Vegetation Development in Abandoned Fallowland in Chapra, Bihar, India

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ABSTRACT

The floristic composition, life form and live shoot biomass estimation of a grassland community developed in abandoned cropland after about nine years at Jai Parkash University Chapra (25^0 36'-$26^0$15'N lat. and $84^0$24'-$85^0$15'E long.) were studied.The floristtic compositoin of the grassland community was composed of 14 species. *Cynodon dactylon* and *Dicanthium* annulatum were the dominant species.Other important species were *Convolvulus arvensis* and *Cyperus rotundus* during the study period.In the study sites cryptophytes, hemicryptophytes and chamaephytes were present however phanerophytes and therophytes were absent. The IVI values ranged from 56.39 to 82.68 for *Cynodon dactylon* and *Dicanthium annulatum*, respectively.The shoot biomass values ranged from 26.83 to 41.32 gm^{-2} in two study sites.The species richness and equitability values ranged from 1.64 to 2.73, and 2.22 to 2.73, respectively at two study sites.

Keywords: Abandoned cropland, Species composition, Importance value index, Species richness, Equatability and Live shoot biomass

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INTRODUCTION

Ecologically a grassland may be defined to be the land on which graminoid (poaceae) species are dominant. Grassland as a whole encomposses the potential natural vegetation of 25% of the earth's land surface (Shantz 1954), and accounts for about 16% (1.89×10^{10} tha^{-1}) of the net primary productivity of plant community (Whittaker and Likens, 1973). According to Singh (1987), grasslands in India occupy 39.81 per cent (12121 thousand ha) area of the total Indian sub-

continent.Grasslands in India have developed either due to deforestation or abandoned cultivation (Misra 1983, Blasco et al. 1983, Singh et al. 1985). Whyte (1968) recogonized that grasslands occur on almost all soil types and their distribution is predominently governed by climatic factors. The tropical grasslands in India are seral in nature due to reccuring biotic operation such as grazing, fire and scraping (Neeraj et al. 2004). Mankind has depended upon grasslands for his existance even since our remote ancestors ventured onto the savannas and began a new mode of existance. Grasses seem to have emerged during the late Cretaceous and by early Miocene and the grasslands probably assumed a prominent place in the earth's vegetation . Most works on grassland ecosystems in India have been reported by Pandeya et al. (1977), Singh and Yadava (1974), Sinha et al. (1991), Ramakrishnan and Ram (1988), Mishra and Mishra (1984) etc.

Since 2006 cultivation of crops has been banned in the J. P. University Chapra, campus and the campus is now a fallowland. Only within nine years the vegetation has developed which is a grassland type. According to Bignal (1996) and Kleijn et al. (2006) some agricultural and agroforestry systems that shape cultural landscape have been recogonized which need conservation relevance includiing biodiversity, habitat and aesthetic values. The variable ecosystems would be lost if agricultural use is abandoned . There are negative as well as positive effects of abandonment of agricultural land.Following are the five main problems related to negative effects of abandonment of cultivation as discussed by Jose et al. (2007) : a) reduction of landscape heterogeneity and promotion of vegetation homogenisation associate and incresead fire frequency, b) soil erosion and desertification, c) reduction of water stocks, d) biodiversity loss and reduced population of adopted species, and e) loss of cultural and aesthetic values.

When abandonment is simultaneous for large extension of farmlands, vegetation homogenization increases (Lasanta-Martineza et al. 2005) and landscape heterogeneity reduces (Hochtl et al.2005). Reduced landscape heterogeneity increases the disturbances (Lloret et al. 2001). Soil erosion is a problem linked to land abandonment in some parts of the world , but not everywhere . The abandonment of pastoral practices had some negative consequences, such as the penetration of invasive species and an increase of unaltered litter on the ground , which leads to the worsening of the pastoral features (Susan et al. 2004). The abandonment of farmland and its detrimental effects on landscape heterogeneity result in the loss of plants (Luoto et al. 2003 and Laiolo et al. 2004) and invertibrates (Inoue et al. 2005 and Daube et al. 2006). The abandonment of agricultural land may also have a variety of positive consequences such as : a) revegetation and forest plantations ,b) water retension and soil recovery, c) nutrient cycling and d) increase in biodiversity (Jose et al. 2007).

Due to colonisation of abandoned land plants and animals can disperse from surrounding habitats and subsequently establish , survive and grow. It integrates natural condition with plant cover. It results increase in the density and distribution of biomass. Rapid ecosystem recovery following cropland abandonment and rural – urban migration has been documented in forested and non forested ecosystems in many regions of the world (Lepers et al. 2005 , Aide et al. 2005, Grau et al. 2007 and Vallejo et al. 2006).There are a lot of benefits obtained from revegetation of abandoned agricultural land. These include hydrological regulation , soil recovery and erosion mitigation, increased fertility and higher water quality. Due to sucessional vegetation development higher evapotranspiration and infiltration rates and therefore runoff is reduced and an increase in water holding capicity takes place (Sponge effect) (Bruijnzeel et al. 2004). Soil properties improve when afforestation practices after land abandonment are successful. Landscape heterogeneity may decrease or increase by the abandonment agricultural land affecting the habitat diversity. Abandonment of agricultural lands promotes population decline of species adapted to open space, however it favours the population and diversity of species characterstic of woody vegetation habitats (Laiolo et al. 2004, Muniz et al. 2006, Dunn et al. 2004 and Otto et al. 2006) and of soil fauna (Kardol et al. 2005). Abandonment leads to a high increase in biodiversity compared with farmland (Dunn et al. 2004 and Kappele et al. 1995). The present study was aimed to know the species composition and live shoot biomass level of grassland vegetation developed after nine years of abandonment of cultivation in the Jai Parkash University campus, Chapra , Bihar, India. Data on such studies are not available in the Indo –Gangetic plains of Bihar.

MATERIALS AND METHODS

This study was conducted at two openly grazed vegetation sites (Site I and Site II). Site I was moderately grazed and site II was intensively grazed. The sites were situated between (25^0 36'-$26^0$15'N lat. and $84^0$24'-$85^0$15'E long.) The maximum tempreture values ranged from 15.4^0to44.5^0. Harvest method of Odum (1960) was employed for the estimation of plant biomass. Ten quadrats of 50cmx50cm sizes were randomly harvested 1cm above the ground surface during the last week of August 2015 . The samples were packed in polyethylene bags separately and brought to the laboratory for identification (Muller 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 Orrisa (Haines, 1921-25) ; Supplement to the Botany of Bihar and Orrisa(Mooney 1950). The phytosociological observations were made. The species present in quadrats were noted and their numbers were counted individually/tiller of each species. The vegetation data were quantatively

analysed for frequency, density, abundance and dominance following Curtis and McIntosh (1950). Relative ferquency, relative density and relative dominance were determined following Phillps (1959) , for dominance shoot biomass data were used. The Importance Value Index (IVI) was the sum of relative frequency, relative density and relative dominance. Following formulae were used (Misra 1968):

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

$$\text{Relative frequency} = \frac{\text{Number of occurrence of the species}}{\text{Number of occurrence of all species}} \times 100$$

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

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

$$\text{Relative dominance} = \frac{\text{Shoot biomass of a species}}{\text{Total shoot biomass of all species}} \times 100$$

Important value index = Relative frequency+ Relative density+ Relative dominance

$$\text{Equitability} = S / \ln ni - \ln ns$$

S=Total number of species in a site

ni =Biomass of most important species

ns =Biomass value of least important species

Species richness = S-1/ In N

S=Total number of species present

N = Total biomass of all species

RESULTS

The present study deals with the phytosociological attributes of an openly grazed vegetation developed in two sites (I and II) after nine years of abandonment of cultivation in the University campus of Jai Prakash University, Chapra. The maximum number of species were recorded 14 at site I whereas this value was 9 at site II. Altogether following 14 species were recorded in both sites:

Aristida cyanantha , *Boerhaavia diffusa* , *Convolvulus arvensis*, *Convolvulus pluricaulis*, *Cyperus alulatus*, *Cynodon dactylon*, *Cyperus dubius*, *Cyperus rotundus*, *Desmodium triflorum*, *Dicanthium annulatum*, *Evolvulus alsinoides*, *Evolvulus nummularius*, *Parthenium hysterophorus* and *Sida cordifolia.*

Frequency : The values for frequency ranged from 20 to 90 (%) at site I and from 10-100(%) at site II (Tables 1 and 2). In site I maximum value (90%) was recorded for *Convolvulus rvensiss*, *Cynodon dactylon*, *Desmodium annulatum* and minimum (20%) *for Convolvulus pluricaulis*, *Cyperus rotundus*, *Desmodium triflorum* , *Evolvulus alsinoides*,*and Sida cordifolia* . In site II maximum value (100%) was recorded for *Convolvulus arvensis* , *Cyperus dubius* and *Dicanthium annulatum* and minimum (10%) for *Evolvulus alsinoides.*

Density : The values for density ranged from 2.8to 351.2 m^{-2} in site I and from 2.4-606.4 m^{-2} in site II (Tables 1 and 2). In site I maximum value (351.2 m^{-2}) recorded for *Cynodon dactylon* and minimum (2.8m^{-2}) for *Convolvulus pluricaulis* and *Desmodium triflorum*. In site II maximum value (606.4m^{-2}) was recorded for *Dicanthium annulatum* and minimum(2.4 m^{-2}) for *Parthenium hysterophorus* .

Abundance : The values for abundance ranged from 11.3to 820 in site I and from 24-606.4 in site II (Tables 1 and Table 2). In site I maximum value (820) was recorded for *Cyperus rotundus* and

minimum (11.3) *for Parthenium hysterophorus* . In site II maximum value (606.4) was recorded for *Dicanthium annulatum* and minimum (24) for *Parthenium hysterophorus.*

Dominance(D_0): The live shoot biomass values ranged from 0.1to 26.83 gm^{-2} in site I and from 0.71-41.32gm^{-2} in site II for individual species (Tables 1 and 2). In site I maximum value (26.83gm^{-2}) was recorded for *Cynodon dactylon* and minimum (0.1gm^{-2}) for *Desmodium triflorum* . In site II maximum value (41.32 gm^{-2}) was recorded for *Dicanthium annulatum* and minimum (0.71 gm^{-2}) for *Parthenium hysterophorus* .

Relative frequency: The values for relative frequency ranged from 2.66-12% in site I and from 1.66-16.66% in site II .In site I maximum value (12%) was recorded for *Convolvulus arvensis, Cynodon dactylon* and *Dicanthium annulatum* and minimum (2.66%) for *Convolvulus pluricaulis*, *Cyperus rotundus* and *Desmodium triflorum*. In site II maximum value (16.66%) was recorded for *Convolvulus arvensis* , *Cyperus dubius* and *Dicanthium annulatum* and minimum (1.66%) for *Parthenium hysterophorus.*

Relative density : The values for relative density ranged from 0.17 to 21.53 % in site I and from 0.13-34.17 % in site II (Tables 1 and 2). In site I maximum value (21.53%) was recoded for *Cynodon dactylon* and minimum (0.17%) for *Convolvulus pluricaulis* and *Desmodium triflorum* .In site II maximum value (34.17%) was recorded for *Dicanthium annulatum* and minimum (0.13%) for *Parthenium hysterophorus* .

Relative dominance(RD_0): The values for relative dominance ranged from 0.08to 22.86 % in site I and from 0.55-31.85 % in site II (Tables1 and 2). In site I maximum value (22.86%) was recorded for *Cynodon dactylon* and minimum (0.08%) for *Desmodium triflorum* . In site II maximum value (31.85%) was recorded for *Dicanthium annulatum* and minimum (0.55%) for *Parthenium hysterophorus* .

Important Value Index(IVI): IVI values ranged from 2.83 to 56.39 % in site I and from 2.34-82.68 % in site II(Tables 1 and 2). In site I maximum value (56.39) was recorded for *Cynodon dactylon* and minimum (2.83) for *Convolvulus pluricaulis*. In site II maximum value (82.68) was recorded for *Dicanthium annulatum* and minimum (2.34) for *Parthenium hysterophorus*.

Table : 1 The phytosociological characteristics of vegetation in fallowland developed after nine years of abandonment of cropping at site I

Species	F(%)	D(m^{-2})	A	D_0(gm^{-2})	RF(%)	RD(%)	RD_0(%)	IVI
Aristida cyanantha	80	145.6	182	8.16	10.66	8.92	6.96	26.54
Boerhaavia diffusa	60	51.2	85.3	5.7	8	3.14	4.86	16
Convolvulus arvensis	90	288.4	320.4	16.80	12	17.69	14.32	44.01
Convolvulus pluricaulis	20	2.8	14	0	2.66	0.17	0	2.83
Cyperus alulatus	40	84	210	6	5.4	5.15	5.11	15.66
Cynodon dactlon	90	351.2	390.2	26.83	12	21.53	22.86	56.39
Cyperus dubius	80	216.4	270.5	11.58	10.66	13.26	9.87	33.79
Cyperus rotundus	20	164	820	9.57	2.66	10.05	8.15	20.86
Desmodium triflorum	20	2.8	14	0.1	2.66	0.17	0.05	2.88
Dicanthium annulatum	90	262.8	292.0	21.83	12	16.11	18.40	46.51
Evolvulus alsinoides	20	32	160	3.7	2.66	1.96	3.15	7.77
Evolvulus nummularus	60	16.4	27.3	1.82	8	1.01	1.55	10.55
Parthenium hysterophorus	60	6.8	11.3	4.98	8	0.41	4.24	12.65
Sida cordifolio	20	6.4	32	0.46	2.66	0.39	0.39	3.44

F = Frequency, D = Density, A = Abundance, D_0 = live shoot biomass, RF = Relative frequency, RD= Relative density, RD_0 = Relative dominance, IVI= Importance Value Index

Table : 2 Phytosociological characteristics of vegetation in fallowland developed after nine years of abandonment of cropping at site II

Species	F(%)	D(m^{-2})	A	D_0(gm^{-2})	RF(%)	RD(%)	RD_0(%)	IVI
Aristida cyanantha	90	184.8	205.3	9.70	15	10.41	7.48	32.89
Boerhavia diffusa	-	-	-	-	-	-	-	-
Convolvulus arvensis	100	206.8	206.8	25.78	16.66	11.65	19.8	48.11
Convolvulus pluricaulis	-	-	-	-	-	-	-	-
Cyperus alulatus	-	-	-	-	-	-	-	-
Cynodon dactylon	90	177.2	196.8	11.53	15	9.98	8.88	33.86
Cyperus dubius	100	479.6	479.6	28.09	16.66	27.02	21.65	65.33
Cyperus rotundus	-	-	-	-	-	-	-	-
Desmodium triflorum	50	46.8	93.6	6.45	8.33	2.63	4.97	15.93
Dicanthium annulatum	100	606.2	606.4	41.32	16.66	34.17	31.85	82.68
Evolvulus alsinoides	20	5.6	28	0.75	3.33	0.31	0.58	4.22
Evolvulus nummularis	40	64.8	162	5.38	6.66	3.65	4.14	14.45
Parthenium hysterophorus	10	2.4	24	0.71	1.66	0.13	0.55	2.34
Sida cordifolia	-	-	-	-	-	-	-	-

F = Frequency, D = Density, A = Abundance, D_0 = live shoot biomass, RF = Relative frequency, RD= Relative density, RD_0 = Relative dominance, IVI= Importance Value Index.

Dicanthium annulatum had maximum importance at both the sites followed by *Cynodon dactylon* at sites I and *Cyperus rotundus* at sites II . The species richness values were 2.73 and 1.64 at sites I and sites II, respecttively. The equitability value ranged from 2.22 to 2.51 (Table 3).

Table: 3 Species composition of grassland community at Site I and Site II

Variables	Site I	Site II
Total number of species	14	9
Species common to both sites.	9	
Species exclusive to either sites.	5	00
Equitability	2.51	2.22
Species richness	2.73	1.64

DISCUSSION

The present investigation deals with the floristic composition of the vegetation in rainy season (Site I and Site II) in Jai Prakash University campus , Chapra. The herbaceous grass-domminated community of study sites contain high percentage of hemicryptophytes, cryptophytes and chaemophytes (Table 4) that appears as a result of grazing and browsing in the area .Generally grasslands are rich in hemicryptophytes (Braun Blanquet, 1932). Maximum percentage of hemicryptophytes and absence of phanerophytes and therophytic species attributed to be due to influence of periodicity, soil characterestics, climatic condition as well as the biotic interferences (Table 5). Similar findings were also reported in grasslands of India (Singh and Ambasht 1975,Abdar, 2013, Bark and Misra, 1997). In the present study at two sites relatively higher number of species at site I can be attributed to moderate grazing. The much higher abundance and

dominance of species like *Aristida cyanantha*, *Convolvulus abinoids*, *Cyperus rotundus* and *Dicanthium annulatum* at site II may be related to their characteristic growth pattern showing profuse sprouting and flowering even at highly disturbed sites.

Table: 4 Life forms of different species in study sites

Species	Life form occurred
Aristida cyanantha	He
Boerhaavia diffusa	He
Convolvulus arvensis	He
Convolvulus pluricaulis	He
Cyperus alulatus	He
Cynodon dactylon	He
Cyperus dubuis	He
Cyperus rotundus	Cry
Desmodium triflorum	He
Dicanthium annulatum	He
Evolvulus alsinoides	He
Evolvulus nummularus	Cha
Parthenium hysterphorus	He
Sida cordifolia	Cry

Table : 5 Biological spectra of the study sites as compared to other grassland types

Region	Pha(%)	Cha(%)	Hem(%)	Cry(%)	The(%)
Raunkiaer's normal spectrum (Raunkier, 1934)	16	9.0	26	6	43
Varanasi (Rao, 1968)	40.0	6.0	1.0	10.0	43.0
Varanasi (Singh and Ambasht, 1975)	-	4.2	19.2	6.3	70.2
Berhampur (Misra and Misra, 1979)	5.7	25.7	14.3	5.7	48.6
Western Orrisa (Naik, 1985)	3.0	21.20	18.20	6.0	51.50
South Orrisa (Patnaik, 1993)	3.58	17.86	25.00	10.71	42.86
Present study	-	7.14	78.57	14.28	-

Pha =Phanerophytes, Cha =Chamaephytes, Hem= Hemicryptophytes, Cry= Cryptophytes, The = Therophytes

The frequency values ranged from 20 to 90 % at sites I to 20 to 100% at sites II.In site I maximum value (90%%) was recorded for *Cynodon dactylon* and minimum value (20%) for *Convolvulus pluricaulis*. In site II maximum value (100%) was recorded for *Dicanthium annulatum* and minimum value(20%) for *Evolvulus alsinoides*.The density values ranged from 2.8to 351.2 m^{-2} at site I and 2.4to 606.2 m^{-2} at site II.However in Kurushetra density values ranged from 471to 2143 m^{-2} (Singh and Yadava, 1974) , in Varanasi values ranged from 1963 to 11055 m^{-2} (Singh 1967) , in Ujjain values ranged from 104 to 862 m^{-2} (Misra 1973), and in Ratlam values ranged from 21to 4700 m^{-2} (Billore 1973). The IVI values ranged from2.83 to 56.39 at site I and from 2.34 to 82.68 at site II. On the basis of IVI values in the present study at site I *C. dactylon – D. annulatum* community and at site II *D. annulatum – C. dubius* community have developed after nine years of abandonment of cropland. In a study of grassland vegetation at Kurushetra,Singh and Yadava (1974) noted that some species exhibit maximum density during rainy season (e.g *Bothriochloa pertusa* and *Sorghum halepens)* . The live shoot biomass values ranged from 0.1 to 26.83 gm^{-2} and site I to 0.7to 41.32 at site II. Pandeya (1974) has reported live

shoot biomass value for *Cenchrus ciliaris* dominated grassland from 0 to 228 gm^{-2}, at Rajkot, India. Kumar and Joshi (1972) have reported live shoot biomass values for mixed grass dominated grassland from 35 to 76 gm^{-2} at Pilani,India ; 105 to 1974 gm^{-2} at Kurshetra (Singh and Yadava 1974) ,24 to 457 gm^{-2} at Ujjain (Misra 1973) , 1 to 363 gm^{-2} at Ratlam(Billore 1973) , 14 to 572gm^{-2} at Sagar for *Heteropogon* dominated grassland (Jain1971).

***C. dactylon* :** It is also known as Doob grass. The blades are a grey – green and are shorts, usually 2-15 cm long with rough edges. It is fast growing and tough and useful for sports fields,as when damaged it will recover quickly. Doob grass has been cultivated on saline soils. It is also highly aggressive, crowding out most other grasses and invading other habitats, and has become a hard to-eradicate weed in some areas.

***D. annulatum* :** The species is quite variable. The stems spread outwards, then grow erect at the ends. Each node on the stem is enriched with a ring of hairs. It can be used in fields for grazing , livestock, and cut for hay and silage. It forms a tuft that can stand up to grazing pressure.

***C. dubius* :** This species is distributed in old world tropics . It is a perennial herb growing in seasonally flooded areas and in pockets of soil in rocks. It is not confined to wetlands and in sometimes found as a weed in fields and near the sea. It is also seen in open shady places.

CONCLUSION

In the moderate grazing site I had more number of species than the intensively grazed site II. Intensive grazing decreased the total number of species.The life form studies indicated a hemi-cry chaemephytic flora. The live shoot biomass values in growing season is less than the other studies conducted in India. *P. hysterophorus* is invading the study sites aggressively affecting the plant diversity in the study sites . Thus to accelerate the natural course of sucession intensive grazing should be checked and eradication of *Parthenium*_ is needed.

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