J. Indian bot. Soc Vol. 86 (3 & 4) 2007 : 123-128

FLORISTIC AND PHENOLOGICAL ANALYSIS OF GROUND VEGETATION GROWN UNDER *EUCALYPTUS HYBRID* AND *DALBERGIA SISSOO* PLANTATION

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The present study deals with phytosociology and phenology of ground vegetation in *Eucalyptus hybrid* and *Dalbergia sissoo* plantation in Haridwar forest division. The total number of plant species recorded were 39, 35, 28 in *Eucalyptus hybrid* and 29, 25, 23 in *Dalbergia sissoo* during rainy, winter and summer season respectively. *Chrysopogon fulvus* was dominating the community grown under *Eucalyptus hybrid* plantation by having maximum value of IVI and co-dominating by *Arundinella nepalensis*. However *Parthenium hysterophorus* was dominating the community grown under *Dalbergia sissoo* plantation and co- dominated by *Cynodon dactylon* and *Oxalis corniculata*. Similarity of species was noted between two corresponding communities. The phenological study of ground vegetation revealed that majority of annuals flower & fruit produced their seeds in rainy season while fruiting and seed maturation in a number of perennial are activated during winter.

KEY WORDS: *Eucalyptus hybrid*, *Dalbergia sissoo*, ground vegetation, phenology, phytosociology.

Vegetation is an important part of ecosystem that interprets the effects of total environment (Billing, 1952). Vegetation complex fluctuates from season to season in a cycle over the years in a successional way and the fluctuations suggest a response by each species population to prevailing heat, moisture and light as modified by the vegetation itself (Heady, 1958).

Branson *et al.* (1970) suggested that IVI of a species in different communities might express a true approximation of a given set of environmental complexes. Phenology is the art of observing life cycle phases or activities of plants in their temporal occurrence throughout the year (Lieth, 1970). The importance of phenological events is much more meaningful in describing and explaining seasonal aspects of ecological phenomena (Agrawal, 1990 and Negi *et al.*1992).

There is a paucity of informations regarding the species composition, phytosociology, phenology, plant biomass a productivity of ground vegetation grown under over storey of trees. Thus the present study was undertaken with a view to assess the phytosociology and phenology of ground vegetation.

MATERIALS AND METHODS

The present study was conducted at Chiriapur range Haridwar forest division. The forest is located at 76 °4' to 78 °15'east longitude and 29° 4' to 30 °5' north latitude, at an altitude of 415 to 565 m above mean sea level .The present study was carried out in *Eucalyptus hybrid* and *Dalbergia sissoo* plantation. Both the plantation is forty years old. The sites of one Km^2 were identified under dense canopy of each plantation. The structure of forest floor community was studied during Jan 2004 to Jan 2005. The study sites were surveyed several times within the year for extensive plant collection (Singh and Yadav, 1974). 30 quadrates of 25 x 25 cm^2 were laid along transects from various directions during in every season. The size of quadrate was determined by the species area curve following Misra (1968) and Dhasmana (1983) and number of quadrates by following the method described by Kershaw (1973). In the present study the vegetation data were analyzed quantitatively for frequency, density, and abundance by the formula proposed by Curtis and Mc Intosh (1951). The relative values of frequency, density, and dominance were determined (Phillips, 1959) and these values were summed to represent IVI of individual species.

Indices of similarity and dissimilarity between

Table 1: Seasonal distribution and importance value index (IVI) of ground vegetation in *Dalbergia sissoo* and *Eucalyptus hybrid* plantation

Plant Species	Family	*Dalbergia sissoo*			*Eucalyptus hybrid*		
		R	W	S	R	W	S
Achyranthes aspera L.	Amaranthaceae	5.11	-	5.89	1.6	3.15	-
Adhatoda vasica Nees.	Acanthaceae	3.56	14.39	4.8	1.5	2.02	2.47
Aerva sanguinolenta (L.) Blume	Amaranthaceae	-	-	-	1.5	1.04	-
Ageratum conyzoides L.	Compositae	4.81	14.42	4.26	-	-	-
Argemone maxicana L.	Papaveraceae	-	-	-	-	2.06	3.34
Arundinella nepalensis Trinius.	Poaceae	-	-	-	39.88	65.32	44.98
Avena fatua L.	Poaceae	-	-	-	3.14	-	-
Boerhavia diffusa L.	Nyctaginaceae	-	-	-	2.19	-	-
Bothriochloa intermedia (R.Br.) *A. Camus*	Poaceae	-	-	-	1.42	-	-
Cannabis sativa L.	Canapinaceae	3.31	8.82	-	2.32	-	-
Cassia occidentalis L.	Caesalpiniaceae	2.21	2.88	-	1.42	1.13	-
Cassia tora L.	Caesalpiniaceae	3.14	11.56	4.1	1.54	-	2.8
Chenopodium album L.	Chenopodiaceae	-	8.44	-	-	-	-
Chrysopogon fulvus (Sprengel) chlovenda	Poaceae	8.14	18.09	17.17	126.04	105.62	72.61
Clerodendrum phlomides L.F.	Verbenaceae	-	-	-	-	1.05	3.72
*Cymbopogon martini (*Roxb.) *W.Watson*	Poaceae	-	-	-	2.93	1.89	3.19
Cynodon dactylon (L.) *Pers*	Poaceae	68.82	68.93	61.29	28.41	30.12	21.35
Cyperus defformis Linn.	Cyperaceae	5.01	8.65	-	3.81	5.04	-
Datura metel L.	Solanaceae	3.8	16.56	-	-	-	-
Desmodium gangeticum (L.) DC	Fabaceae	-	-	-	-	2.84	-
Dicanthium annulatum (Forsk.) Stapf.	Poaceae	-	5.79	4.95	-	-	-
Eleusine indica (L.) *Gaertn.*	Poaceae	-	-	-	1.52	-	-
Eragrostis poaeoides Beauv.	Poaceae	-	-	-	1.42	-	-
Eulaliopsis binata (Retz.) Hubbard.	Poaceae	-	-	-	25.23	23.94	29.64
Euphorbia hirta L.	Euphorbiaceae	4.96	8.68	1.98	2.99	3.15	4.25
Euphorbia thymifolia L.	Euphorbiaceae	-	2.96	1.04	2.11	1.99	-
Evolvulus nummularius L.	Convolvulaceae	13.01	32.98	6.52	7.11	5.41	12.51
Fumaria indica (Haussak) Pug.	Fumariaceae	-	-	4.02	-	-	5.36
Helicterus isora L.	Sterculiaceae	2.18	8.19	-	-	-	-
Heteropogon contortus (L.) P.Beauv.ex. Roemer & Schutes	Poaceae	-	-	-	3.52	-	-
Justicia simplex D.Doon.	Acanthaceae	2.94	8.27	-	3.01	2.15	-
Lathyrus aphaca L.	Fabaceae	2.33	10.91	-	-	-	4.56
Malvestrum coromandelianum (L.) Garcke,	Malvaceae	-	-	-	3.06	1.16	2.76
Mimosa pudica L.	Mimosaceae	-	-	-	1.79	-	-
Murraya koenigii (L.) Sprengel.	Rutaceae	4.83	-	5.85	2.38	2.49	4.59
Oplismenus compositus (L.) P.Beauv	Poaceae	-	-	-	1.5	1.89	2.7
Oxalis corniculata L.	Oxalidaceae	31.83	90.74	51.2	-	3.37	42.63
Parthenium hysterophorus L.	Asteraceae	111.8	83.29	68.29	6.7	3.88	8.94
Peristrophe paniculata (Forsk.) Brumitt.	Acanthaceae	1.88	-	4.02	-	1.92	-
Poa annua L.	Poaceae	3.8	2.88	-	-	3.03	4.99
Portulaca oleracea Linn.	Portulaceae	6.28	5.56	6.63	-	-	-
Rungia pectinata (L) Nees.	Acanthaceae	9.13	16.9	9.59	5.85	13.88	7.71
Saccharum spontaneum L.	Poaceae	2.77	-	3.17	1.58	2.09	2.3
Setaria glauca (L.) Beauv.	Poaceae	-	-	-	2.86	0.95	3.67
Sida cordata (Burm.F.) Borss.	Malvaceae	-	-	-	3.81	-	-
Sida cordifolia L.	Malvaceae	-	-	-	2.27	4.26	-
Sida rhombifolia L.	Malvaceae	3.08	11.05	2.13	2.77	1.04	-
Solanum indicum L.	Solanaceae	-	-	-	-	2.12	5.36
Solanum nigrum L.	Solanaceae	3.46	11.17	2.99	3.06	-	-
Sonchus oleraceus L.	Asteraceae	-	-	-	1.68	2.04	4.38
Stellaria media (L.) Vill.	Caryophyllaceae	4.37	-	4.76	6.73	1.98	4.75
Urena lobata L.	Malvaceae	7.79	17.65	7.61	-	-	-
Vernonia cinerea (L.) Lessing.	Asteraceae	-	-	-	1.58	1.05	4.56
Xanthium strumarium L.	Rhamnaceae	0.93	-	2.21	0.73	3.08	2.85
Withania somnifera (L.) Dural	Solanaceae	1.61	-	-	-	-	-

R-rainy W – winter S- summer

two selected sites were calculated by using formulae as per Misra (1989)

Index of similarity: Cs=2j / (a + b)

Where Cs =Similarity coefficient
J =Number of species common to both sites
a = Total number of species in site 1
b = Total number of species in site 2
Index of dissimilarity = 1-S

10 plants each of Fifty-five species belonging to over twenty-four families were analyzed for phenological studies. In the last week of each month two days were spend examining the phytophases. The phytophase categories adopted for this study are as follows (Chhangani, 2004):

Flower buds: Light colour, often soapy

Mature flowers: Flower parts uncurled and bright in colour.

Immature fruits: Immature texture, small size, and light green - pink.

Mature fruits: Full size, mature texture, and dark colour.

RESULTS

Phytosociological studies – A total of 29, 25 and 23 plant species were recorded during Rainy, winter and summer season respectively in *Dalbergia sissoo* plantation. The rainy season is characterized by *Parthenium hysterophorus* as a dominant species having highest IVI value (111.89) and *Cynodon dactylon* was co – dominant species with IVI (68.82) *Oxalis corniculata* showed maximum value of IVI (90.73) followed by *Parthenium hysterophorus* (83.29) in Winter season. In summer season, *Parthenium hysterophorus* showed maximum value IVI (68.29) followed by Cynodon *dactylon* (61.29). The species that attained the minimum value of IVI in different season at *Dalbergia sissoo* plantation are *Xanthium strumarium* (0.93) in Rainy season, *Poa annua* and *Cassia occidentalis* (2.88) in winter and *Euphorbia thymifolia* (1.04) in summer season. (Table-1)

In *Eucalyptus hybrid* plantation, the total number of plant species recorded was 39, 35 and 28 during rainy, winter and summer season respectively. *Chrysopogon fulvus* was dominating the community followed by *Arundinella nepalensis*. The maximum value of IVI for *Chrysopogon fulvus* was recorded in rainy season (126.04), followed by (105.62) in winter season and minimum in summer season (72.61) respectively. However, *Arundinella nepalensis*, the next important species attain maximum value of IVI in winter season (65.32) and minimum in rainy season (39.88). The species that attained the minimum value of IVI in different season are *Xanthium strumarium* in rainy season (.73), *Setaria glauca* in winter season (0.95) and *Saccharum spontaneum* in summer season (2.3). (Table–1)

Higher number of species was recorded at *Eucalyptus hybrid* plantation. It might be due to higher germination and survival. *Eucalyptus hybrid* plantation provides better condition for maximum regeneration and aggregation of species (Bhandari *et al.*, 1999). The number of species present at a site also depends on soil conditions as well. The density of most of the plants was found higher in rainy season as compared to winter and summer at both plantations. The results are in conformity with Srivastava (1978) and Sydes and Grime (1981). The nature of plant community at a place is determined by the species that grow and develop in such environment (Bliss, 1962). Difference in the species composition from site to site is mostly due to micro – environmental changes due to intense biotic disturbances. The indices of similarity and dissimilarity between site 1 and site 2 were .59, .53 and .63 in rainy, winter and summer season respectively which indicated that there is more similarity of species between two corresponding communities. (Table 2).

Table-2: Index of similarity (S) and Index of Dissimilarity (1 –S) between *Eucalyptus hybrid* and *Dalbergia sissoo* plantations.

Seasons	Similarity Coefficient	Dissimilarity Coefficient
Rainy	0.59	0.41
Winter	0.53	0.47
Summer	0.63	0.37
Average	0.57	0.43

PHENOLOGICAL ANALYSIS

FLOWERING : Fifty five species belonging to over 24 families were analysed for phenological studies. Majority of plant species (24) flowered in monsoon, These are *Canabis sativa, Cassia occidentalis, Chenopodium album, Mimosa pudica, Peristrophe paniculata, Portulaca oleracea,* and *Sida rhombifolia, Boerhavia diffusa, Bothriochloa intermedia, Cymbopogon martini, Cyperus defformis, Datura metel, Desmodium gangeticum, Eleusine indica, Eragrostis poaeoides, Eulaliopsis binata, Euphorbia thymifolia, Evolvulus nummularius, Heteropogon contortus, Oplismenus compositus, Setaria glauca, Sonchus oleraceus , Vernonia cinerea* and *Urena lobata.*

In monsoon – winter only five species were flowered. These are *Arundinella nepalensis, Chrysopogon fulvus, Saccharum spontaneum, Rungia pectinata* and *Xanthium strumarium.* Fourteen species flowered in late summer – Monsoon was *Achyranthes aspera, Ageratum conyzoides, Argemone maxicana, Cassia tora, Clerodendrum phlomides, Cynodon dactylon, Dicanthium annulatum, Euphorbia hirta, Helicterus isora, Malvestrum coromandelianum, Sida cordata, Sida cordifolia, Solanum indicum, and Solanum nigrum.*

Table-3: Seasonal flower and Fruit pattern of different ground species present at *Eucalyptus hybrid* and *Dalbergia sissoo* plantations.

Seasons	No. of species Flower	No. of Species Fruit
Summer (March-May)	4	5
Summer-Monsoon	14	4
Monsoon (June-September)	24	4
Monsoon-Winter	5	25
Winter (October-February)	1	13
Winter-Summer	5	2
All seasons	2	2
Total No. of species	55	55

Four species flowered in summer season were *Avena fatua, Justicia simplex, Withania somnifera, and Murraya koenigii.* In winter season only one species were flowered witch are *Aerva sanguinolenta.* In winter- summer, five species witch flowered, were *Adhatoda vasica, Fumaria indica, Poa annua, Stellaria media* and *Lathyrus aphaca.*

Two species, *Oxalis corniculata* and *Parthenium hysterophorus* flowered approximately in all seasons. The majority of species therefore appeared to follow a simple annual cycle for flowering except these species. Seasonal flowering pattern has been given in Table 3.

Table 4 reveals the percentage of species showing phenophases. Flowering of maximum species were recorded in August (Rainy season) however minimum flowering were reported in months of December.

Fruiting: -Fruiting takes place throughout the year reaching peak is in October. (Table 4). In summer only five species, *Adhatoda vasica, Fumaria indica, Poa annua, Stellaria media* and *Lathyrus aphaca* fruit during Peak summer months (March, April, May).

Four species, *Avena fatua, Withania somnifera, Sida cordifolia,* and *Solanum indicum* fruit during summer –monsoon period, Twenty five species, *Achyranthes aspera, Ageratum conyzoides, Boerhavia diffusa, Bothriochloa intermedia, Cannabis sativa, Cassia occidentalis, Cassia tora, Cymbopogon martini, Cynodon dactylon, Datura metel, Desmodium gangeticum, Eleusine indica, Euphorbia hirta, Evolvulus nummularius, Heteropogon contortus, Malvestrum coromandelianum, Mimosa pudica, Peristrophe*

Table-4: Percentage of Phenophases of ground species in different months during the study period

Month	Flowering	Fruiting
January	7.27	12.72
February	10.91	5.45
March	20.00	9.09
April	40.00	12.72
May	38.18	18.18
June	45.45	18.18
July	58.18	33.32
August	67.27	40.00
September	49.09	54.55
October	14.55	70.91
November	9.09	61.82
December	3.60	29.09

paniculata, Parthenium hysterophorus, Setaria glauca, Sida cordata, Solanum nigrum. Sonchus *oleraceus, Vernonia cinerea* and *Urena lobata* were found fruiting during monsoon – winter months.

In winter season, *Arundinella nepalensis, Chrysopogon fulvus, Chenopodium album, Cyperus defformis, Helicterus isora, Eulaliopsis binata, Euphorbia thymifolia, Justica simplex, Oplismenus compositus, Peristrophe paniculata, Saccharum spontaneum, Sida rhombifolia,* and *Xanthium strumarium* were fruit. However, in monsoon season, only four species *Argemone maxicana, Clerodendrum phlomides, Eragrostis poaeoides and Murraya koenigii* were in fruiting, and remaining two species, *Aerva sanguinolenta*, and *Portulaca oleracea* produce fruits in winter – summer months. *Dicanthium annulatum* and *Oxalis corniculata* produce fruit in all three season. Seasonal fruiting pattern is shown in Table 3 whereas month wise availability of fruits is given in Table 4.

The present study reveals the community is dominated by evergreen species. Various phenological characters of each species are regulated by environmental parameters like temperature, soil, nutrients and altitude. In addition to this slope aspect is also important for governing a particular phenophases. Vegetative growth that started with bud burst in February was completed by April in 80% taxa.

Majority of annuals flowers fruit and produced their seeds in rainy season while fruiting and maturation in a number of perennial are activated during winter. Agrawal (1990), Negi *et al.*, (1992) Bhandari *et al.*, (1999), and Singh (2003) explained identical results. Bhat *et al.*, (2001) studied the phenology of underground species of tropical moist forest of western Ghat region of Uttara Khannda district in South India and concluded that the herbs showed the flowering and fruiting concentration in a single peak during monsoon and post monsoon study, which also supports the present study.

Rains trigger the phenological events. Photodynamic analysis reveals that various phenophases from sprouting to seed maturation have phenological calendar, witch begins with the advent of the first shower of rain. The episodic growth of vegetation in rainy season illustrates it to be the peak growth period for the majority of plants. Most of the workers (Singh and Yadava, 1974; Agrawal, 1990 and Negi *et al.*, 1992) concluded that the progression of temperature and moisture conditions influence vegetative growth.

The Authors wish to express their gratitude to Prof D. D. Bhatt, Principal, Govt. P. G. College, and Kotdwar for providing lab and other facilities.

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