



## Phenology, life form and leaf spectra of the vegetation of kokarai valley, district swat

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Article published on September 28, 2016

**Key words:** Life form, Leaf spectra, Phenology, Ethnobotany, Kokarai valley

### Abstract

Kokarai valley District Swat is rich in plant biodiversity. The plant species varies in their phenological behavior, life form and leaf size spectra. There is no previous record in the area and therefore the study was designed to explore the species diversity, phenology, life form and leaf size spectra of the Kokarai valley that indicates the climate of the area. Phenological behaviour of plant species were recorded from May-August (81.29%) and September-November (18.70%). The dominant life form was therophytes (39.10%) and dominant leaf size spectra was microphyll (45.81%). The therophytic life form indicates the disturbed vegetation while the microphyll leaf spectra indicates that the area are moist temperate and receive a good amount of rain fall. It can be concluded from the study that the phenerophytes should be restored through habitat restoration and the anthropogenic effects on forest should be minimized.

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## Introduction

Kokarai Valley located at 34° 44'. 645" North, and 72° 27'. 628" East on north-western side of District Swat at Hindu Raj series of Hindu Kush Mountains range. The elevation of the area ranges from 3612ft to 8828ft above sea level (Anonymous, 2000). The natural vegetation of Kokarai Valley can be classified as; subtropical forest at lower elevations and temperate forests at higher elevations (Champion *et al.*, 1965; Beg, 1975). Study area comprised of 6520 hectares, out of which 3126 hectares are cultivated and 3394 hectares are uncultivated while 1374 hectares of area is composed of forests. Chinar Jambil and Kokarai are the main streams which meet with each other's at Kokarai (Anonymous, 2000).

The warmest months of summer season are June, July and August with average daily temperature 38 to 43°C. While the coolest months are December, January and February with average daily temperature 15 to 18°C. Maximum rainfall occur in the month of March with 238 mm and the maximum relative humidity can be detected in the month of February with 80% (Yousfzai *et al.*, 2010).

Biodiversity provides vital renewable natural resource with agricultural, pharmaceutical, scientific, ecological and medical values (Khan *et al.*, 2012). Permanent loss of biodiversity can be caused by over exploitation, habitat destruction, war and pollution (Haq, 2015). A good floristic indicator is floristic composition, because different floristic composition indicated the presence of various environmental factors therefore leading to intra-specific and inter-specific diversity. In the life cycle of a plant species each and every phase is greatly influenced by a number of ecological factors.

The diverse stages of the plant remain totally embedded in an environmental complex (Haq *et al.*, 2015a). There is a synchronization of phonological behavior of the plant species and the numerous factors of the environment that plants are spoken of biological clocks.

This is frequently controlled by external signals from the environment (Zhang *et al.*, 2006). This study was proposed as there is no previous record regarding biodiversity, phenology, life form and leaf size spectra in the study area.

## Materials and methods

### Survey

The study was conducted in 2014 and 2015 to explore the species diversity and vegetation structure of Kokarai Valley. 15 stands were selected on the basis of physiognomy of the vegetation (Haq *et al.*, 2015b).

### Plant collection and preservation

Three samples of each plant species were collected from various parts of the area. The collected specimens were dried and poisoned by using Ethyl Alcohol, CuSo<sub>4</sub>, and Mercuric Chloride. The poisoned plants were mounted on standard herbarium sheets (17.5" x11.5") and identified with the help of Flora of Pakistan (Nasir and Ali, 1972; Nasir and Ali 1970, 1989; Ali and Nasir 1990, 1992; Ali and Qaiser, 1993, 2009.) The voucher specimens were put in Herbarium Hazara University (HU). The data of Altitude, Latitude and Longitude were taken with the help of GPS.

### Phenology, life form and leaf spectra

Flowering and fruiting of plant species were observed by general surveys and trips were carried out bimonthly (Malik. *et al.*, 2005; McLaren and McDonald 2005). Phytoclimatic spectrum and leaf size spectra of the flora based on the life form was arranged in different classes according to Raunkiaer's classification (Raunkiaer, 1934).

## Results and discussion

### Floristic composition

In the study area 155 plants species comprises of 138 genera and 74 families were observed (Table 1). Asteraceae was the dominant family having 16 species followed by Rosaceae 13 species, Lamiaceae 12 species and Poaceae with 7 plant species. Our results are supported by Haq *et al.* (2010), who worked on the species diversity of Nandiar valley and reported the dominance of Asteraceae in the area.

**Table 1.** Plant species, life form and leaf size spectra of Kokarai valley.

V. No	Botanical Name	Family name	Life form	Leaf spectra	Flowering	Fruiting
118	<i>Achillea millefolium</i> L.	Asteraceae	Th	Na	May-June	July-Aug
44B	<i>Achyranthus aspera</i> L.	Amaranthaceae	Th	Meso	June-July	Sept
17	<i>Adiantum incisum</i> L.	Pteridaceae	H	Na	June-Aug	Sept-Oct
41	<i>Aegopodium burtii</i> E.Nasir	Umbelliferae	Th	Mic	Sept-Oct	Nov
105	<i>Aesculus indica</i> (Wall.ex Camb.) Hook.f.	Hippocastanaceae	Mp	Mic	May-June	July- Aug
6j	<i>Ajuga bracteosa</i> Wall.ex Benth.	Lamiaceae	Th	Mic	Mar-May	June-July
13B	<i>Amaranthus caudatus</i> L.	Amaranthaceae	Th	Mic	May-July	Sept-Oct
117	<i>Anchusa arvensis</i> (L.) M.Bieb.	Boraginaceae	H	Mic	April-June	Sept-Oct
78	<i>Androsace sempervivoids</i> Jacq.ex Duby	Primulaceae	Th	Mic	April-June	July-Aug
15b	<i>Apluda mutica</i> L.	Poaceae	H	Na	Sept-Oct	Nov
109	<i>Aquilegia fragrans</i> Benth.	Ranunculaceae	H	Na	May-June	Sept
21	<i>Arisaema utile</i> Hook.f.ex Schott	Colchicaaceae	Th	Meso	June-July	Sept
123	<i>Artemisia scoporia</i> Waldst. & Kitam.	Asteraceae	Ch	Mic	June-Aug	Aug
129	<i>Asparagus gracilis</i> Royle	Liliaceae	Ch	L	May-June	July-Aug
26b	<i>Asplenium ceterach</i> L.	Aspleniaceae	G	Meso	July-Aug	Sept-Oct
62	<i>Berberis lycium</i> Royle	Berberidaceae	Np	Mic	May-June	July- Aug
43	<i>Berginia ciliata</i> (Haw.)Sternb.	saxifragaceae	Th	Meso	June-July	Sept
52 B	<i>Bidens cernua</i> L.	Asteraceae	Th	Na	May-Aug	Sept-Nov
38	<i>Bistorta amplexicaulis</i> (D.Don)Green	Polygonaceae	Th	Meso	June-July	Sept-Oct
125	<i>Bromus catharticus</i> Vahi.	Poaceae	H	Na	May-June	July-Aug
72	<i>Buddleja crispa</i> Benth.	Buddlejaceae	Np	Na	June-Aug	Sept-Oct
82	<i>Bupleurum falcatum</i> L.	Daticaceae	Th	L	May-June	July-Aug
71	<i>Calamintha umbrosa</i> (M.Bieb.) Fish. & C.A.Mey.	Lamiaceae	Th	Na	May-June	July-Aug
74	<i>Campanula latifolia</i> L.	Campanulcae	H	Na	April-June	July-Aug
50b	<i>Campanula patula</i> L.	Campanulaceae	Th	Na	June-Aug	Sept-Oct
3B	<i>Cannabus sativa</i> L.	Cannabinaceae	Th	Mic	May-June	July- Aug
49b	<i>Carpesium abrotanoides</i> L.	Asteraceae	Th	Mic	May-June	July
40b	<i>Caryopteris odorata</i> (Ham.ex Roxb.)	Lamiaceae	Th	Mic	June-Aug	Sept-Oct
24B	<i>Caynodon dactylon</i> (L.) Pers.	Poaceae	G	Le	March	Sept
2B	<i>Celtis caucasica</i> Willd.	Ulmaceae	Mp	Mic	July-Aug	Sept-Oct
31	<i>Cerastium fontanum</i> Baumg.	Caryophyllaceae	Th	Mic	May-June	July-Aug
131	<i>Chenopodium album</i> L.	Chenopodiaceae	Th	N	June-July	Aug
90	<i>Chrysopogan aucheri</i> (Boiss.) Stapf.	Poaceae	H	Mic	April-May	June-July
13J	<i>Cichorium intybus</i> L.	Asteraceae	Th	Meso	April-May	June-July
9	<i>Cirsium falconerai</i> (Hook.f.)Petrak	Asteraceae	Th	Mic	April-June	July-Aug
14B	<i>Conyza pseudoconyza</i>	Asteraceae	H	Meso	April-May	June-July
5J	<i>Conyza canadensis</i> (L.) Cronquist	Asteraceae	Th	Mic	April-May	June-July
27B	<i>Cotoneaster nummularia</i> Fisch.& Meyar	Roseaceae	Np	Na	May-June	July-Aug
9b	<i>Cryptogramma stelleri</i> (Gmel.) Prantl.	Pteridaceae	G	Ma	July-Aug	Sept-Oct
128	<i>Daphne mucronata</i> Royle	Thymelaceae	Np	NA	April-May	June-July
30B	<i>Datura stramonium</i> L.	Solnaceae	Th	Meso	June-July	Aug
18B	<i>Debregeasia salicifolia</i> (D.Don)Rendle	Urticaceae	MesoP	Mic	April-May	June-July
119	<i>Dedonaea viscosa</i> (L.)Jacq.	Sapindaceae	Np	Mic	April-May	June-July
65	<i>Desmodium elegans</i> DC.	Papilionaceae	Np	Mic	July-Aug	Sept-Oct
67	<i>Dicliptera bupleoroidues</i> Nees	Acanthaceae	Ch	Mic	May-June	July-Aug
60	<i>Dicliptera roxburghiana</i> Ness	Acanthaceae	Th	Mic	May-June	July-Aug
51B	<i>Diospyras kaki</i> L.	Ebenaceae	Mp	Meso	April-May	June-Aug
17B	<i>Diospyrus lotus</i> L.	Ebenaceae	Mp	Mic	Sept-Oct	Nov
98	<i>Dryopteris ramosa</i> L.	Aspidiaceae	H	Ma	May-June	July-Aug

Y	<i>Duchesnea indica</i> (Andrews)Focke	Roseaceae	H	Na	Mar-April	May-June
5B	<i>Ehretia serrata</i> Roxb.	Boraginaceae	MesoP	Meso	May-June	July-Aug
33	<i>Elcholtzia fruticosa</i> Roxb.ex (D.Don) Rehder	Lamiaceae	Th	Mic	June-Aug	Sept
14	<i>Epilobium laxum</i> Royle	Onagraceae	Th	N	June-July	Sept
121	<i>Eucalyptus lanceolatus</i> L.	Myrtaceae	Mp	Mic	April-May	June-July
103	<i>Euonymus fimbriatus</i> Wall.	Celastraceae	Mp	Meso	May-June	July-Aug
12B	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Th	Mic	Sept-Oct	Nov
112	<i>Euphorbia wallichii</i> Hook.f	Euphorbeaceae	Th	N	Sept-Oct	Oct-Nov
11	<i>Fragaria nubicola</i> Lindll.ex Lacaita	Roseaceae	Th	Mic	May-June	Sept-Oct
22	<i>Galinosaga pariviflora</i> Cav.	Asteraceae	Th	Le	June-July	Aug
2	<i>Galium aparine</i> L.	Rubiaceae	Th	L	May-June	July
35	<i>Geranium ocellatam</i> Camb. In Jacq.	Geraniaceae	Ch	Mic	Sept-Oct	Oct-Nov
40	<i>Geum urbanum</i> L.	Roseaceae	Th	Meso	Sept-Oct	Oct-Nov
50	<i>Girardinia palmata</i> (Forssk.) Gaudich	Urticaceae	Th	Na	Sept-Oct	Oct
11B	<i>Grewia optiva</i> Drum.ex Burret	Teliaceae	Th	L	Feb-March	April-May
25b	<i>Hedera nepalensis</i> K. Koch.	Araliaceae	L	Mic	April-Aug	Sept-Oct
47b	<i>Heliotropium macrophylla</i>	Boraginaceae	Th	Mic	Sept-Oct	Oct-Nov
86	<i>Hypericum perforatum</i> L.	Guttiferae	L	Mic	Sept-Oct	Nov
56	<i>Impatiens brachycentra</i> Kar. & Kir.	Balsaminaceae	Th	Mic	Sept-Oct	Oct-Nov
39b	<i>Impatiens bicolor</i> Royle	Balsaminaceae	Th	Mic	Sept-Oct	Nov
25	<i>Impatiens thomsonii</i> Hook.f.	Balsaminaceae	Th	Mic	June-Aug	Sept
52	<i>Indigofera heterantha</i> Wall.ex Brandis	Papilionaceae	Np	Le	May-June	Sept-Oct
111	<i>Indigofera hebeptala</i> Baker	Fabaceae	Np	Mic	May-June	July-Aug
79	<i>Jasminium officinale</i> L.	Ebenaceae	Np	Mic	April-May	June-Aug
	<i>Juglans regia</i> L.	Juglandaceae	Mp	Meso	April-May	June-July
37	<i>Lactuca dissecta</i> D.Don	Asteraceae	Th	Mic	Mar-April	May-June
16b	<i>Lactuca lemola</i> L.	Asteraceae	Ch	Meso	Sept-Oct	Oct-Nov
34	<i>Lamium album</i> L.	Lamiaceae	Ch	Na	Sept-Oct	Nov
73	<i>Lepidium rudirale</i> HooK and Anders.non L.	Brassicaceae	Th	Na	June	July
62B	<i>Lindelofia longiflora</i> (Benth.) Lehm.	Boraginaceae	Ch	Meso	Sept-Oct	Oct-Nov
32	<i>Malva neglecta</i> Wallr.	Malvaceae	Th	Mic	Mar-April	May-June
69	<i>Maytenus wallichiana</i> (Springe) Raju& Bull.	Celastraceae	Mp	Mic	April-May	June-July
114	<i>Medicago lupulina</i> L.	Papilionaceae	H	Na	April-May	June-July
1B	<i>Melia azedarach</i> L.	Meliaceae	Th	N	April-May	June-July
94	<i>Micromeria biflora</i> Benth.	Lamiaceae	H	Mic	Feb-March	April-May
7b	<i>Monathea buxifolia</i> (Falc.) A. DC.	Sapotaceae	Mp	Mic	May-June	July-Aug
27	<i>Myosotis arvensis</i> (L.) Hill	Boraginaceae	Th	Mic	Sept-Oct	Oct-Nov
28B	<i>Myrsine africana</i> L.	Myrsinaceae	Np	Na	Sept	Oct-Nov
55	<i>Nepeta govaniiana</i> (Wall. ex Benth.) Benth.	Lamiaceae	Th	Meso	May-June	July-Aug
39	<i>Nepeta laevigata</i> (D.Don) Hand.-Mazz.	Lamiaceae	Th	Mic	May-June	July-Aug
115	<i>Oenothera rosa</i> L.'Hert.ex Ait.	Onagraceae	Th	Na	April-May	June-July
126	<i>Oleo ferruginea</i> Royle	oleacea	Mp	Mic	May-June	July-Aug
24	<i>Onychium contiguum</i> Wall. ex C. Hope,	Adiantaceae	H	Le	June-July	Sept
58	<i>Origanum vulgare</i> L.	Lamiaceae	Ch	Mic	April-May	June-July
93	<i>Oxalis corniculata</i> L.	Oxiladaceae	G	Mic	Mar-April	May-June
110	<i>Paeonia emodi</i> Wall.ex Royle	Paeoniaceae	G	Meso	June-July	Sept
7	<i>Poa bulbosa</i> L.	Poaceae	H	Na	April-May	June-July
61B	<i>Parthenum hysterophorus</i> L.	Asteraceae	Th	Meso	May-June	July-Aug
12	<i>Phagnalon niveum</i> Edgew.	Asteraceae	Ch	Na	May-June	July-Aug
22B	<i>Phegopteris connectalis</i> (Michx.)Watt.	Thelypheidaceae	G	Ma	Sept-Oct	Nov
113	<i>Picea smithiana</i> (Wall.) Boiss.	Pinaceae	Mp	Na	Mar-April	May
42B	<i>Pilea umbrosa</i> blame.mns	Articaceae	Th	Meso	April-May	June-July
122	<i>Pinus roxburghii</i> Sargent	Pinaceae	Mp	Na	Mar-April	May

28	<i>Pinus walliciana</i> A.B. Jackson	Pinaceae	Mp	Na	Mar-April	May-June
75	<i>Piptatherum glauca</i> (L.) Coss.	Poaceae	H	Mic	June-July	Sept
4	<i>Plantago lanceolata</i> L.	Plantaginaceae	Th	Meso	June-July	August
105	<i>Platanus orientalis</i> L.	Platanaceae	Mp	Meg	April-May	June-July
20b	<i>Polygonium muculosa</i> L.	Polygonaceae	Ch	Mic	April-June	Sept-Oct
19	<i>Polystichum piceopaleaceum</i> Tagawa	Dryopteridaceae	G	Na	June-Aug	Sept-Oct
91	<i>Potentilla astroguisorbis</i> (L.) RAEUSCH.	Roseaceae	Th	Na	Sept	Oct
23	<i>Potentilla nepalensis</i> Hook.f.ex	Roseaceae	Th	Na	Sept	Oct
104	<i>Prunus cornuta</i> (Wall.ex Royle) Steud.	Roseaceae	MesoP	Mic	May-June	Sept-Nov
99	<i>Pteridium aquilinum</i> (L.) Kuhn	Dennstaedtiaceae	G	Mic	May-June	July-Aug
21b	<i>Pteris cretica</i> L.	Pteridaceae	H	Mic	May-June	July-Aug
127	<i>Pycnopus flavidus</i> (Retz.) T.Koyama	Cyperaceae	Ch	Na	May-June	July-Aug
55b	<i>Pyrus pseudopashia</i> L.	Roseaceae	Mp	Mic	Sept-Oct	Oct-Nov
57	<i>Quercus dilatata</i> Lindl.ex Royle	Fagaceae	Mp	Mic	May-June	July-Aug
59	<i>Quercus incana</i> Roxb.	Fagaceae	Mp	Mic	April	June
10	<i>Ranunculus repens</i> -L.	Ranunculaceae	H	Mic	Sept-Oct	Oct-Nov
6B	<i>Rhus punjabensis</i> J.L.Stewart ex Brandis	Anacardiaceae	MesoP	Mic	April-May	June-July
48	<i>Robdosia rugosa</i> (Wallich ex Benth.) Hara	Lamiaceae	Np	Mic	July-Aug	Sept-Oct
23b	<i>Rubia cordifolia</i> L.	Rubiaceae	L	Mic	Sept	Oct
37B	<i>Rubus ellipticus</i> Smith	Roseaceae	Np	Mic	June	July
130	<i>Rubus fruticosus</i> Agg.	Roseaceae	Np	Mic	April-May	June-July
36B	<i>Rubus sanctus</i> Schreber	Roseaceae	Np	Mic	May-June	July-Aug
15	<i>Rumex dentatus</i> L.	Polygonaceae	Th	Meso	Aug	Sept
35B	<i>Rumex hastatus</i> D.Don	Polygonaceae	Th	N	April-May	June-July
4b	<i>Sageretia thea</i> Brongn.	Rhamnaceae	Np	Mic	Sept	Oct
101	<i>Salix pumilia angustifolia</i> L.	Salicaceae	Mp	Mic	April-may	June-July
54	<i>Salvia nubicola</i> Wall.ex Sweet	Lamiaceae	Th	Meso	Sept	Oct
43B	<i>Sarcococca saligna</i> (D.Don) Muell.Arg.	Buxaceae	Np	Meso	April-May	June-July
16	<i>Scutellaria scorodonia</i> Hedge	Lamiaceae	Np	Mic	May-June	July-Aug
44	<i>Silene indica</i> Roxb.ex Otth.	Caryophyllaceae	Th	Na	June-Aug	Sept-Oct
97	<i>Silene vulgaris</i> (Moench)Garcke	Caryophyllaceae	Th	Na	May-June	July-Aug
36	<i>Skimmia laureola</i> (DC.)Sieb. & Zucc.ex Walp.	Rutaceae	Np	Mic	Sept	Oct
63B	<i>Smilax glaucophylla</i> Klotzsch	Smilacaceae	L	L	May-June	July-Aug
68	<i>Solanum nigrum</i> var.nigrum L.	Solanaceae	Th	Mic	July	Sept-Oct
92	<i>Sonchus asper</i> (L.)Hill.	Asteraceae	Th	Mic	Mar-April	May-June
107	<i>Sorbaria tomentosa</i> (Lindl.) Rehder	Roseaceae	Np	Mic	June-Aug	Sept-Oct
61	<i>Spiraea canescens</i> Bush.	Rosaceae	Np	Na	April-May	Sept
60B	<i>Staria pumila</i> (Poir.)Roem. & Schult.	Poaceae	Th	Na	June-July	Sept
46B	<i>Strobilanthus glutinosus</i> Nees.	Acanthaceae	Th	N	June-July	Sept
1	<i>Swertia cordata</i> (G.Don) Clarke	Gentianaceae	Th	Mic	Sept	Oct-Nov
42	<i>Syringa emodi</i> Wall.ex Royle	Oleaceae	Mp	Meso	Sept	Sept-Oct
3	<i>Taraxacum officinale</i> Weber	Asteraceae	Ch	Mic	Mar-April	May-June
29	<i>Taxus fauna</i> Nan Li & R.R.Mill	Taxaceae	Mp	L	May-June	Sept
89	<i>Trifolium repens</i> L.	Fabaceae	G	Na	April-May	June-July
30	<i>Urtica dioica</i> L.	Urticaceae	Th	Mic	April-May	May-June
20	<i>Valeriana jatamansi</i> Jones	Valerianaceae	G	Mic	May	June-July
87	<i>Viburnum grandiflorum</i> Wall.ex DC.	Caprifoliaceae	Np	Mic	April-May	June-July
51	<i>Viola canescens</i> Wall.ex Roxb.	Violaceae	H	Mic	Feb-April	May-June
58B	<i>Vitex negundo</i> L.	Verbenaceae	Np	Na	April-May	June-July
80	<i>Wikstroemia canescence</i> Miesn.	Thymelaceae	Np	Na	May-June	July-Aug
54B	<i>Xanthium strumarium</i> L.	Asteraceae	Ch	Meso	Sept	Oct-Nov
29B	<i>Zanthoxylum aromatum</i> DC.	Rutaceae	Np	Meso	April	May
31b	<i>Zizyphus sativa</i> Gaerth.	Rhamnaceae	Mp	Na	May-June	July-Aug

*Phenology*

Phenology of the plant species including flower and fruiting of each species (Table 1). The study area has two major flowering periods. The first season starts from May to August in which

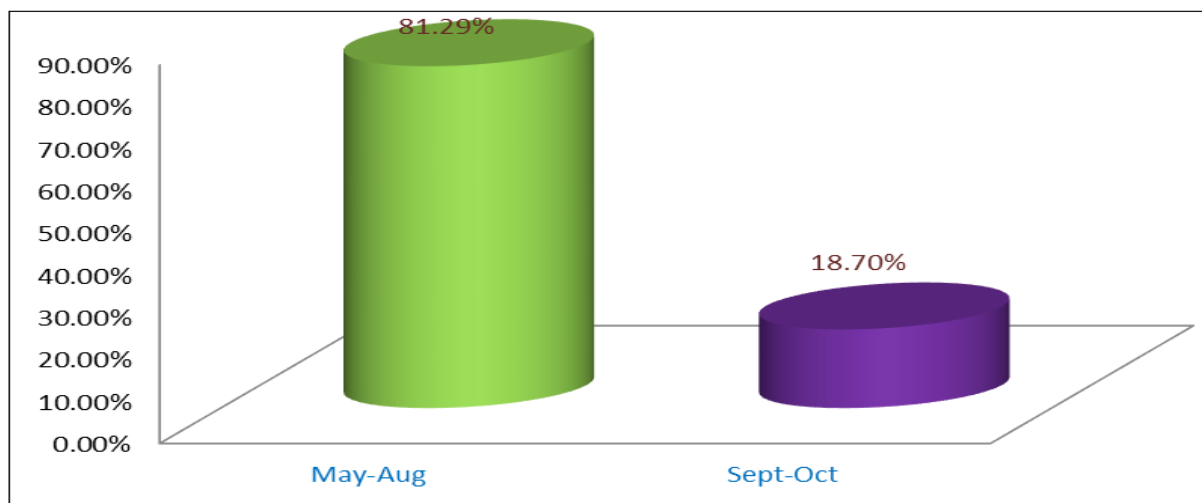
a total 126 (81.29%) plant species were observed in flowering stages. During this season herbs were 56.35%, shrubs (16.67%), trees (15.87%), grasses (4.76%), ferns (5.56%) and climbers were 0.79%.

**Table 2.** Economic uses summary of plant species recorded from Kokarai valley.

S. No	Economic uses purposes	Plants used	% of use
1	Medicinal plants	108	38.57
2	Fodder plants	44	15.71
3	Fuel wood plants	34	12.14
4	Pot herb plants	16	5.71
5	Timber wood species	6	2.14
6	Furniture	4	1.43
7	Poison plants	3	1.07
8	Agriculture Tools	8	2.86
9	Milk Curding plants	2	0.71
10	Basket making plants	3	1.07
11	Fields Fencing plants	8	2.86
12	Honey bee Plants	3	1.07
13	Shade plants	5	1.79
14	Wild fruit plants	8	2.86
15	Evil plants	1	0.36
16	Herbal tea	2	0.71
17	Ornamental plants	6	2.14
18	Condiment plants	3	1.07
19	Constriction plants	5	1.79
20	Gun butts	2	0.71
21	Hedges plants	3	1.07
22	Tooth brush plants	3	1.07
23	Veterinary Medicines Plants	2	0.71
24	Perfumes plants	1	0.36

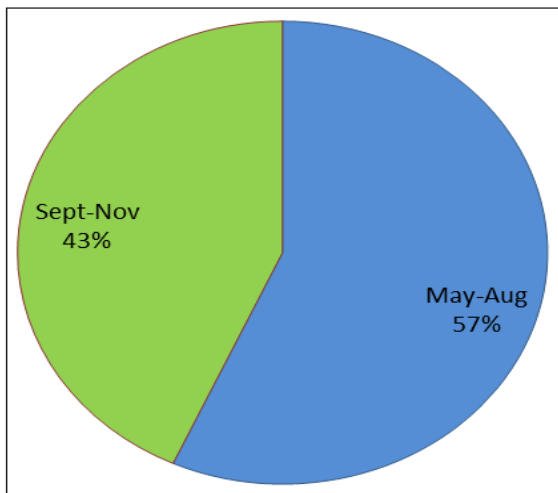
The second flowering period was observed from September to November, in this season 29 (18.70%) plant species were observed in blooming. In this season herbs were 72.41%,

shrubs and trees (10.34%) each, grasses and ferns 3.45% each were observed in flowering, while no climber was recorded flowering in this season (Fig. 1).



**Fig. 1.** Flowering seasons of plant species recorded from Kokarai valley.





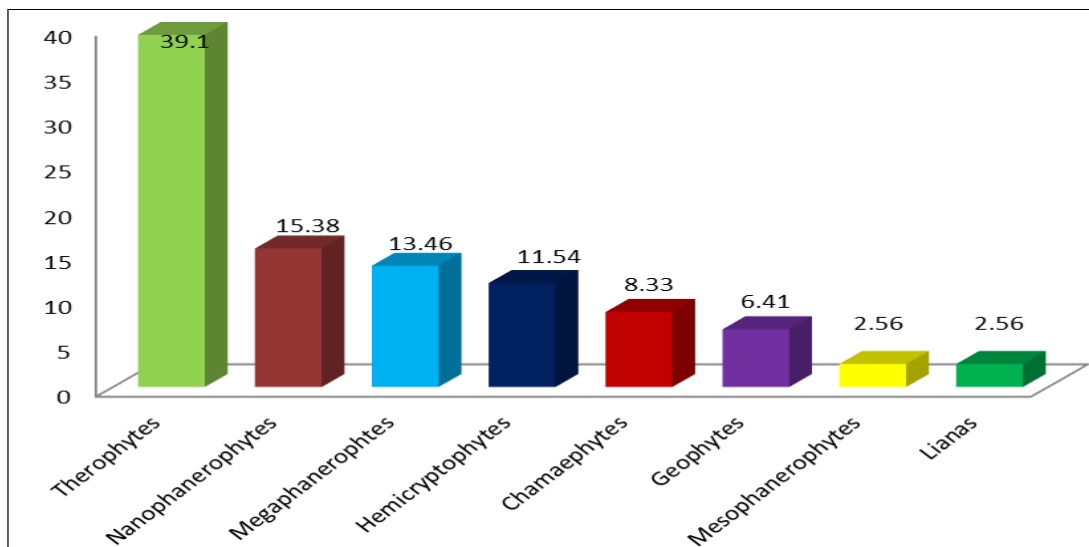
**Fig. 2.** Fruiting seasons of plant species recorded from Kokarai valley.

The lowest fruiting was observed from September and onward in which 67 (43.22%) plant species were in fruiting condition while from May to August was

observed the highest fruiting stage during this 88 (56.77%) plant species were observed in fruiting (Fig. 2). Our results are in agreement with the result of Haq (2015) who also reported similar result in his phytosociological investigations.

*Life-form classes*

The result revealed that the dominant life form class was Therophytes with 39.10% followed by Nanophanerophytes (15.38%), Megaphanerophytes (13.46%), Hemicryptophytes (11.54%), Chamaephytes (8.33%), Geophytes (6.41%), Mesophanerophyte and Lianas having 2.56% (Fig. 3). Our result are in line with Sharma (2003) and Sher and Khan (2007), who worked on District Jammu and Chagharzi Valley, District Buner and they reported that the dominant life classes were Therophytes followed by Nanophanerophytes and Megaphanerophytes.



**Fig. 3.** Graphical representation of life-form classes recorded from Kokarai valley.

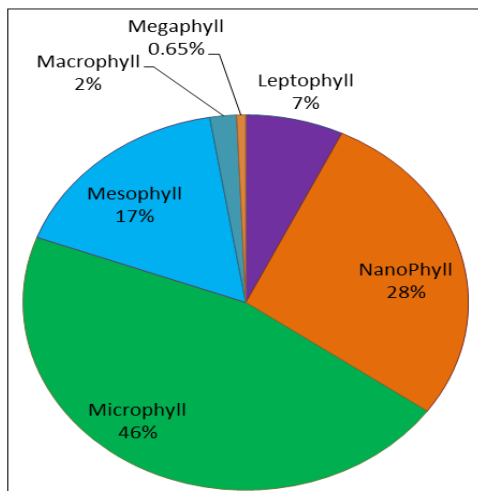
*Leaf spectra*

The leading leaf spectra was microphyll with 45.81%, followed by nanophyll (27.74%), mesophyll (16.77%), leptophyll (7.10%), macrophyll (1.94%) and megaphyll (0.65%) (Fig. 4). Our result are similar with Greller (1988) and Qadir and Tareen (1987) who studied Srilanka and Quetta District, they reported that in these areas the dominating leaf spectra classes were microphylls followed by nanophylls and mesophylls.

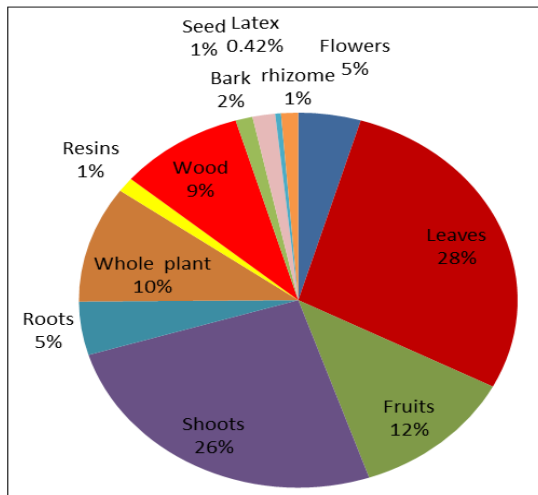
*Ethnobotanical Uses*

The ethnobotanical uses of different plant species were recorded in the study area and 16 ethnobotanical classes were identified (Table 2).

Our results are in line with Hamayun (2005) who observed Utror and Garbal Valleys District Swat, Ahmad *et al* (2010), Nandiar Khuwar District Battagram, Haq *et al.*, (2012) from Allai valley have also reported similar results.



**Fig. 4.** Graphical representation of leaf spectra recorded from Kokarai valley



**Fig. 5.** Parts used summary of plant species recorded from Kokarai valley.

*Parts use of the plant species*

Leaves were dominant used part (67 species, 28.03%), followed young shoots (61 species, 25.52%), and fruit (29 species, 12.13%), whole plants (24 species, 10.04%), wood (22 species, 9.21%), flowers and roots (11 species, 4.60%) each, barks (4 species, 1.67%) rhizomes, seed, resins, (3 species, 1.26%) each, latex (1 spp) as shown in Fig. 5.

**Conclusion**

Kokarai valley is rich in plant biodiversity however in last few years the native plant diversity has been reduced due to anthropogenic and biotic disturbances such as uncontrolled serious seasonal grazing, trampling and harvesting of medicinal flora.

From the recent research, it can be inferred that seasons have great effect on soil properties and biodiversity. An increase in biodiversity was recorded during spring and summer periods which decrease after that as fall season and winter approached caused decrease in diversity due to dry ecological situations, slow growth rate and other climatic factors. The dominance of therophytes indicated that the study area was under serious biotic pressure due to severe grazing, high population and deforestation. There is a need to control the degradation and disorder processes deteriorating the community structure and phyto- diversity of the northern Himalayan regions.

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