}$) in different herbaceous community.

Author(s)	Year	Location	Type of community (dominated)	Amount ($g\ m^{-2}\ yr^{-1}$)
Singh	1967	Varanasi	*Dichanthium*	213-309
Jain & Misra	1972	Sagar	*Heteropogon*	1284
Singh & Yadava	1972	Kurukhetra	Mixed	676
Choudhury	1972	Varanasi	*Dichanthium*	551
Misra	1973	Ujjain	*Dichanthium*	425
Singh & Ambasht	1975	Varanasi	*Heteropogon*	170-207
Billore & Mall	1977	Rotlam	Sehima	417
Misra	1978	Berhampur	*Aristida*	491
Pandey	1978	Varanasi	*Aristida*	334
Rath	1980	Berhampur	*Aristida*	851
Malana	1981	Berhampur	*Heteropogon*	727
Pandya & Sidha	1987	Khavda	Suaeda	487
Patnaik	1993	South Orissa	*Heteropogon*	197
Pradhan	1994	Bhubaneswar	*Aristida*	495
Behera	1994	Phulbani	*Heteropogon*	339
Barik	2006	Berhampur	*Aristida*	289
Present study		Rangamatia	Mixed type	691

Table- 24. Total annual net primary production g m^{-2} yr^{-1} of different grassland community.

Author (s)	**Year**	**Location**	**Type of community (Dominance)**	**Annual rain fall mm**	**NPP ($g\ m^{-2} yr^{-1}$).**
Ambasht ***et al.***	1972	Varanasi	*Dichanthium*	725	1420
Varshney	1972	New Delhi	*Heteropogon*	800	1330
Singh & Yadava	1972	Kurukhetra	*Panicum*	770	2980
Misra	1973	Ujjain	*Dichantium*	1030	989
Billore & Mall	1977	Ratlam	Sehima	1257	846
Misra	1978	Berhampur	*Aristida*	1200	1447
Malana	1981	Berhampur	*Aristida*	1355	1180
Pradhan	1994	Bhubaneswar	*Aristida*	858	1474
Behera	1994	Phulbani	*Heteropogon*	1763	809
Barik	2006	Berhampur	*Aristida*	1341	929
Present study		Rangamatia	Mixed type	1906	6403

Table - 25. System transfer function of production of certain grassland community.

Author (s)	Year	Location	TNP to ANP	TNP to SD	TNP toL	TNP to BNP	ANP to SD	SD to L	L to LD	BNP to BD
Singh & Yadava	1974	Kurukhetra	0.68	--	--	0.32	0.54	0.76	0.94	1.05
Misra	1973	Ujjain	0.57	--	--	0.42	0.74	0.82	0.62	0.76
Billore & Mall	1977	Ratlam	0.50	0.48	0.02	0.49	0.96	0.85	0.71	0.59
Rath	1980	Berhampur	0.51	0.27	0.07	0.49	0.54	0.27	0.90	0.86
Malana	1981	Berhampur	0.61	0.25	0.15	0.38	0.40	0.59	0.94	0.71
Misra & Misra	1984	Berhampur	0.66	0.54	0.11	0.34	0.82	0.84	0.94	0.52
Naik	1985	Rourkela	0.73	0.37	0.07	0.27	0.52	0.19	0.75	0.71
Pandey & Sidha	1987	Khavda	0.24	--	--	0.76	0.31	0.24	0.96	0.97
Pradhan	1994	Bhubaneswar	0.66	0.43	0.08	0.33	0.43	0.31	0.67	0.40
Behera	1994	Phulbani	0.58	0.39	0.15	0.41	0.67	0.38	1.01	0.55
Barik	2006	Berhampur	0.69	0.25	0.08	0.31	0.36	0.32	0.88	0.97
Present study		Rangamatia	0.89	--	--	0.11	0.03	0.49	0.15	0.66

Table - 26. Turnover rate of organic matter in various plant communities.

Author(s)	Year	Type of community (Dominant)	Turnover rate		
			Live green	Litter	Below ground
Ovington et al.	1963	Prairie	97	45	47
		Savana	98	45	45
Iwaki ***et al.***	1964	*Arundinella*	97	63	19
Golley	1965	*Andropogon*	90-92	--	48-62
Dahlman&Kucera	1965	Prairie	--	--	26
Singh	1967	*Dichanthium*	--	--	51-54
Old	1969	Prairie	--	--	45
Precsenyi	1971	*Artemisietum*	50-60	90-99	40-60
		Peucedanetum	88	60	42
Sims & Singh	1971	Mixed	--	--	22-51
Jain & Misra	1972	*Heteropogon*	--	--	83
Misra	1973	*Dichanthium*	--	82	45
Billore	1973	Sehima	99	96	47
Misra & Misra	1979	*Aristida*	77	119	52
Rath	1980	*Aristida*	105	87	68
Malana	1981	*Aristida*	82	87	42
Naik	1985	Mixed	59	72	30
Pandya & Sidha	1987	Suaeda	--	--	83
Tripathy	1989	Mixed	--	--	96
Patnaik	1993	*Heteropogon*	99	97	74
Pradhan	1994	*Aristida*	101	123	67
Behera	1994	*Heteropogon*	79	97	49
Barik	2006	*Aristida*	64	70	37
Present study	--	Mixed type	93	79	94

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6.1 INTRODUCTION

A community consists of different individual cohabiting together in an inter-related environment. Thus it is essential to know the relationship existing among the individuals as well as among the various attributes of the community. Literature review revealed a lot of work on the inter relationship study of various structural and functional attributes of the community (Odum,1962; Black, 1963;Pearce ***et al***.,1965; Mc. Naughton, 1967; Singh, 1967;Beavington, 1969; Singh,1972;Baier ***et al***.,1972;Misra,1973;Precsenyi, 1973;Billore,1973;Mall ***et al***., 1974;Mall & Billore, 1974; Singh & Ambasht, 1975;Singh & Billore,1975;Das ***et al***.,1975; Auclair ***et al*.,**1976; Gupta & Misra, 1978; Misra, 1978; Naik, 1985; Tripathy, 1989; Patnaik, 1993; Pradhan, 1994; Behera, 1994;Barik 2003 and so on.

In this study also an attempt was made to find out the relationship existing

1. among the dominant species
2. among the various compartmental biomass of the community.
3. among density with various climatological features.
4. among the density and biomass of the community.

6.2 RELATIONSHIPS AMONG THE DOMINANT SPECIES

Table - 5, showed the monthly density value of 6 dominant species (i.e. *Cynodon dactylon, Digitaria abludens, Eleusine indica, Vetiveria zizanioides, Phyllanthus fraternus* and *side cordifolia*) along with the other species during the study period. When the *Cynodon dactylon* was correlated with *Digitaria abludens* it showed a positive correlation(r = 0.849) significant at p = 0.001. The regression equation was found to be y = - 0.513 + 0.7051x, where ‘x’ represents the density value of *Cynodon dactylon* and ‘y’ for the density value of *Digitaria abludens* (Fig.-29).*Cynodon dactylon* with *Eleusine indica* (Fig.-30), *Cynodon dactylon* with *Vetiveria zizanioides* (Fig.-31), *Cynodon dactylon* with *phyllanthus* *fraternus* (Fig.-32), *Digitaria abludens* with *Eleusine indica* (Fig.-34), *Digitaria abludens* with *Vetiveria zizanioides* (Fig.-35), *Digitaria abludens* with *Phyllanthus fraternus* (Fig.-36), *Eleusine indica* with *Vetiveria zizanioides* (Fig.-38), *Eleusine indica* with *Phyllanthus fraternus* (Fig.-39) and *Vetiveria zizanioides* with *Phyllanthus fraternus* (Fig.-41) also exhibited positive correlation, significant at p = 0.001. However the *Cynodon dactylon*, *Digitaria abludens*, *Eleusine indica*, *Vetiveria zizanioides* and *phyllanthus fraternus* when correlated with *Sida cordifolia* did not show significant co-relationship among them (Fig.-33, 37, 40, 42 & 43 respectively).

Thus the interrelationship study among the 6 dominant species (based on density value) revealed that out of six species, *Cynodon dactylon, Digitaria abludens, Eleusine indica, Vetiveria zizanioides* and *Phyllanthus fraternus* were dependent on each other, where as they had independent existence with respect to *Sida cordifolia*. Table-27 showed simple correlation coefficient, level of significance and regression equation for six dominant species.

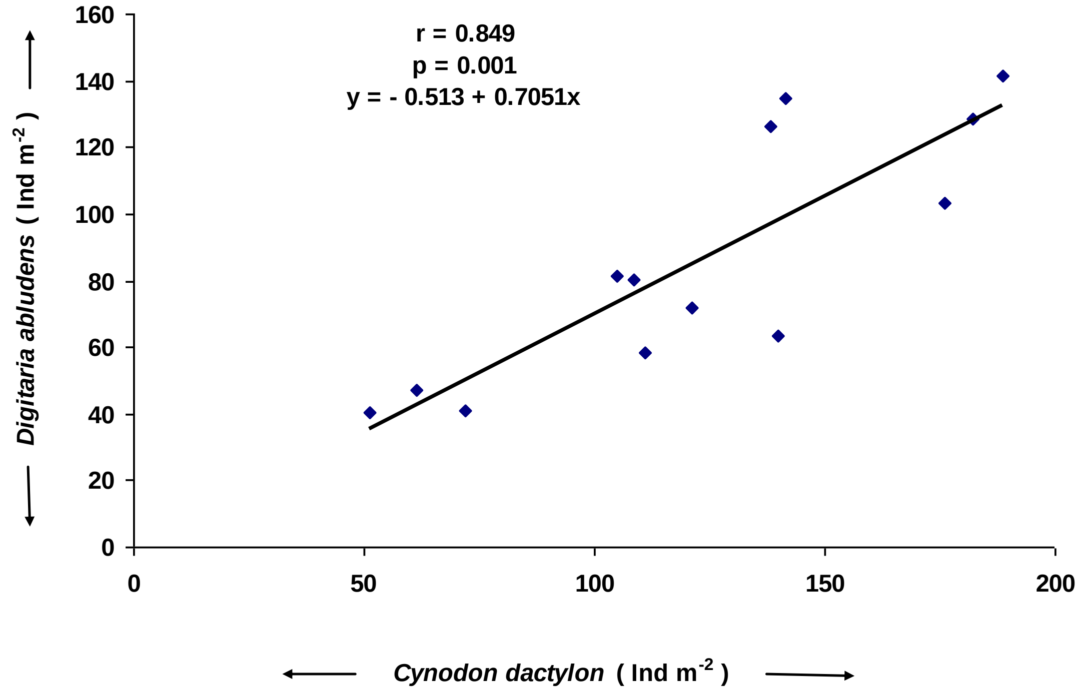

Fig.- 29. Correlation between *Cynodon dactylon* and *Digitaria abludens* .

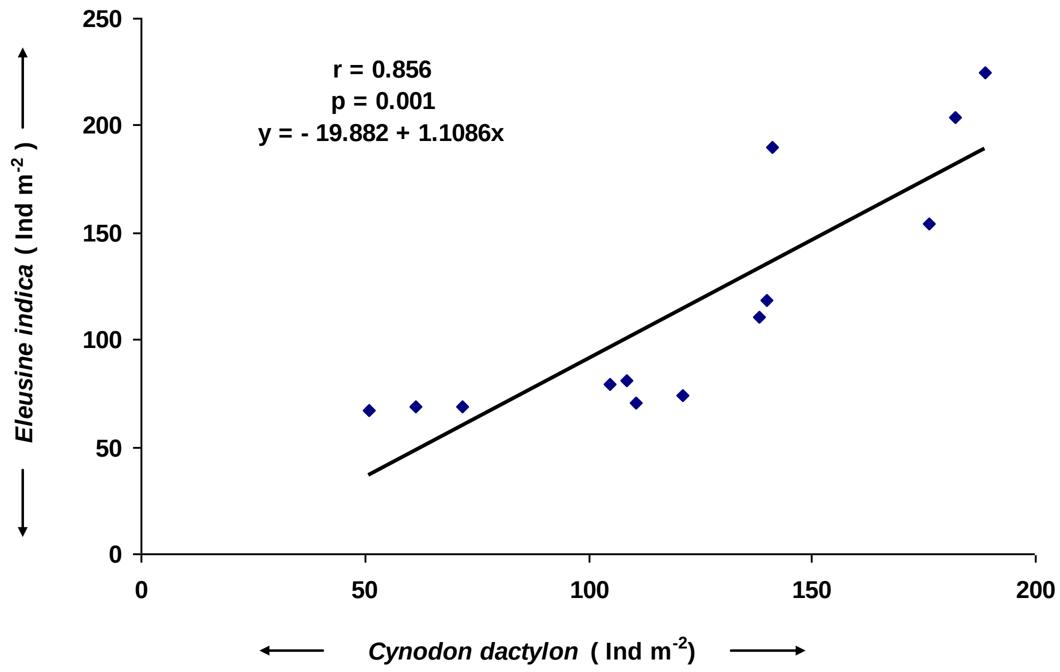

Fig.- 30. Correlation between *Cynodon dactylon* and *Eleusine indica* .

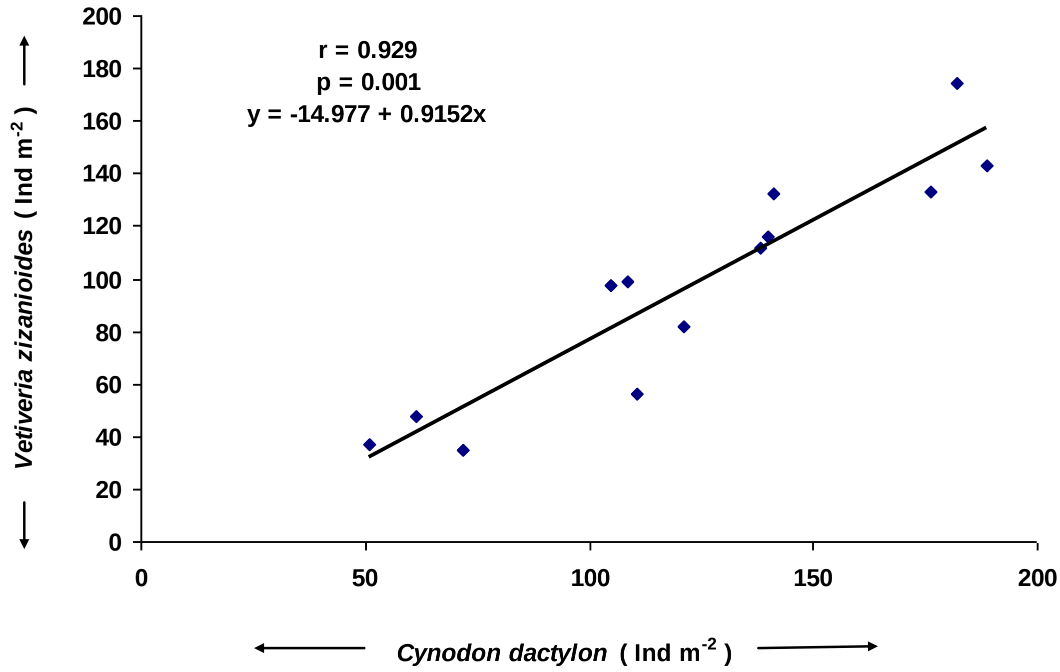

Fig.- 31. Correlation between *Cynodon dactylon* and *Vetiveria zizanioides.*

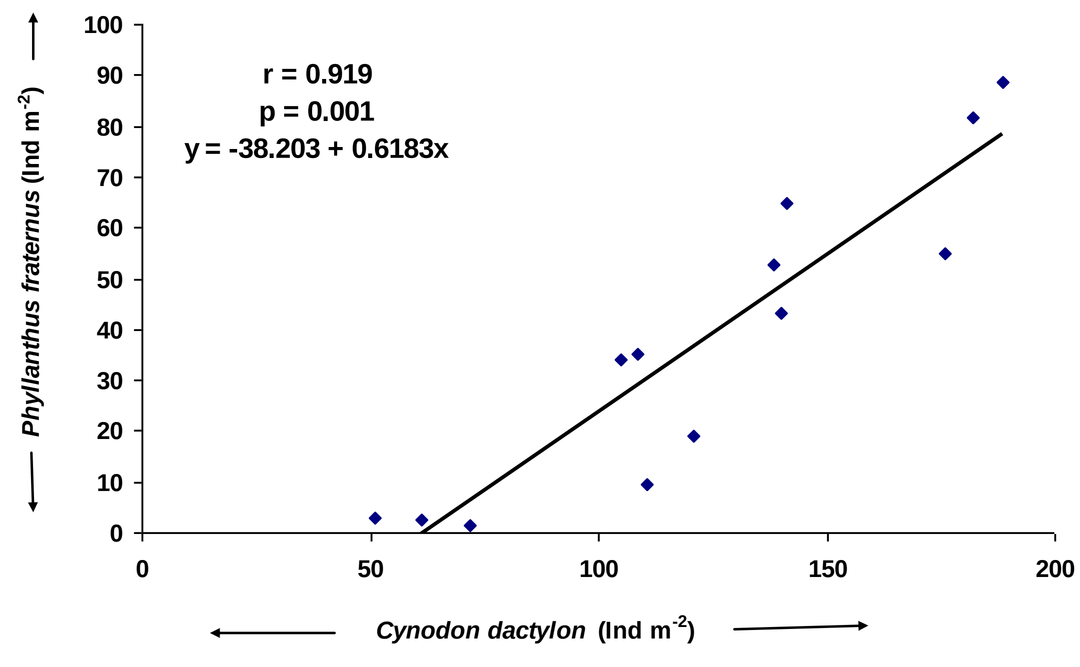

Fig.- 32. Correlation between *Cynodon dactylon* and *Phyllanthus fraternus.*

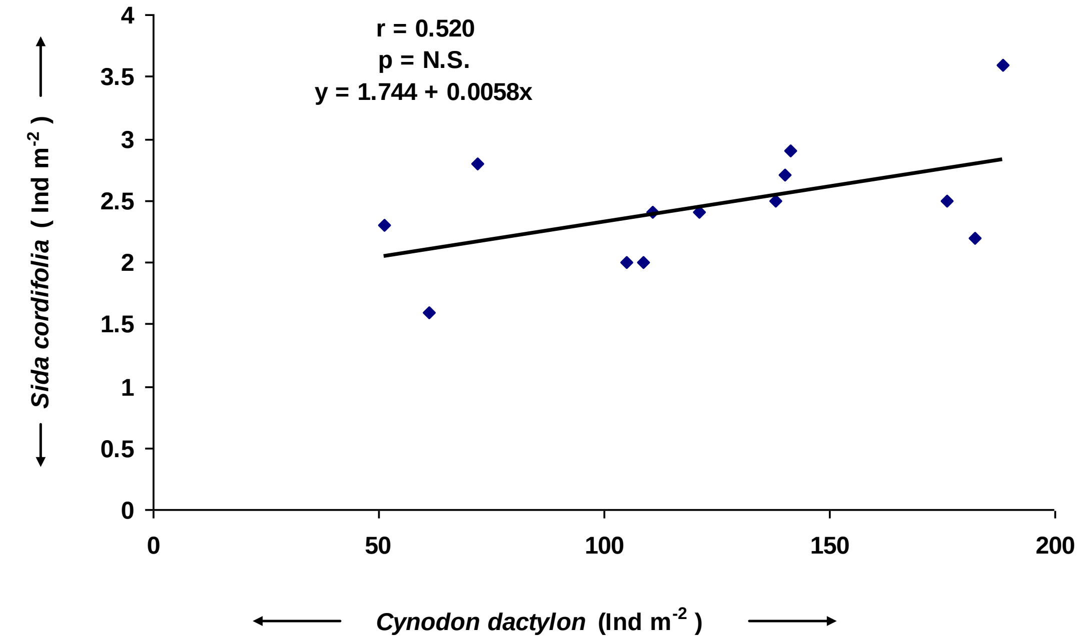

Fig.- 33. Correlation between *Cynodon dactylon* and *Sida cordifolia*.

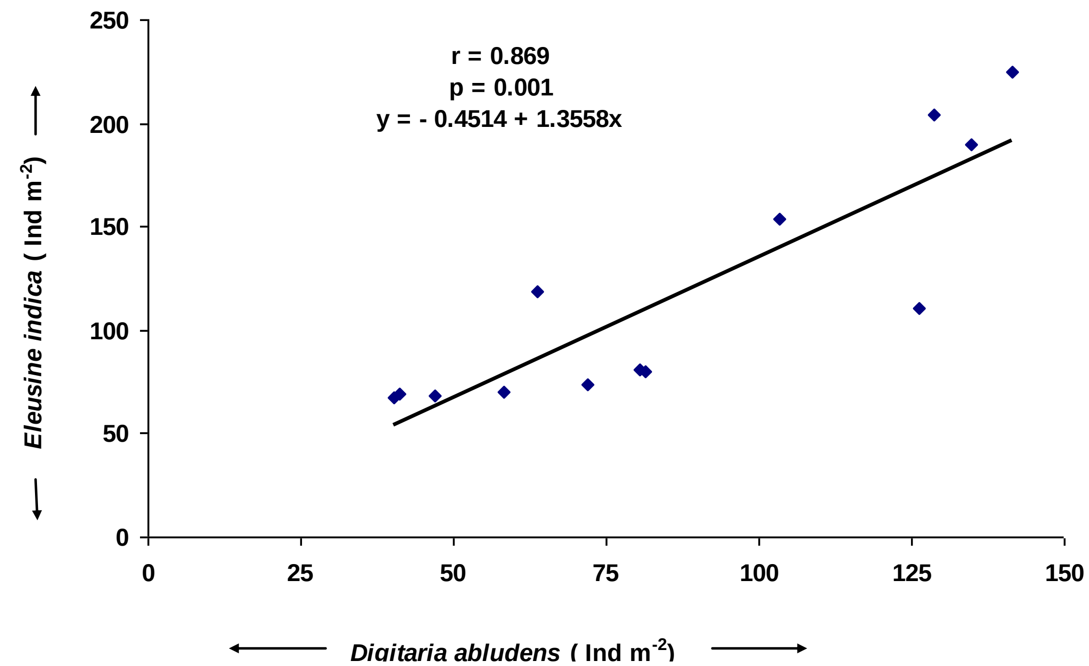

Fig.- 34. Correlation between *Digitaria abludens* and *Eleusine indica* .

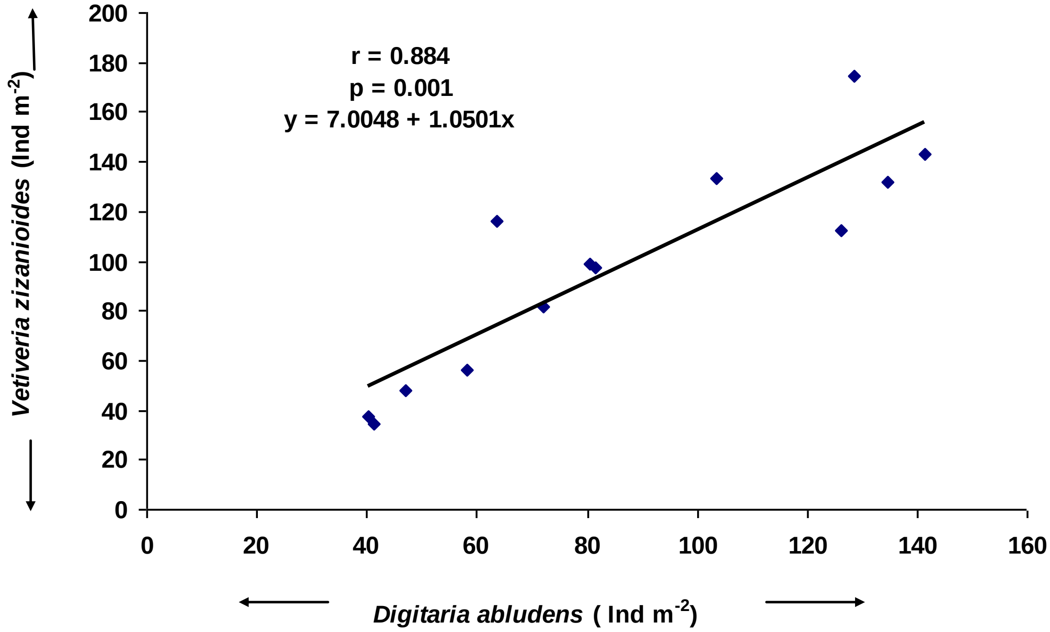

Fig.- 35. Correlation between *Digitaria abludens* and *Vetiveria zizanioides.*

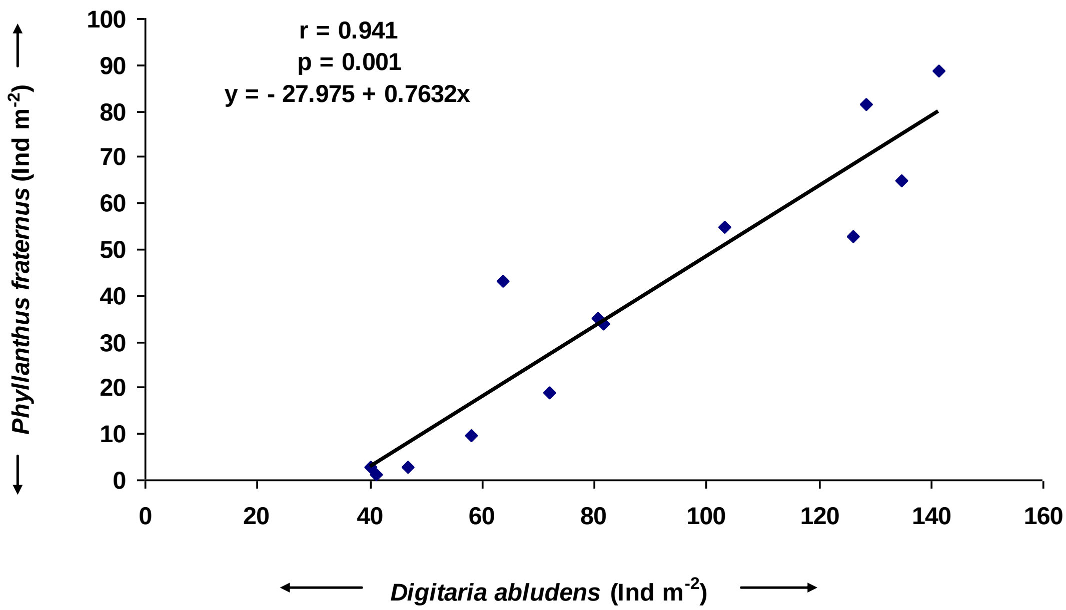

Fig. - 36. Correlation between *Digitaria abludens* and *Phyllanthus fraternus.*

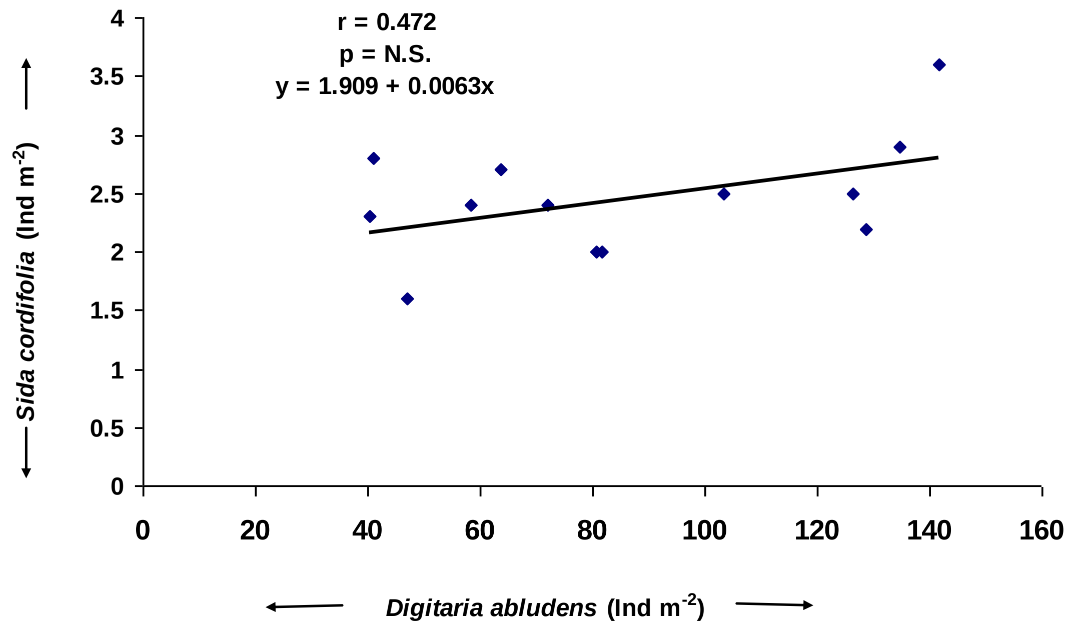

Fig.- 37. Correlation between *Digitaria abludens* and *Sida cordifolia*.

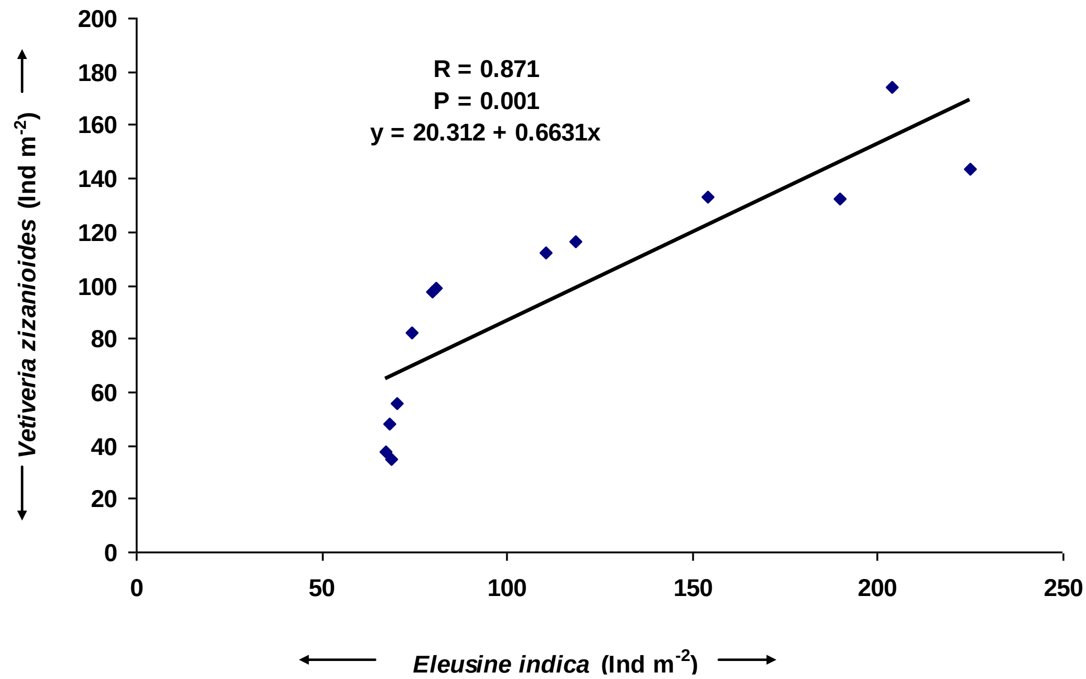

Fig.- 38. Correlation between *Eleusine indica* and *Vetiveria zizanioides*.

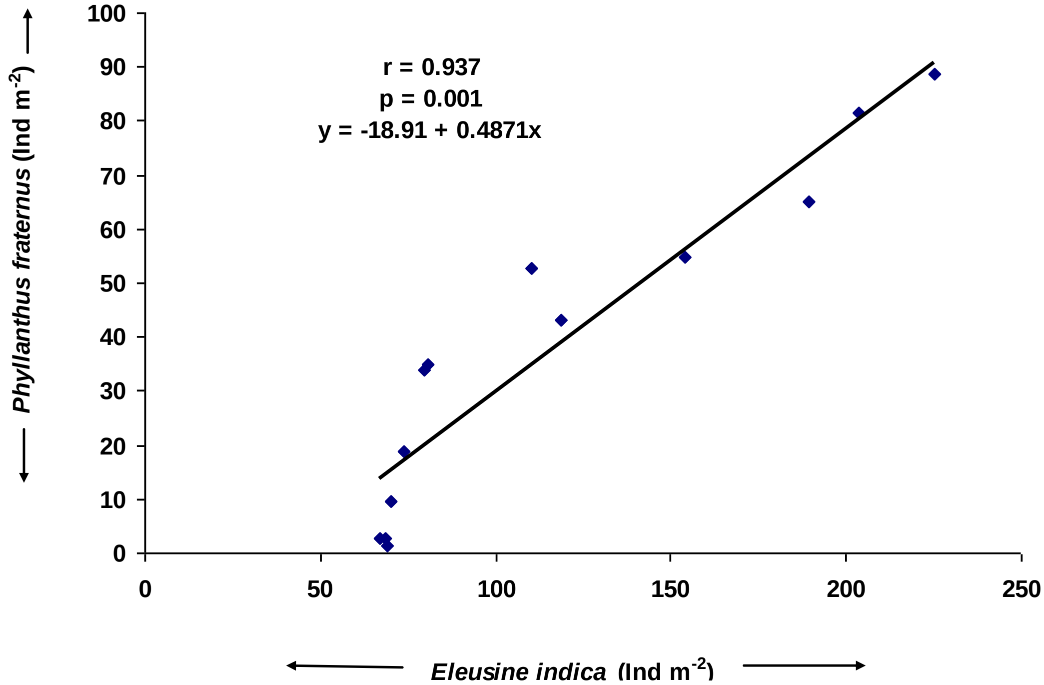

Fig.- 39. Correlation between *Eleusine indica* and *Phyllanthus fraternus.*

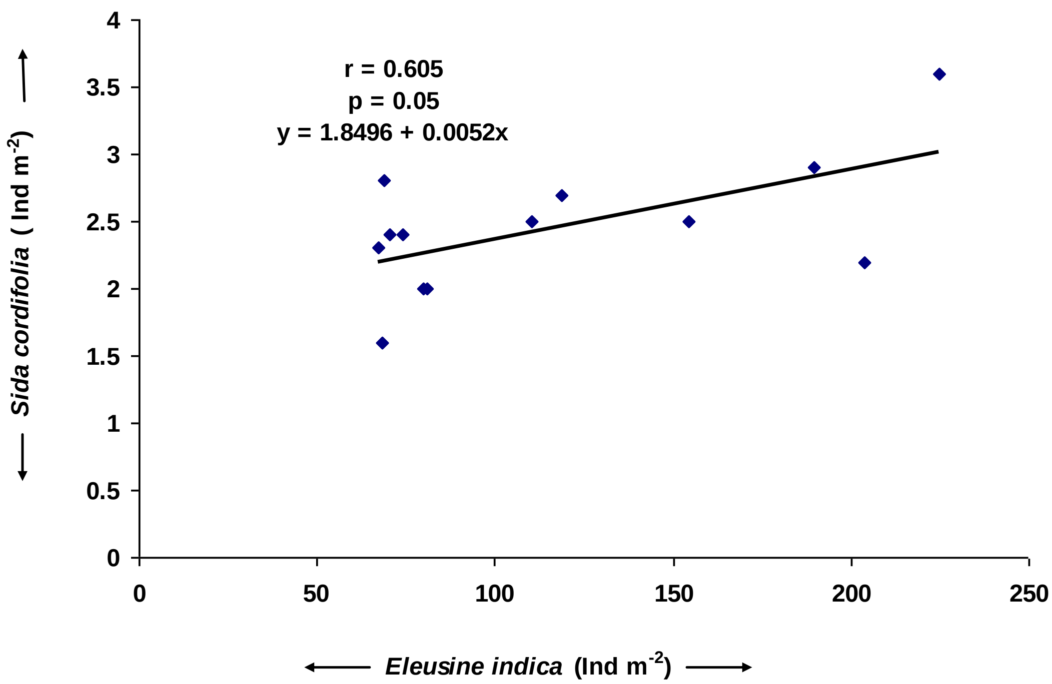

Fig.- 40. Correlation between *Eleusine indica* and *Sida cordifolia.*

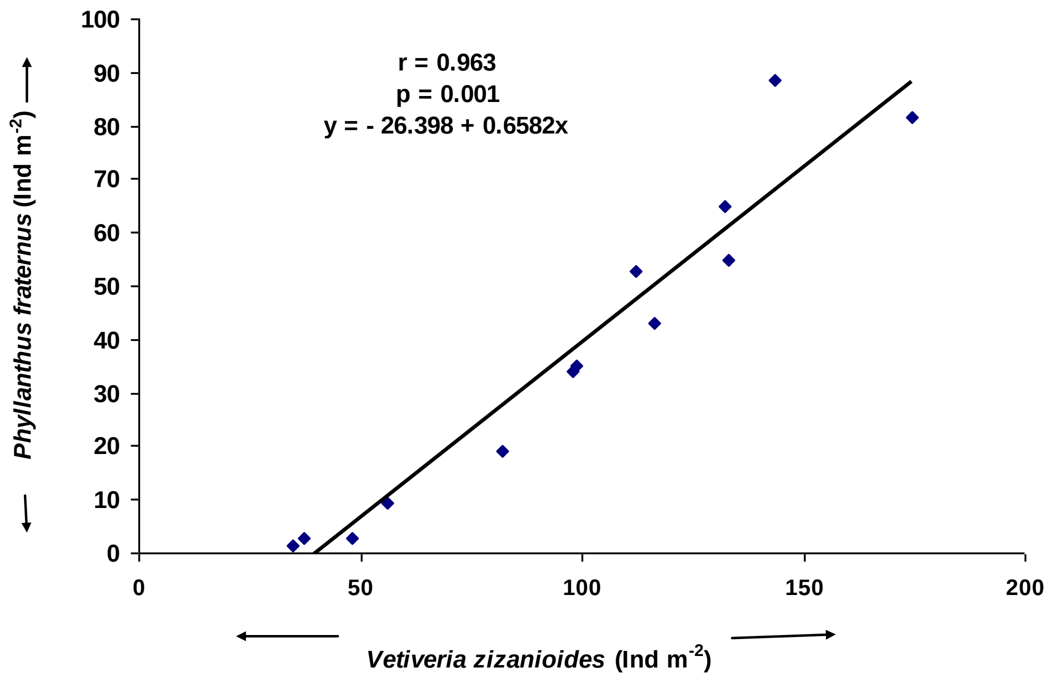

Fig.- 41. Correlation between *Vetiveria zizanioides* and *Phyllanthus fraternus.*

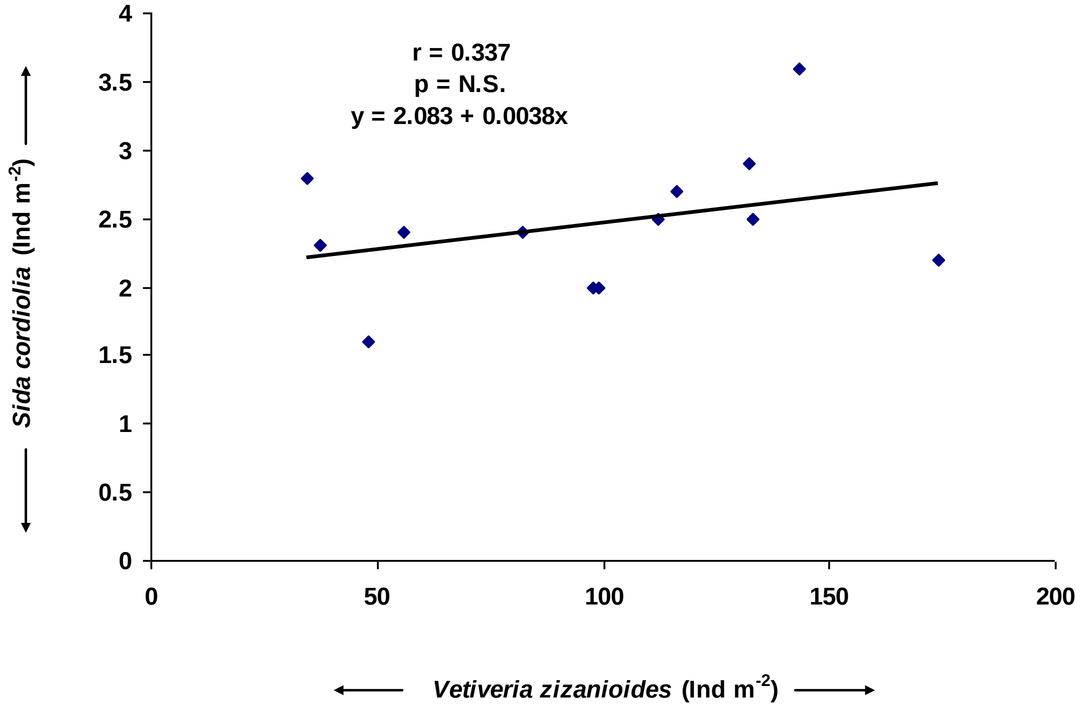

Fig.- 42. Correlation between *Vetiveria zizanioides* and *Sida cordifolia.*

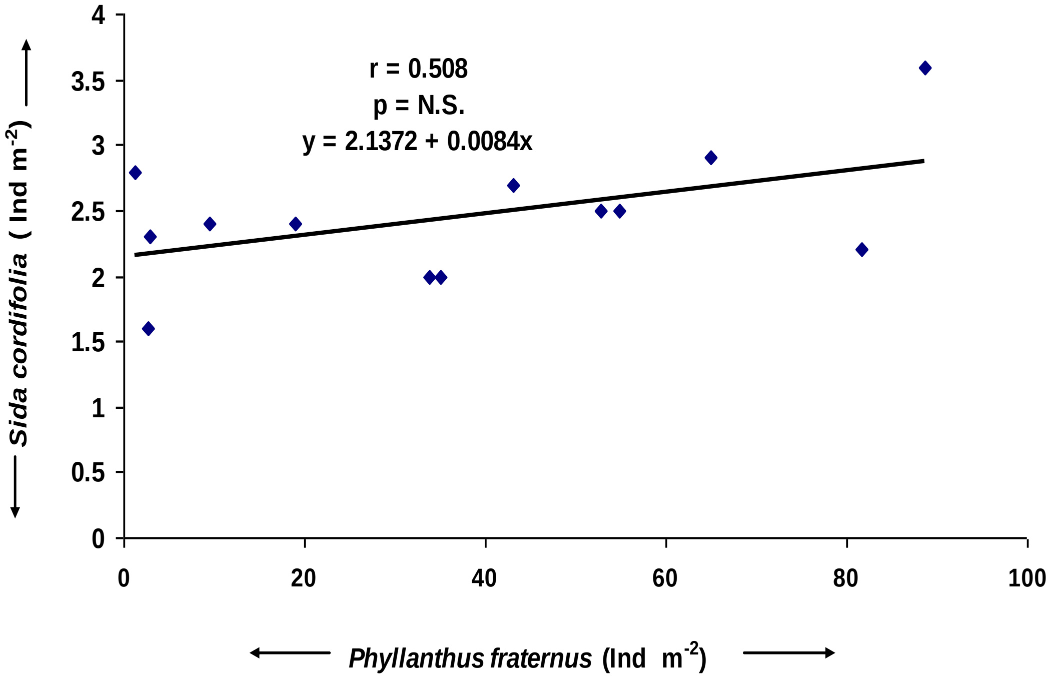

Fig.- 43. Correlation between *Phyllanthus fraternus* and *Sida cordifolia*.

Table- 27 Correlation coefficient (r), Significant level (p), Regression equation (y) of six dominant species.

Species name	*Cynodon dactylon*	*Digitaria abludens*	*Eleusine indica*	*Vetiveria zizanioides*	*Phyllanthus fraternus*	*Sida cordifolia*
Cynodon dactylon	——	r = 0.849 p = 0.001 y = - 0.513 + 0.7051x	r = 0.856 p = 0.001 y = - 19.882 +1.1086x	r = 0.929 p = 0.001 y = -14.977 + 0.9152x	r = 0.919 p = 0.001 y = - 38.203 + 0.6183x	r = 0.520 p = N.S. y = 1.744 + 0.0058x
Digitaria abludens	——	——	r = 0.869 p = 0.001 y = -0.4514 + 1.3558x	r = 0.884 p = 0.001 y = 7.0048 + 1.0501x	r = 0.941 p = 0.001 y = -27.975 + 0.7632x	r = 0.472 p = N.S. y = 1.909 + 0.0063x
Eleusine indica	——	——	——	r = 0.871 p = 0.001 y = 20.312 + 0.6631x	r = 0.937 p = 0.001 y = -18.91 + 0.4871x	r = 0.605 p = 0.05 y = 1.8496 + 0.0052x
Vetiveria zizanioides	——	——	——	——	r = 0.963 p = 0.001 y = - 26.398 + 0.6582x	r = 0.337 p = N.S. y = 2.083 + 0.0038x
Phyllanthus fraternus	——	——	——	——	——	r = 0.508 p = N.S. y = 2.1372 + 0.0084
Sida cordifolia	——	——	——	——	——	——

6.3. RELATIONSHIPS AMONG THE VARIOUS COMPARTMENTAL BIOMASS

Figure-13 to 20 represents various compartmental biomass value of the community. When the correlation was established among themselves, it was observed that live green grass biomass with live green non-grass biomass exhibited correlation (r = 0.976) significant at p = 0.001 (Fig.-44). Besides, the livegreen grass with below ground (Fig. - 45), livegreen non - grass with below ground (Fig.-46), total live green with below ground (Fig.- 47) and total above ground biomass with below ground biomass (Fig.-50) also showed correlation significant at p = 0.001. The livegreen (grass + non-grass).biomass did not show significant correlation with standing dead biomass (Fig.-48), standing dead biomass with litter biomass (Fig.-49) as well did not show significant relationship.

Thus from the above seven sets of correlation it is found that live green biomass with standing dead biomass and standing dead biomass with litter biomass was not significantly related. Whereas the live green grass biomass and live green non-grass biomass, live green biomass and below ground biomass, total above ground biomass and below ground biomass showed dependence. The correlation coefficient values, their confidence levels and regression equations for these seven sets of variables are shown in Table-28.

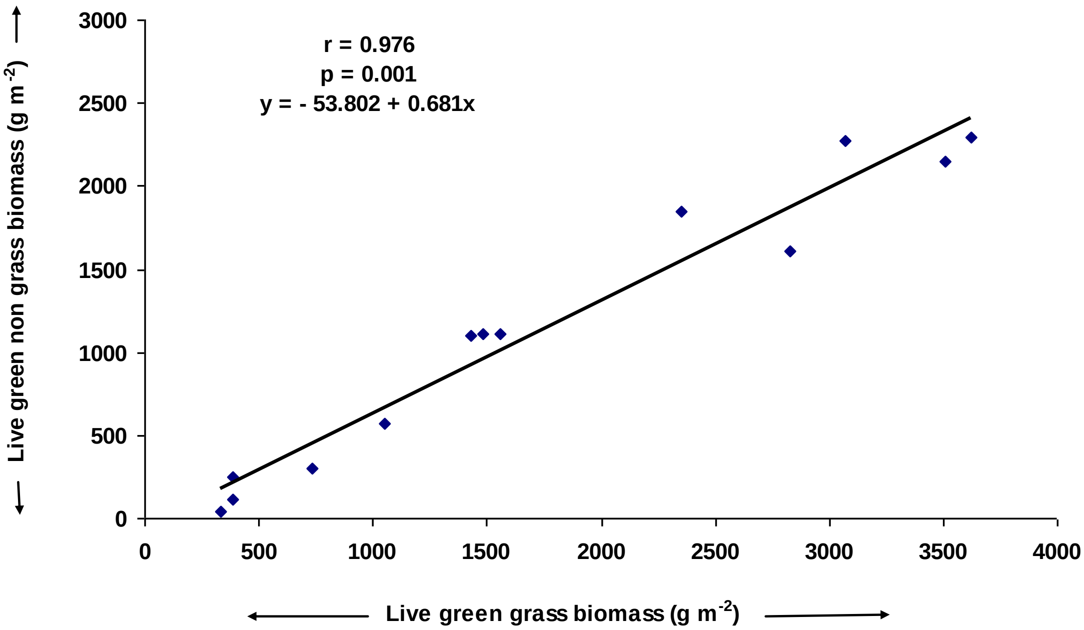

Fig.- 44. Correlation between live green grass biomass and live green non grass biomass.

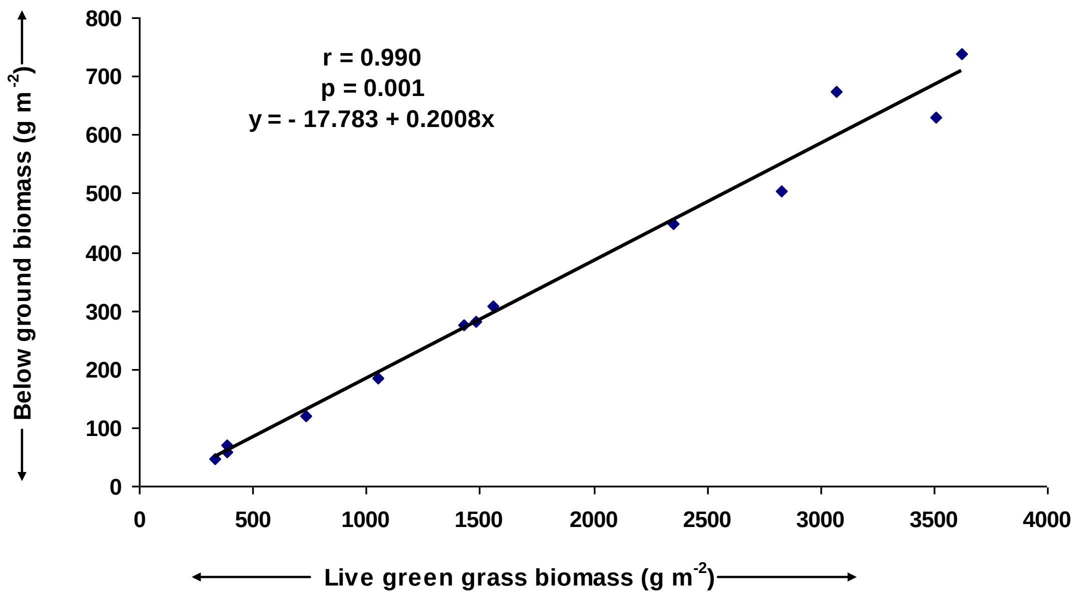

Fig. - 45. Correlation between live green grass biomass and below ground biomass.

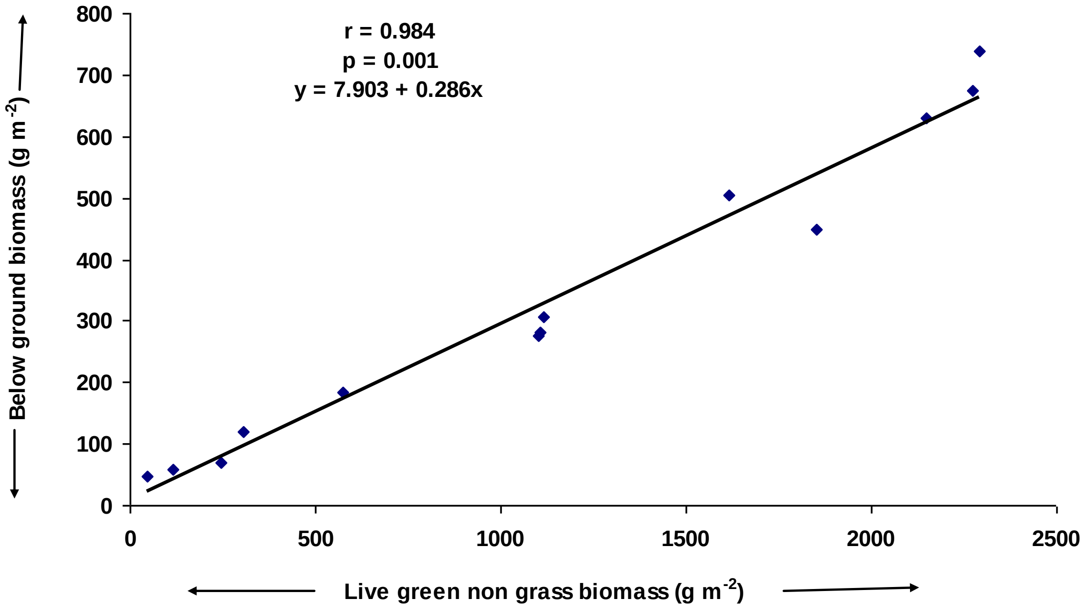

Fig. - 46. Correlation between live green non grass biomass and below ground biomass.

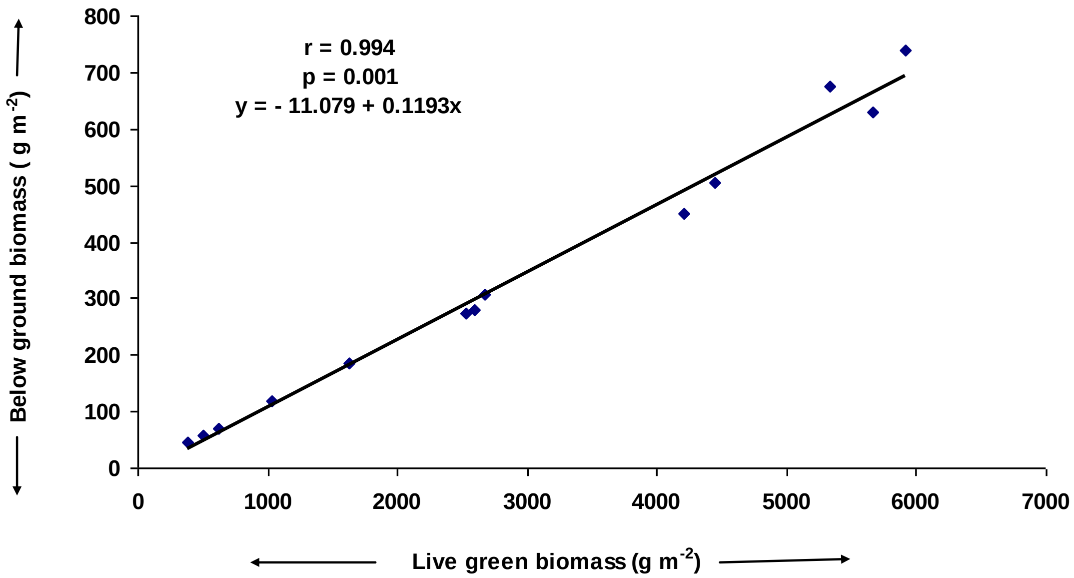

Fig. - 47. Correlation between live green (grass + non grass) and below ground biomass.

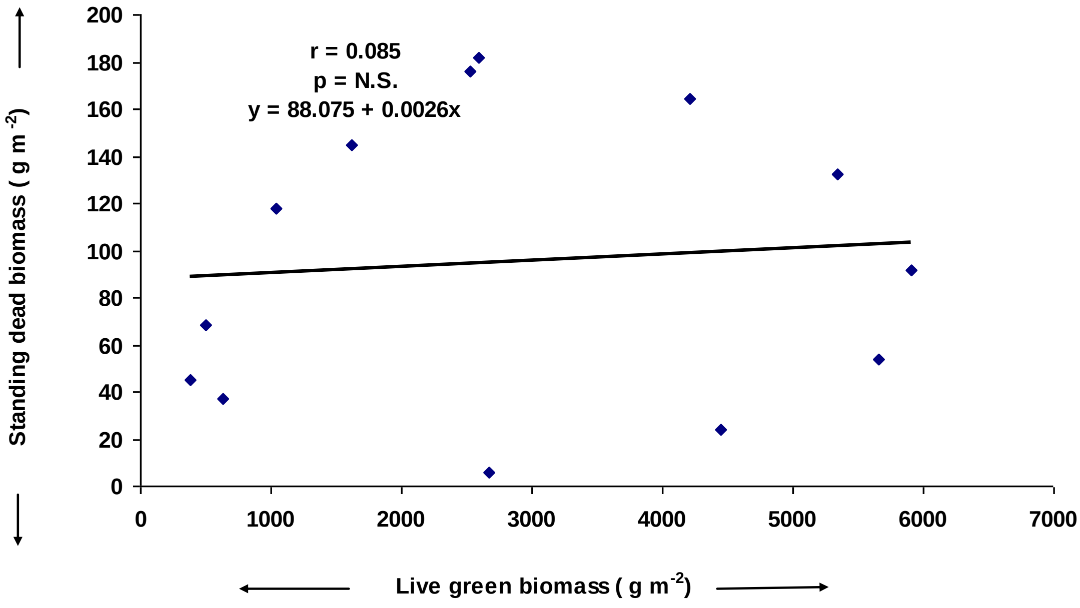

Fig. - 48. **Correlation between live green (grass + non-grass) biomass and standing dead biomass.**

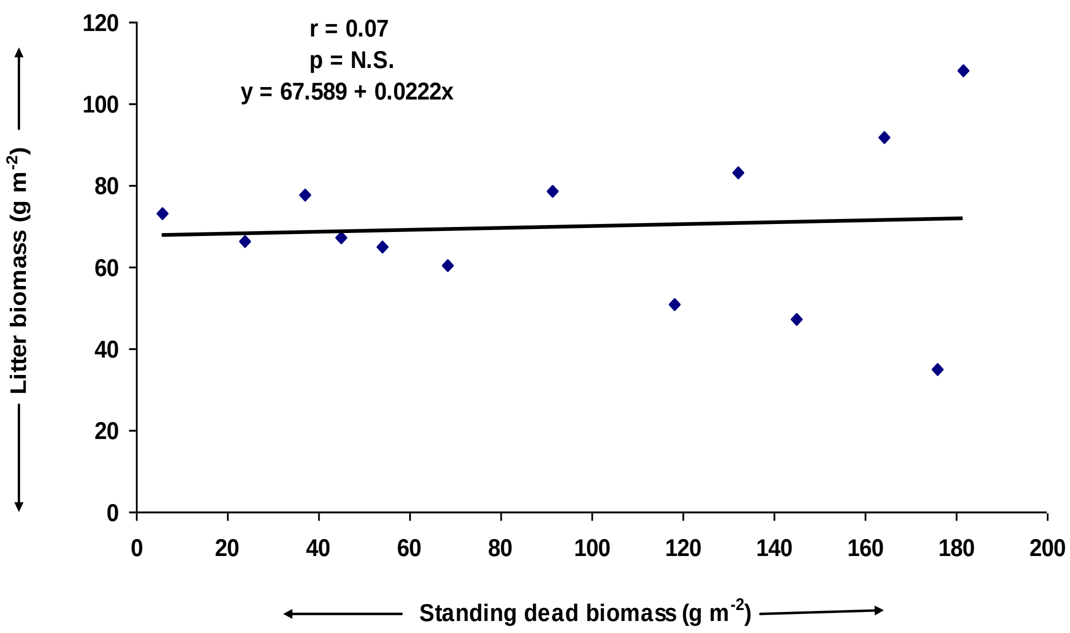

Fig. - 49. **Correlation between standing dead biomass and litter biomass.**

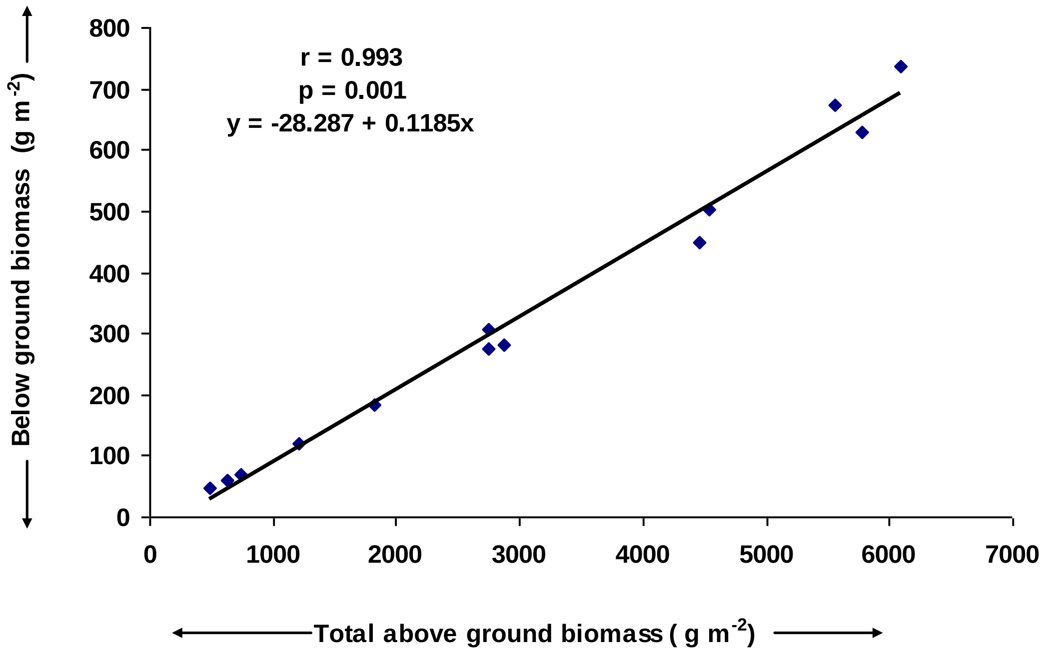

Fig. - 50. Corelation between total above ground biomass and below ground biomass.

Table - 28 Correlation coefficient, Confidence level and Regression equation of some biomass compartments.

Correlation variables	Correlation coefficient	Confidence level	Regression equation
Live green grass biomass with Live green non- grass biomass	r = 0.976	p = 0.001	y = - 53.802 + 0.681 x
Live green grass biomass with Below ground biomass	r = 0.990	p = 0.001	y = - 17.783 + 0.2008 x
Live green non-grass biomass with Below ground biomass	r = 0.984	p = 0.001	y = 7.903 + 0.286 x
Live green (grass+non-grass) biomass with Below ground biomass	r = 0.994	p = 0.001	y = - 11.079 + 0.1193 x
Live green biomass with Standing dead biomass	r = 0.085	NS	y = 88.075 + 0.0026 x
Standing dead biomass with Litter biomass	r = 0.07	NS	y = 67.589 + 0.0222 x
Total Above ground biomass with Below ground biomass	r = 0.993	p = 001	y = - 28.287 + 0.1185 x

6.4. RELATIONSHIPS AMONG THE DENSITY WITH VARIOUS CLIMATOLOGICAL FEATURES

Table-29 gives monthly density data, mean minimum atmospheric temperature, mean maximum atmospheric temperature, rainfall and wind velocity of the experimental site. When the density was correlated with mean minimum atmospheric temperature, mean maximum atmospheric temperature and wind velocity, no significant correlation were observed (Fig. - 51, 52, 54 respectively). However the density of the community with rainfall showed correlationship significant at $p = 0.05$ (Fig.-53). This indicates that the mean minimum and maximum atmospheric temperature and the velocity of wind were not dependent on the species density of the community. Besides, the value of minimum and maximum atmospheric temperature and wind velocity with respect to total density fluctuated allover the study period. The density of the community on the other hand exhibited significant correlationship ($r = 0.05$) with the amount of rainfall. It can be assumed that the rainfall and species density of the community is dependent on each other.

Table - 29 Monthly variation in total density (Ind m^{-2}), mean minimum and mean maximum atmospheric temperature (^{o}C), amount of rain fall (mm) and wind velocity (Km h^{-1}) of the experimental site during the study period.

Months	Total density	Min. temperature	Max. temperature	Rain fall	wind velocity
Dec.	1445.3	11.85	28.53	0	2.14
Jan.	966.5	11.42	28.04	4.2	2.72
Feb.	661.9	16.37	30.96	42.2	3.82
Mar.	252.4	19.39	34.36	40.6	2.99
Apr.	204.9	24.27	38.17	52.2	4.31
May.	284.2	24.81	38.98	64.6	3.61
Jun.	1385.4	24.33	35.48	325.2	4.23
Jul.	2527.9	22.84	32.9	499.8	2.72
Aug.	3176.1	23.82	33.54	375.6	2.12
Sep.	3439.8	23.44	33	461.6	3.58
Oct.	2975.1	21.56	31.49	20.6	2.25
Nov.	2364.1	17.64	31.53	19.6	1.99
Dec.	1496	9.93	27.1	0	2.54

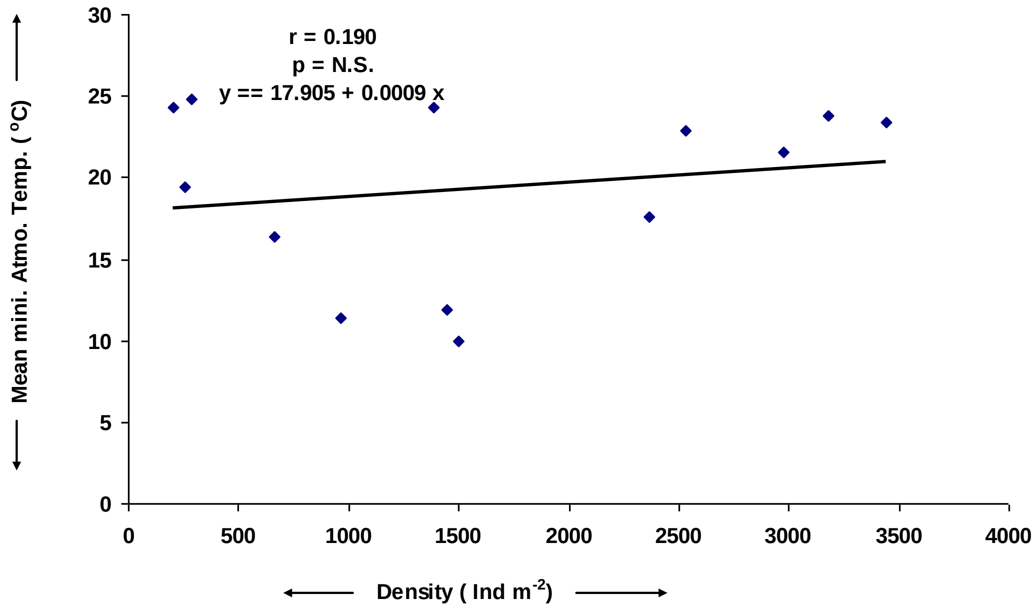

Fig.- 51. Correlation between total density and mean minimum atmospheric temperature (°C).

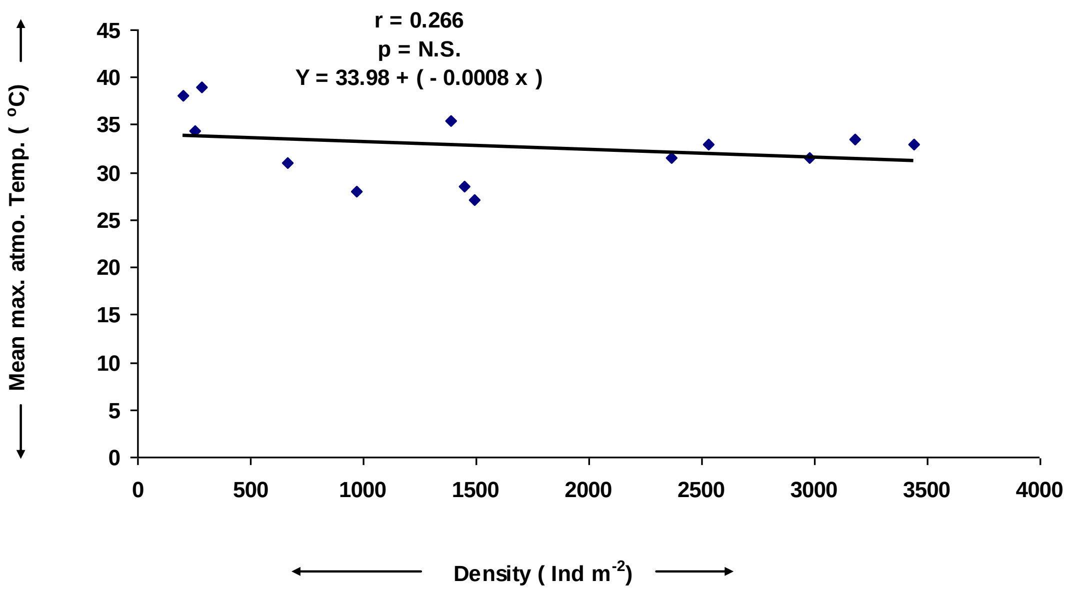

Fig.- 52. Correlation between total density and mean maximum atmospheric temperature(°C).

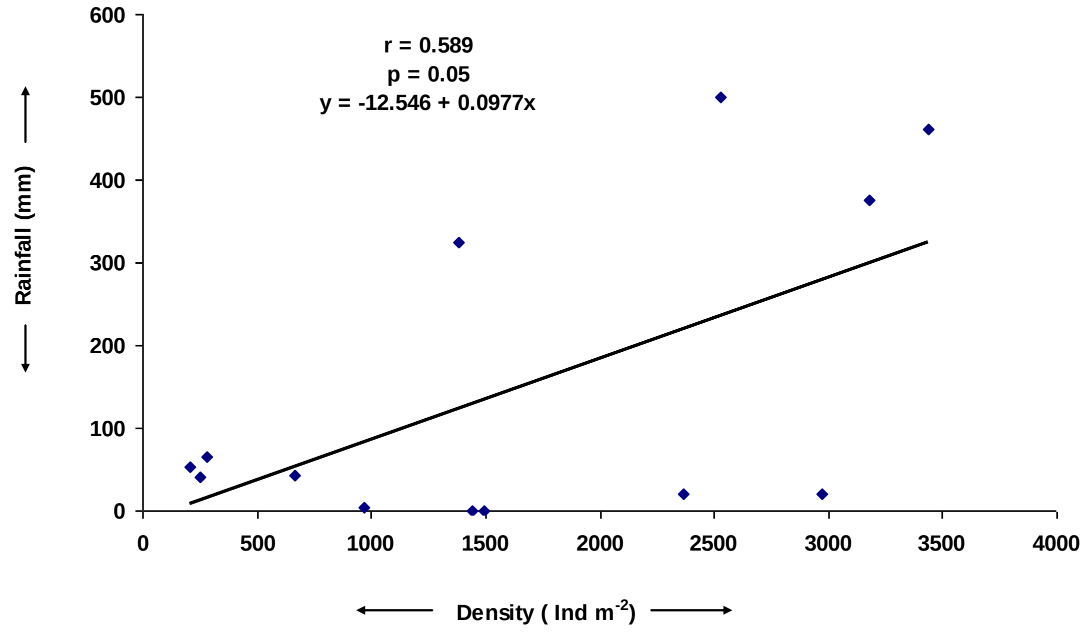

Fig.- 53. Correlation between total density and amount of rainfall (mm).

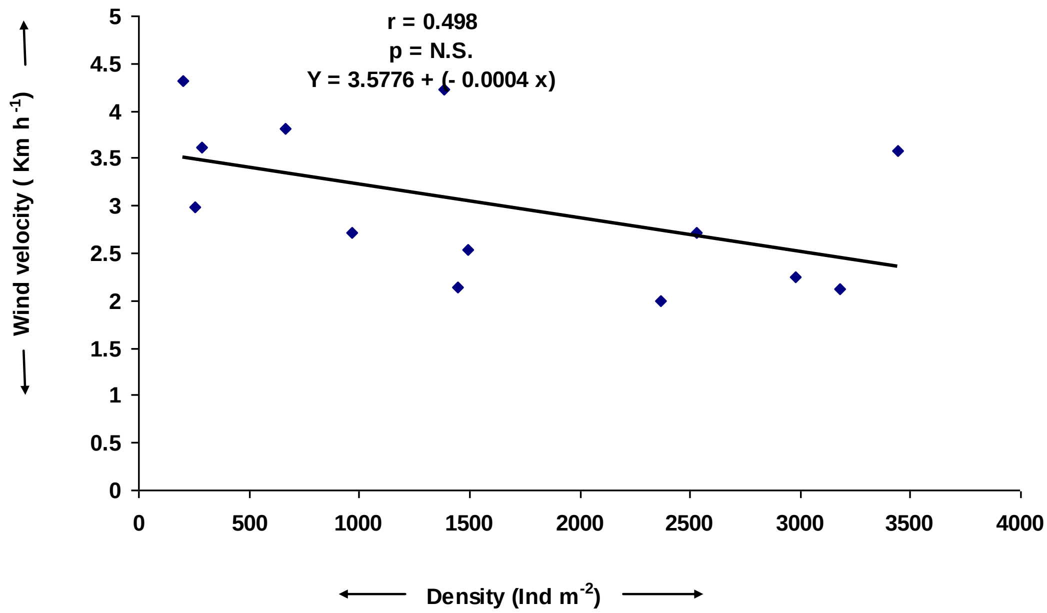

Fig.- 54. Correlation between total density and wind velocity (Km h^{-1}).

6.5 RELATIONSHIPS AMONG THE DENSITY WITH VARIOUS BIOMASS COMPARTMENTS

Table-30 represents the monthly density and biomass values of the community. While studying the correlation among total density and standing dead biomass (Fig.-58) and total density and litter biomass (Fig.-59) no significant correlation was observed. It can be assumed that the standing dead biomass and litter biomass did not depend on the density of the community.

However the density of grasses with live green grass biomass (Fig.-55), density of non grasses with live green non-grass biomass (Fig.-56), total density (grasses + non-grasses) with total live green biomass (Fig.-57), total density with total above ground biomass (Fig.-60), total density with below ground biomass (Fig.-61) and total density with total biomass (Fig.-62) showed positive correlations significant at p= 0.001. This indicates that the density of grasses and live green grass biomass, density of non-grass and live green non-grass biomass, total density and total live green biomass, total density and total above ground biomass, total density and below ground biomass, total density and total biomass, all were dependent on each other as they showed significant correlation among themselves. Table-31, showed the correlation coefficient, level of significance and regression equation among the density and various biomass compartments of the community.

Table - 30 Monthly variation in density (Ind m^{-2}) and biomass (g m^{-2}) values of the experimental site.

Months	Density (Ind. m^{-2})			Biomass (g m^{-2})							
	Grasses	Non grasses	Total	Live green grasses	Live green non grasses	Total live green	Standing dead	Litter	Above ground	Below ground	Total
Dec.	1057.1	388.2	1445.3	1428.47	1101.7	2530.17	175.84	35.12	2741.13	274.76	2980.77
Jan.	790.2	176.3	966.5	1052.17	571.84	1624.01	144.95	47.28	1816.24	184.09	1953.05
Feb.	581	80.9	661.9	731.89	306.05	1037.94	118.13	51	1207.07	118.86	1274.93
Mar.	236.7	15.7	252.4	387.97	114.05	502.02	68.21	60.56	630.79	58.91	629.14
Apr.	199.8	5.1	204.9	332.94	45.68	378.62	44.73	67.24	490.59	46.42	469.77
May.	239.5	44.7	284.2	382.51	245.11	627.62	37.03	77.84	742.49	70.13	734.78
Jun.	1099.9	285.5	1385.4	1555.85	1113.66	2669.51	5.5	73.24	2748.25	306.68	2981.69
Jul.	1999.6	528.3	2527.9	2829.94	1614.13	4444.07	23.75	66.56	4534.38	503.55	4971.37
Aug.	2432.4	743.7	3176.1	3509.57	2148.67	5658.24	53.92	65.08	5777.24	628.68	6340.84
Sep.	2568.2	871.6	3439.8	3622.47	2291.78	5914.25	91.43	78.76	6084.44	737.8	6743.48
Oct.	2210.5	764.6	2975.1	3066.5	2271.19	5337.69	132.24	83.4	5553.33	674.43	6144.36
Nov.	1717.2	646.9	2364.1	2353.65	1852.63	4206.28	164.12	92.04	4462.44	448.93	4819.33
Dec.	1106.1	389.9	1496	1482.05	1108.14	2590.19	181.56	108.08	2879.83	280.49	3052.24

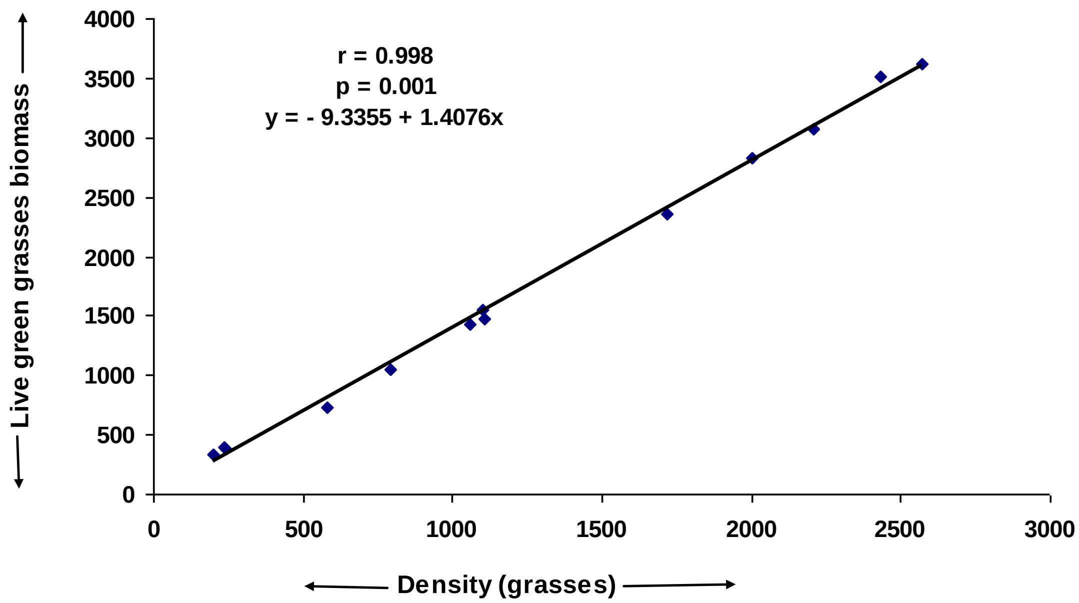

Fig.- 55. Correlation between density of grasses and live green grasses biomass.

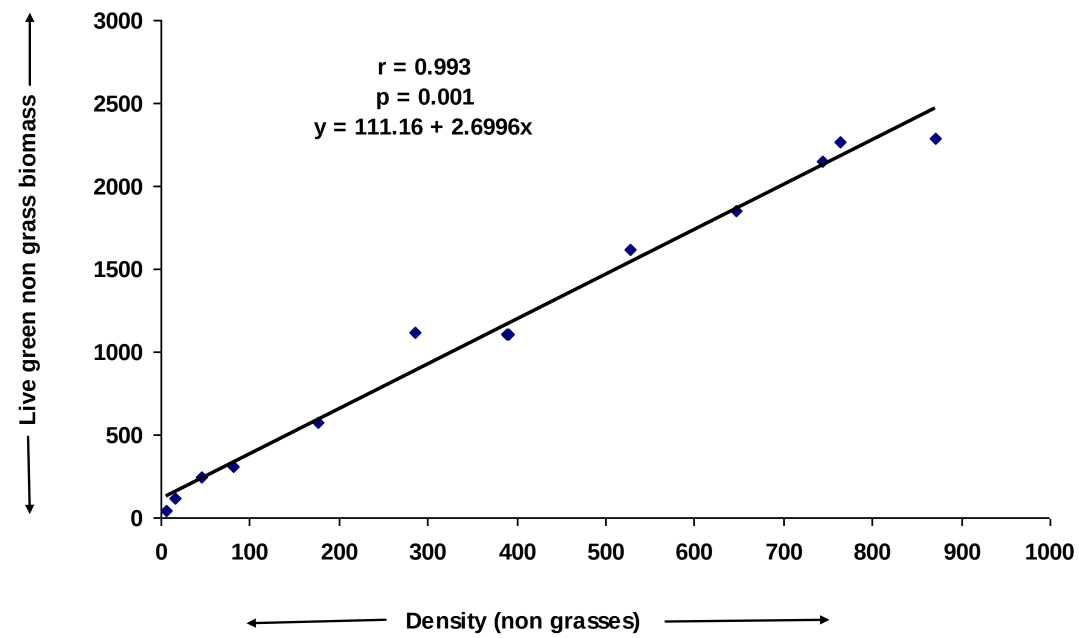

Fig.- 56. Correlation between density of non grasses and live green biomass.

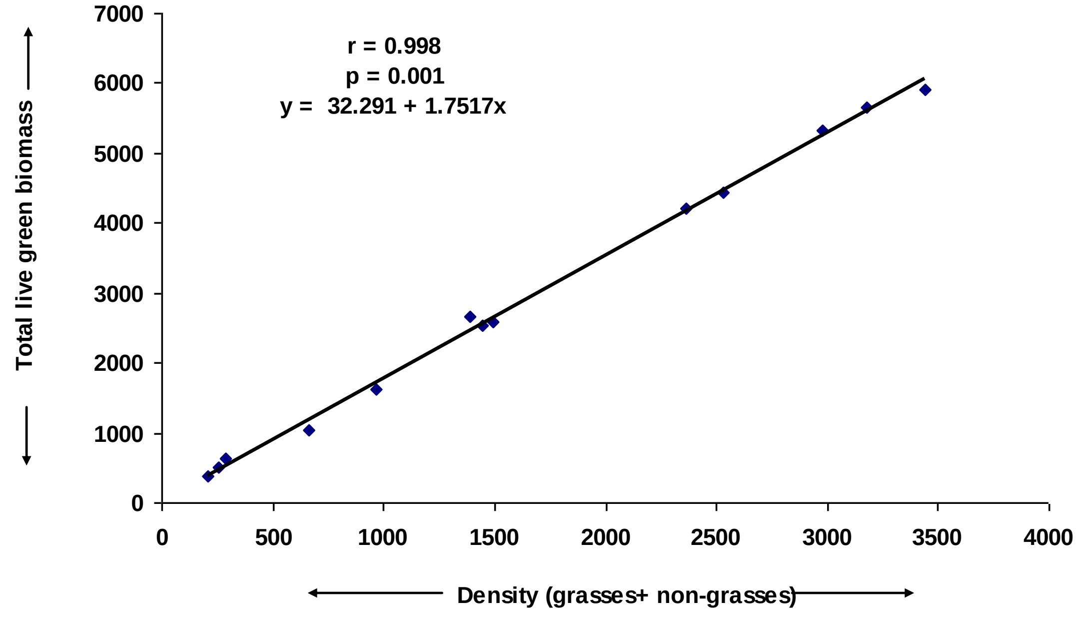

Fig.- 57. Correlation between total density and total live green biomass.

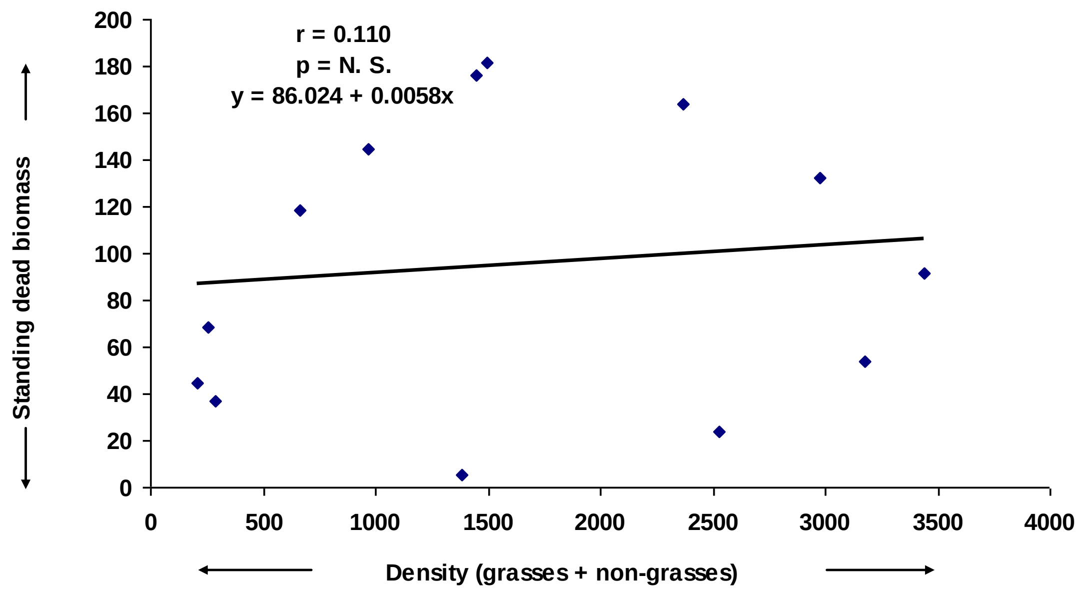

Fig.- 58. Correlation between total density and standing dead biomass.

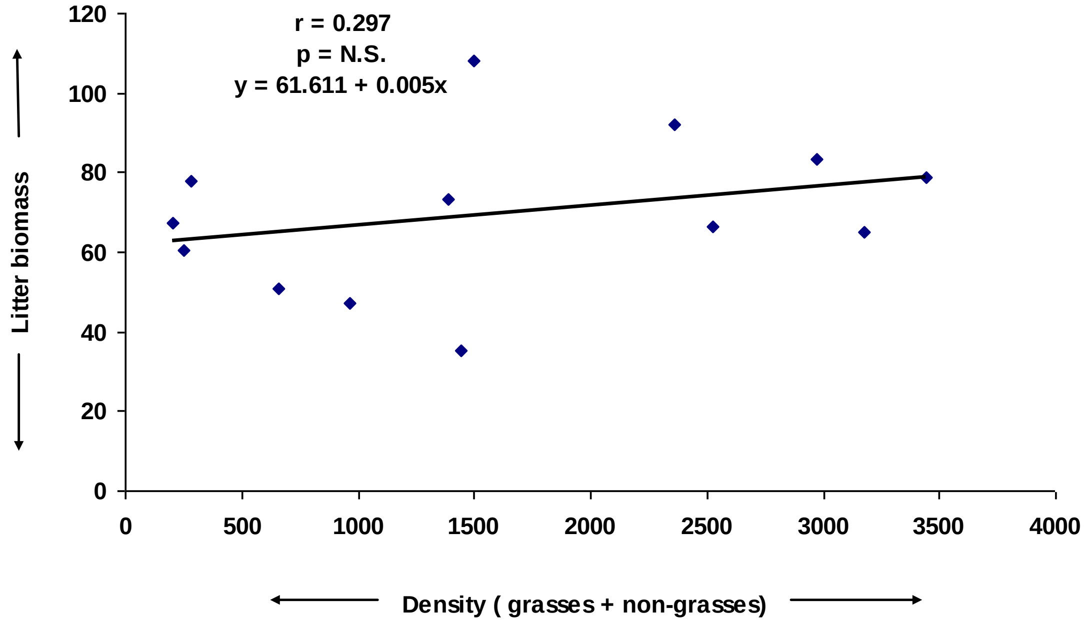

Fig.- 59. Correlation between total density and litter biomass.

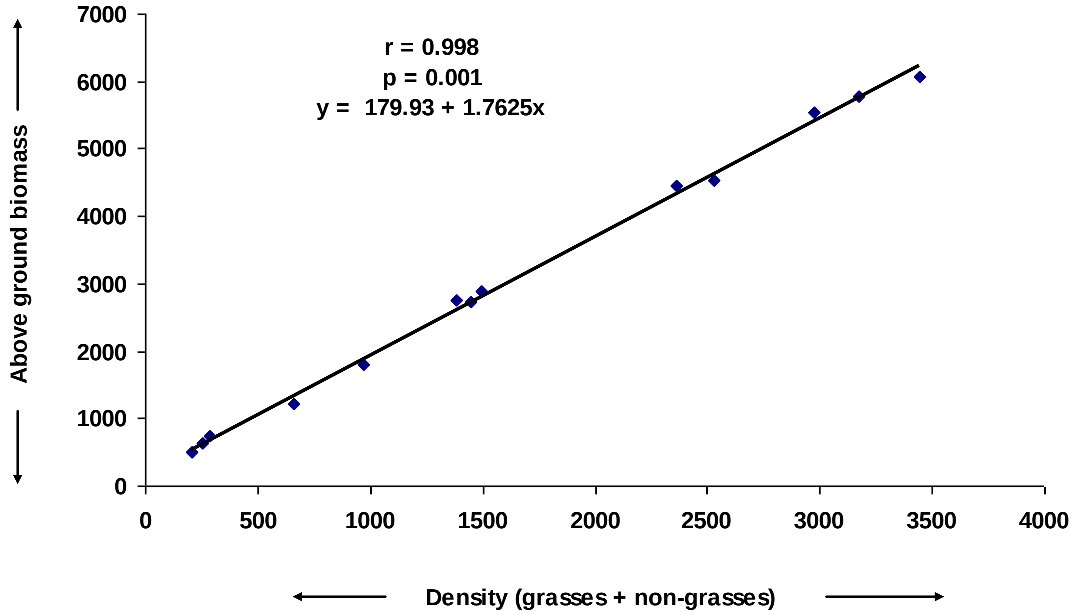

Fig.- 60. Correlation between total density and total above ground biomass.

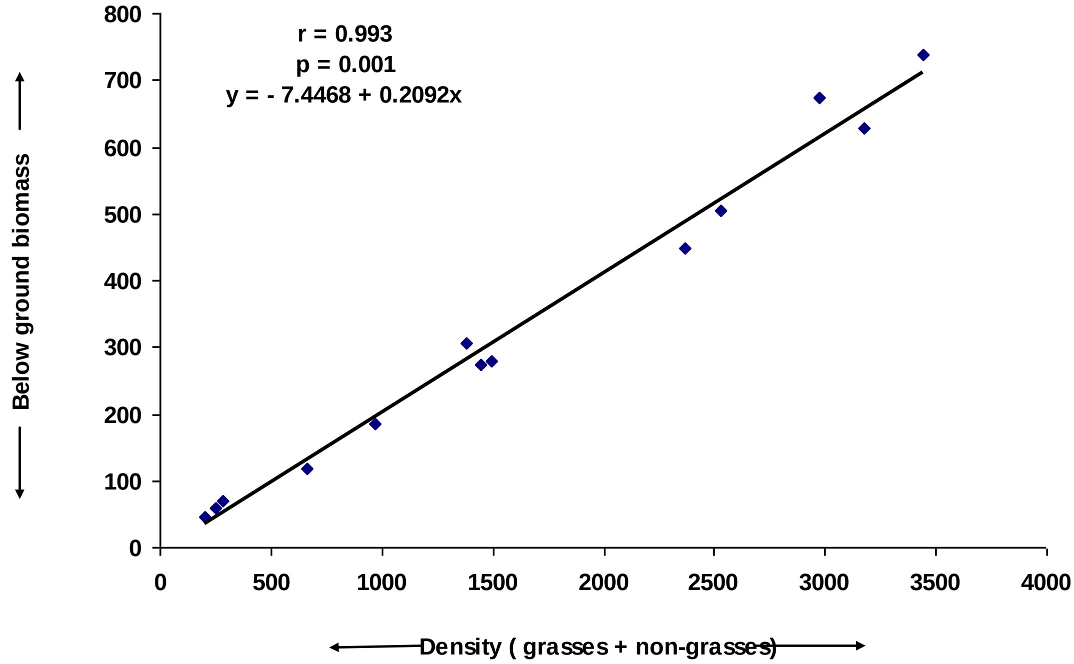

Fig.- 61. Correlation between total density and below ground biomass.

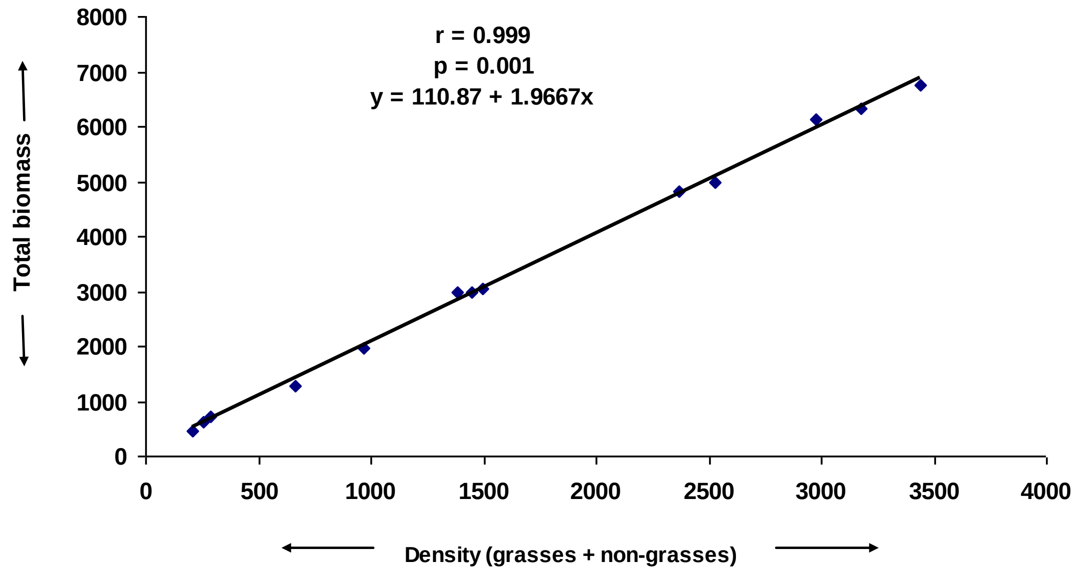

Fig.- 62. Correlation between total density and total biomass.

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Grasslands control soil erosion, restore soil fertility and are regarded as the cheapest source of nutrients for livestock. They are rich in proteins, vitamins and minerals. Some of the plant species are used as fodder for grasshoppers, rabbit, deer, domestic animals i.e. cow, buffalo, goat, sheep and many other herbivore. Various species of grasses are being used for paper and pulp making industries. A number of species are used to produce aromatic oil. Some of the species are used as herbal medicines also. Besides, grasses increase the water holding capacity of the soil and control the runoff especially in arid and semiarid regions. The life-form and primary productivity of a grassland community provide necessary data and information to the observers, researchers and planners to build up a correct ecological model of an area. The ecologist and environmentalist in both developed and developing countries are increasingly being engaged now - a - days in the research project relating to analysis of grassland community with a view to conserve nature through various environmental research programmes. Much importance is laid on the life-form and primary productivity of various grassland communities and their interaction with various biotic and abiotic factors affecting the flora of a particular habitat. Reports are available on the life-form and primary productivity of some grassland communities of the eastern region of the Orissa. However, no work has been made so far, on the ecology of grassland community especially in northern belt of the state. Keeping all these facts into consideration, an attempt was made to study the life-form and primary productivity of a grassland community from December 2006 to December 2007 in the northern part of the state “Orissa”.

The experimental site was selected at Rangamatia, situated at a distance of 15 kms away from North Orissa University and 11 kms from Baripada, the District headquarter of Mayurbhanj in the state of Orissa. It is located at 86^0 41’ E longitudes and 21^0 56’ N latitude. The altitude of the site is above 135.7m.The experimental site was protected from grazing and human interferences for a period of 1 year prior to start of the investigation. The climate of the locality is monsoonal with three distinct seasons viz. rainy (July to October), winter (November to February) and summer (March to June). The total rainfall during the study period was 1906.2 mm of which a maximum of 499.8 mm was recorded during July. The minimum and maximum atmospheric temperature during the study period was found to be normal. December showed the lowest temperature (9.93 ^{0}C) whereas May experienced the highest temperature (38.9^{0}C).The wind velocity was maximum (4.31 km h^{-1}) during April and minimum (1.99 km h^{-1}) in the month of November. The soil of the experimental site was found to be moderately acidic (pH = 5.5). The available phosphorus content was high (1.2 ppm) in lower soil and minimum (0.5 ppm) in middle soil profile. The potassium showed gradual reduction from surface (100.3 ppm) to middle (87.6 ppm) and then to lower (81.1 ppm) soil depth. The over all organic carbon (0.61%), nitrogen based on organic carbon content (0.5 to 0.75%), and available potassium (59 to 140 ppm) were found medium where as the available phosphorus content was found to be very low (< 2 ppm) in the soil.

The floristic composition of the grassland community comprises with 36 species. Out of which, 15 species were grasses and 21 species were non-grasses. The community exhibited almost all the species during the month of July, August, September, October and November whereas April experienced a less number of 6 species (4 grasses and 2 non grasses). *Cynodon dactylon, Digitaria abludens*, *Eleusine indica*, *Vetiveria zizanioides* among the grasses and *phyllanthus fraternus* and *Sida cordifolia* among the non-grasses were found dominant during the study period. The life-form of the community consisted of the class chamaephyte 27.78%, hemicryptophyte 25%, cryptophyte (geophyte) 16.67% and the therophyte 30.55%. Phanerophytes were found to be absent. The stratification of the study site revealed all the 3 types of strata in the grassland community. Out of 36 species, 9 species were found to be top strata where as middle and lower strata comprised of 10 and 17 species respectively.

The structural attributes i.e. frequency, density, abundance etc. of the experimental grassland community were determined month wise 1m x 1m size quadrats was used for this study as determined by species area curve. *Cynodon dactylon*, *Digitaria abludens*, *Eleusine indica*, *Vetiveria zizanioides* among the grasses and *Phyllanthus fraternus* and *Sida cordifolia* among the non - grasses exhibited higher percentage of frequency through out the sampling period. The community represented high density value (3439.8 Ind m^{-2}) in the month of September. The density value of the community showed gradual decline in trend from December to January, then to February, March and lowest in the month of April. Thereafter the value increased from April to May, June, July, August and then to September. Again a declined trend of density value was observed from September to December. The grasses showed highest density values as compared to that of the density of non-grasses.

The basal area was found to be maximum in the month of October and minimum in the month of April. The value showed a gradual decline in trend from December to January to February then to March and lowest in the month of April. Thereafter, an increasing trend in value was observed from April onwards and attained a peak during October. Again a declined trend of basal area was noticed till to the end of the sampling period (December). The total basal cover of the experimental site showed minimum during April and maximum in the month of September. The basal covers gradually decreased from December to April and then it increases till September and onward the value exhibited a decline trend till to the end of the sampling period.

The grasses showed higher importance value index (IVI) than that of the non - grasses. The grasses contributed lowest IVI in the month of September (154.839) and non-grasses in the month of April (59.396). The IVI for grasses gradually increases from December to April and then it declined up to September and onwards it showed again an increasing trend till to the end of the sampling period. However, the IVI of non - grasses showed an opposite trend i.e. the value decreases from December to April, then an increasing trend of values were marked from April to September. Thereafter it decreases till to the end of the sampling period. The grasses exhibited peak IVI in the month of April (240.591) and non-grasses in the month of September (145.146).

The density based diversity index showed, the highest diversity index value during August (1.325) and lowest in the month of April (0.661). The value gradually decreased from January to April and then it started increasing till August. Thereafter the value exhibited a decline trend till to the end of the sampling period. The dominance index based on density value on the other hand showed an opposite trend compared to diversity index value. The dominance value was maximum in April (0.243) and minimum in August (0.066). A negative correlation was found between diversity and dominance indices ($r = -0.893$, $p = 0.001$).

Sequential harvest method was employed for the determination of biomass in the last week of every month. The live green biomass (grasses, non grasses and total live green) of the study site showed gradual declined in trend from December to January, February, March and lowest in the month of April. Thereafter it increased and attained a peak during September and onwards a gradual decreased in trend was observed till to the end of the sampling period.

The standing dead biomass gradually decreased from December to June and onwards, the value started an increasing trend and showed the peak in the month of December (181.56 g m^{-2}). Minimum standing dead biomass was recorded in the month of June (5.5 g m^{-2}).

The litter biomass of the community exhibited an increasing trend from December to January, February, March, April and May. Thereafter the value showed a declined trend till August (65.08 g m^{-2}).The litter biomass again showed an increasing trend showing a maximum of 108.08 g m^{-2} during the last sampling period i.e. in the month of December.

Total above ground biomass is the sum total of live green biomass and standing dead biomass. It was found to be minimum in the month of April (423.35 g m^{-2}) and maximum during September (6005.68 g m^{-2}). The sequence of monthly above ground biomass values showed similar trend to that observed in case of live green biomass values.

The below ground biomass values decreased from December (274.76 gm^{-2}) to April (46.42 g m^{-2}) and onwards the values showed gradual increased in trend till September (737.8 g m^{-2}) and then decreased till December.

The total biomass of the community ranges from 469.77 g m^{-2} to 6743.48 g m^{-2}. The maximum biomass was observed in September and minimum in the month of April. A gradual decrease in total biomass value was found from December to April, then the value started increasing showing a peak during September and onwards the value again followed a decreasing trend till to the end of the sampling period.

The primary productivity of each category of plant materials i.e. live green, standing dead, litter and below ground parts was calculated by summing up of the positive increments of concerned biomass during the study period. Grass production was found to be minimum during May (49.57 g m^{-2}) and maximum in the month of July (1274.09 g m^{-2}). The production of grass exhibited an increasing trend from May to June and then to July. Thereafter the value declined till September. The annual grass production was found to be 3289.53 g m^{-2} yr^{-1}. The non-grass production showed maximum in the month of June (868.55 g m^{-2}) and minimum in the month of September (141.11 g m^{-2}). The annual non-grass production was found to be 2246.10 g m^{-2} yr^{-1}.

The total live green production showed their minimum and maximum value during May (249.00 g m^{-2}) and June (2041.89 g m^{-2}). Out of the annual net live green production (5535.63 g m^{-2} yr^{-1}) 59.42% was contributed by grasses and 40.58% by non-grasses. The standing dead production was found to be 176.06 g m^{-2} yr^{-1}. The rate of production was nil during December to June. July and onwards continuous production of standing dead was observed showing a maximum of 40.81 g m^{-2} during October. Litter production was nil during June, July and August.

The net annual litter production was 85.72 g m^{-2} yr^{-1}. Net above ground production was found to be 5711.69 g m^{-2} yr^{-1} of which June showed a maximum of 2041.89 g m^{-2}.The production was found to be nil in the month of January, February, March and April. The net above ground production exhibited a gradual declined in trend from June December showing a minimum of 17.44 g m^{-2} of production. A maximum of 236.55 g m^{-2} of below ground production was observed during June. Then the rate of production gradually decreased till September. A minimum of 23.71 g m^{-2} of production was observed in the month of May. Total below ground production was found to be 691.38 g m^{-2} yr^{-1}.

Total net production (6403.07 g m^{-2} yr^{-1}) was derived by adding the above ground net production (5711.69 g m^{-2} yr^{-1}) and below ground net production (691.38 g m^{-2} yr^{-1}). Gross primary production of the community was found to be 8323.99 g m^{-2} yr^{-1}. This was derived by adding respirator loss (1920.92 g m^{-2} yr^{-1}) to total net production of the community. About 89.22% of the total net production remained in the above-ground parts and about 10.78% directed towards belowground parts. From the above ground net production 0.48 g m^{-2} day^{-1} was transferred to standing dead. The transfer rate from standing dead to litter was 0.23 g m^{-2} day^{-1}. The rate of disappearance of litter and below ground were 0.03 g m^{-2} day^{-1} and 1.25 g m^{-2} day^{-1} respectively. The total disappearance of organic matter was at the rate of 1.28 g m^{-2} day^{-1} or in other words about 7.34% of the total net production was lost annually.

The transfer function of above-ground net production (0.89) was 8.09 times higher than that of belowground net production (0.11). It was also observed that the transfer function of aboveground net production to live green production and standing dead production were 0.97 and 0.03 respectively. The system transfer function of standing dead to litter production was found to be 0.49. The disappearance of belowground (0.66) was high compared to litter disappearance (0.15). The above ground net live green production to standing dead production (0.03) was found to be very less among the other components of the community. The turnover rates of non-grasses were found to be maximum (98.01%) as compared to that of grasses (90.81%). Among the components of the community i.e. livegreen, standing dead and below ground the turnover rate was not significantly different from each other (93.60%, 96.97% and 93.71% respectively).The litter component showed less turnover rate (79.31%) in the community. The turnover time of livegreen non-grasses on the other hand exhibited one month less compared to livegreen grasses i.e.

grasses showed turnover time of 13 - 14 months and the non-grasses showed 12 - 13 months. The turnover time of the livegreen, standing dead and below ground did not show any differences (i.e. 12 - 13 months in each) whereas the litter component exhibited a maximum turnover time (15 - 16 months) among the components of the community.

The interrelationship study among the 6 dominant species (based on density value) revealed that out of six species, *Cynodon dactylon, Digitaria abludens, Eleusine indica, Vetiveria zizanioides* and *Phyllanthus fraternus* were dependent on each other, where as they had independent existence with respect to *Sida cordifolia*.

Various compartmental biomasses i.e. the live green biomass with standing dead biomass and standing dead biomass with litter biomass were not significantly related. Whereas livegreen grass biomass and livegreen non-grass biomass, livegreen biomass and below ground biomass, total above ground biomass and below ground biomass showed interdependence.

Beside, when the mean minimum atmospheric temperature, mean maximum atmospheric temperature and wind velocity were correlated with density value, no significant correlations were observed. However the density of the community with rainfall showed correlationship significant at $p = 0.05$.

The density of grasses and livegreen grass biomass, density of non-grasses and livegreen non-grass biomass, total density and total livegreen biomass, total density and total above ground biomass, total density and below ground biomass, total density and total biomass, all were dependent on each other.

Compared to other grassland communities, the present grassland community showed little variation. However, the factors like soil condition, rainfall, atmospheric temperature, wind velocity and such others, regulates the life-forms and primary productivity of the community.

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APPENDIX – I

Floristic list of experimental grassland community

Grasses

1	*Alloteropsis cimicina* (L.) Stapf	Poaceae
2	*Cynodon dactylon* (L.)Pers.	Poaceae
3	*Cyperus castaneus* Willd.	Cyperaceae
4	*Digitaria abludens*(Roem.& Schult.)Veldk.	Poaceae
5	*Digitaria longiflora* (Retz.) Pers.	Poaceae
6	*Eleusine indica* (L.) Gaertn.	Poaceae
7	*Eragrostis tenella* (L.)P.Beauv.ex Roem.& Schult.	Poaceae
8	*Eragrostis unioloides*(Retz.)Nees ex Steud.	Poaceae
9	*Fimbristylis dichotoma* (L.) Vahl	Cyperaceae
10	*Fimbristylis ovata* (Burm.f.)Kern	Cyperaceae
11	*Lipocarpha sphacelata* (Vahl) Kunth	Cyperaceae
12	*Paspalum scrobiculatum* L.	Poaceae
13	*Scleria lithosperma* (L.) Sw.	Cyperaceae
14	*Setaria intermedia* Roem & Schult.	Poaceae
15	*Vetiveria zizanioides* (L.) Nash ex Small	Poaceae

Non grasses

1	*Aclisia secundiflora* (Bl.)Bakh.f.	Commelinaceae
2	*Ageratum conyzoides* L.	Asteraceae
3	*Alysicarpus vaginalis* (L.) DC.	Fabaceae
4	*Centranthera indica* (L.) Gamble	Scrophulariaceae
5	*Desmodium triflorum* (L.) DC.	Fabaceae
6	*Elephantopus scaber* L.	Asteraceae
7	*Emilia sonchifolia* (L.) DC.	Asteraceae
8	*Evolvulus nummularius* (L.) L.	Convolvulaceae
9	*Hedyotis herbacea* L.	Rubiaceae
10	*Lindernia anagallis* (Burm.f.)Pennell	Scrophulariaceae
11	*Lindernia crustacea* (L.) F.v. Muell.	Scrophulariaceae
12	*Ludwigia hyssopifolia* (G.Don)Excell	Onagraceae
13	*Mecardonia procumbens* (Mill.)Small	Scrophulariaceae
14	*Melochia corchorifolia* L.	Sterculiaceae
15	*Murdannia nudiflora* (L.) Brenan	Commelinaceae
16	*Oxalis corniculata* L.	Oxalidaceae
17	*Phyllanthus fraternus* Webster	Euphorbiaceae
18	*Rungia pectinata* (L.)Nees	Acanthaceae
19	*Sida cordifolia* L.	Malvaceae
20	*Spermacoce ramanii* Sivar. & Nair	Rubiaceae
21	*Zornia gibbosa* Spanoghe	Fabaceae

APPENDIX - II

Life-form classes of the experimental grassland community		
1	*Ageratum conyzoides*	Chamaephyte
2	*Alysicarpus vaginalis*	-do-
3	*Centranthera indica*	-do-
4	*Desmodium triflorum*	-do-
5	*Emilia sonchifolia*	-do-
6	*Evolvulus nummularius*	-do-
7	*Ludwigia hyssopifolia*	-do-
8	*Melochia corchorifolia*	-do-
9	*Sida cordifolia*	-do-
10	*Spermacoce ramanii*	-do-
1	*Alloteropsis cimicina*	Hemicryptophyte
2	*Cynodon dactylon*	-do-
3	*Elephantopus scaber*	-do-
4	*Hedyotis herbacea*	-do-
5	*Lindernia anagallis*	-do-
6	*Lindernia crustacea*	-do-
7	*Mecardonia procumbens*	-do-
8	*Oxalis corniculata*	-do-
9	*Rungia pectinata*	-do-
1	*Cyperus castaneus*	Geophyte
2	*Fimbristylis dichotoma*	-do-
3	*Fimbristylis ovata*	-do-
4	*Lipocarpha sphacelata*	-do-
5	*Murdannia nudiflora*	-do-
6	*Scleria lithosperma*	-do-
1	*Aclisia secundiflora*	Therophyte
2	*Digitaria abludens*	-do-
3	*Digitaria longiflora*	-do-
4	*Eleusine indica*	-do-
5	*Eragrostis tenella*	-do-
6	*Eragrostis unioloides*	-do-
7	*Paspalum scrobiculatum*	-do-
8	*Phyllanthus fraternus*	-do-
9	*Setaria intermedia*	-do-
10	*Vetiveria zizanioides*	-do-
11	*Zornia gibbosa*	-do-

APPENDIX – III

Stratification of the experimental grassland flora		
1	*Ageratum conyzoides*	Top strata
2	*Alysicarpus vaginalis*	-do-
3	*Digitaria abludens*	-do-
4	*Digitaria longiflora*	-do-
5	*Eleusine indica*	-do-
6	*Emilia sonchifolia*	-do-
7	*Setaria intermedia*	-do-
8	*Sida cordifolia*	-do-
9	*Vetiveria zizanioides*	-do-
1	*Aclisia secundiflora*	Middle strata
2	*Alloteropsis cimicina*	-do-
3	*Centranthera indica*	-do-
4	*Eragrostis tenella*	-do-
5	*Eragrostis unioloides*	-do-
6	*Fimbristylis dichotoma*	-do-
7	*Ludwigia hyssopifolia*	-do-
8	*Melochia corchorifolia*	-do-
9	*Scleria lithosperma*	-do-
10	*Spermacoce ramanii*	-do-
1	*Cynodon dactylon*	Lower strata
2	*Cyperus castaneus*	-do-
3	*Desmodium triflorum*	-do-
4	*Elephantopus scaber*	-do-
5	*Evolvulus nummularius*	-do-
6	*Fimbristylis ovata*	-do-
7	*Hedyotis herbacea*	-do-
8	*Lindernia anagallis*	-do-
9	*Lindernia crustacea*	-do-
10	*Lipocarpha sphacelata*	-do-
11	*Mecardonia procumbens*	-do-
12	*Murdannia nudiflora*	-do-
13	*Oxalis corniculata*	-do-
14	*Paspalum scrobiculatum*	-do-
15	*Phyllanthus fraternus*	-do-
16	*Rungia pectinata*	-do-
17	*Zornia gibbosa*	-do-