

**ECOLOGICAL EVALUATION OF RANGELAND RESOURCES IN
MASTUJ VALLEY, HINDUKUSH RANGE, PAKISTAN**



BY

SYED MUKARAM SHAH

**DEPARTMENT OF BOTANY
UNIVERSITY OF PESHAWAR
PESHAWAR, PAKISTAN
2014**

DEDICATION

Sincerely dedicated to my beloved parents and sisters

University of Peshawar

Peshawar, Pakistan

Ecological Evaluation of Rangeland Resources in Mastuj Valley,

Hindukush Range, Pakistan

A Dissertation submitted in partial satisfaction of the requirement for the degree of

Doctor of Philosophy

In

BOTANY

By

SYED MUKARAM SHAH

Supervisor: Prof. Dr. Farrukh Hussain

Graduate Studies Committee

1. Prof. Dr. Muhammad Ibrar, Convener
2. Prof. Dr. Muhammad Saeed, Member
3. Prof. Dr. Syed Zahir Shah, Member
4. Dr. Siraj-ud-din, Member
5. Miss. Mussarat Jabeen, Member

The dissertation of Mr. Syed Mukaram Shah is approved


14.3.2014

External Examiner


14/3/2014

Supervisor and Internal Examiner

Professor Dr. Farrukh Hussain
Ex-Dean Faculty of life & Environmental Sciences
University of Peshawar

Date: 14/03/2014

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Syed Mukaram Shah

VITAE

January 13, 1979- Born- Mastuj- Chitral- KPK- Pakistan.

1998 – B.Sc. -- Government Degree College Nowshera.

2000 – M.Sc. Department of Botany, University of Peshawar, Peshawar, Pakistan.

July 1st, 2009 – Lecturer in Botany, Centre of Plant Biodiversity, University of Peshawar.

FIELDS OF STUDY

Major Field:

Alpine Rangeland Ecology

Studies in:

- | | | |
|-----|---|-------------------------------|
| 1. | Bot. 801. Allelopathic interaction | : Prof. Dr. Farrukh Hussain |
| 2. | Bot. 802. Allelopathic interaction Lab. | : Prof. Dr. Farrukh Hussain |
| 3. | Bot. 713. Vegetation Ecology | : Prof. Dr. Farrukh Hussain |
| 4. | Bot. 714. Vegetation Ecology Lab. | : Prof. Dr. Farrukh Hussain |
| 5. | Bot. 902. Intensive studies in Ecology | : Prof. Dr. Farrukh Hussain |
| 6. | Bot. 803. Limnology | : Prof. Dr. Fazli Malik Sarim |
| 7. | Bot. 804. Limnology Lab. | : Prof. Dr. Fazli Malik Sarim |
| 8. | Bot. 715. Molecular Systematics | : Prof. Dr. Abdur Rashid |
| 9. | Bot. 716. Molecular Systematics Lab. | : Prof. Dr. Abdur Rashid |
| 10. | Bot. 711. Pharmacognosy | : Mr. Ghalum Dastagir |
| 11. | Bot. 712. Pharmacognosy Lab | : Mr. Ghalum Dastagir |

Abstract

Ecological Evaluation of Rangeland Resources in Mastuj Valley, Hindukush Range, Pakistan

**By
Syed Mukaram Shah**

Floristic composition comprised of 386 species of 75 families. It includes 60 dicots, 11 monocots, 2 gymnosperms and 2 pteridophyte families. There were 37 monocot genera and 205 dicot genera. Pteridophyte and gymnosperms had 3 and 2 genera respectively. Asteraceae (64 Spp., 16.58 %) and Poaceae (31 Spp., 8.03 %) were the leading families. Biological spectrum of the flora was dominated by therophytes (195 spp., 50.51%), followed by hemicryptophytes (66 spp., 17.09%) and geophytes (61 spp., 15.80%). Leaf-size spectrum showed that nanophylls were leading leaf-size class with 187 (48.44%) species followed by mesophylls (80 spp., 20.72%) and leptophylls 48 (12.43%) species. The simple leaves were present in 289 (74.87%) species followed by dissected leaves in 49 (12.69%) species, while 43 (11.13%) species had compound leaves. Only 5 (1.30%) were aphyllous species. There were 349 (90.41%) non-spiny plants compared to 37 (9.58%) spiny species. There were 297 (76.94%) species in terrestrial habitat and 89 (23.05%) belonged to wet habitats. Majority i.e. 354 (91.70%) species were heliophytes and only 32 (8.29%) species were sciophytes. The flora include 337 (87.30%) wild species and 49 (12.69%) cultivated species. There were 351 (90.93 %) deciduous species and 31 (8.03 %) evergreen species. Ethnobotanical classification of plants indicated that all the 386 plant species had some kind of local uses in the valley. There were 366 (94.82%) species used as fodder, 88 (22.80%) species as medicinal, 58 (15.02%) species were used as fuel wood, 26 (6.73%) species yielded timber wood, 25 (6.48%) species were in use as vegetables, 17 (4.40%) species as condiment, 15 (3.88%) species as fruits, 13 (3.37%) species were used for thatching purposes and 5 (1.29%) species were used for making snuff. Phytosociological studies revealed 43 plant communities, including 5 wetland plant communities, 5 dry land communities and 33 harboured mountain habitat.

Soils were mostly sandy loam with poor organic matter and nutrient status. Cattle and sheep generally preferred whole herbaceous plants for grazing while goats mostly browsed on shoots. Cow grazed 41 plant species. Of them, 21 species were highly palatable, 16 mostly palatable, 3 less palatable and 1 rarely palatable. Parts of plants grazed indicated that in 29 species whole plants and in 12 species leaves were utilized. Forty one species were palatable to goats. Of them, 15 species were highly palatable, 19 mostly palatable, 4 less palatable and 3 species were rarely palatable. In 14 species whole plants were grazed, in 10 species leaves, in 10 species shoots, in 6 species flowers and 1 species fruits were utilized. Sheep grazed 23 plant species. Of them, 13 species were highly palatable, 7 mostly palatable, 2 less palatable and 1 rarely palatable. They used 13 species as whole plant, leaves in 6 species leaves and 4 species shoots were palatable. Biomass production in different plant communities indicated that shrubs / trees contributed more biomass than the forbs / grasses. Herbaceous plants contributed 60811 Kg/ha, shrubs and trees had 127235 Kg/ha and grasses contributed 1899 Kg/ha. Highest productivity of 11510 Kg/ha was measured in *Rheum-Artemisia-Ephedra* community followed by 11370 Kg/ha in *Mentha-Hippophae-Trifolium* community, 10890 Kg/ha in *Hippophae-Cnicus-Myricaria* community and 9758 Kg/ha in *Artemisia-Matricaria-Juniperus* community. The total productivity was 186581 Kg/ha. Chemical evaluation of some selected species revealed that presence and absence of secondary metabolites varied at three phenological stages. Thirteen elements were analyzed at three phenological stages of 28 plants. The concentration of various chemicals varied among individual species and at various phenological stages. Cd, Co, Cr, Cu and Zn were mostly absent and Sr also showed fluctuation among the species. Cell wall constituents, NDF, ADF, lignin, hemicellulose and cellulose also showed variations among individual species at various phenological stages. Proximate analysis showed that DM, moisture, ash, crude protein, fat, crude fiber and NFE exhibited variation among trees, shrubs, herbaceous species and grasses. Studies on the conservation status of plant species revealed that out of 337 plant species, 307 species were vulnerable, 26 endangered and 4 species were rare.

Datura stramonium, *Cuscuta reflexa*, *Matricaria chamomila* and *Chrysanthemum cinerariifolium* were among the rare species. Maximum average fruit output for *Juniperus excelsa* was calculated in Dodorghaz gol 23340/plant, followed by 20646/plant in Mastuj village and 5568/plant in Ghuru gol. Number of fallen fruits were also high in Dodorghaz gol 347 m², followed by 147 m² in Mastuj village and 55 m² in Ghuru gol. Number of seedlings were high in Mastuj village 16 m², followed by 7 m² in Ghuru gol and 5 m² in Dodorghaz gol. The population density showed that female plants were more followed by male plants and bisexual plants respectively in the area.

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GENERAL INTRODUCTION

Location of the area

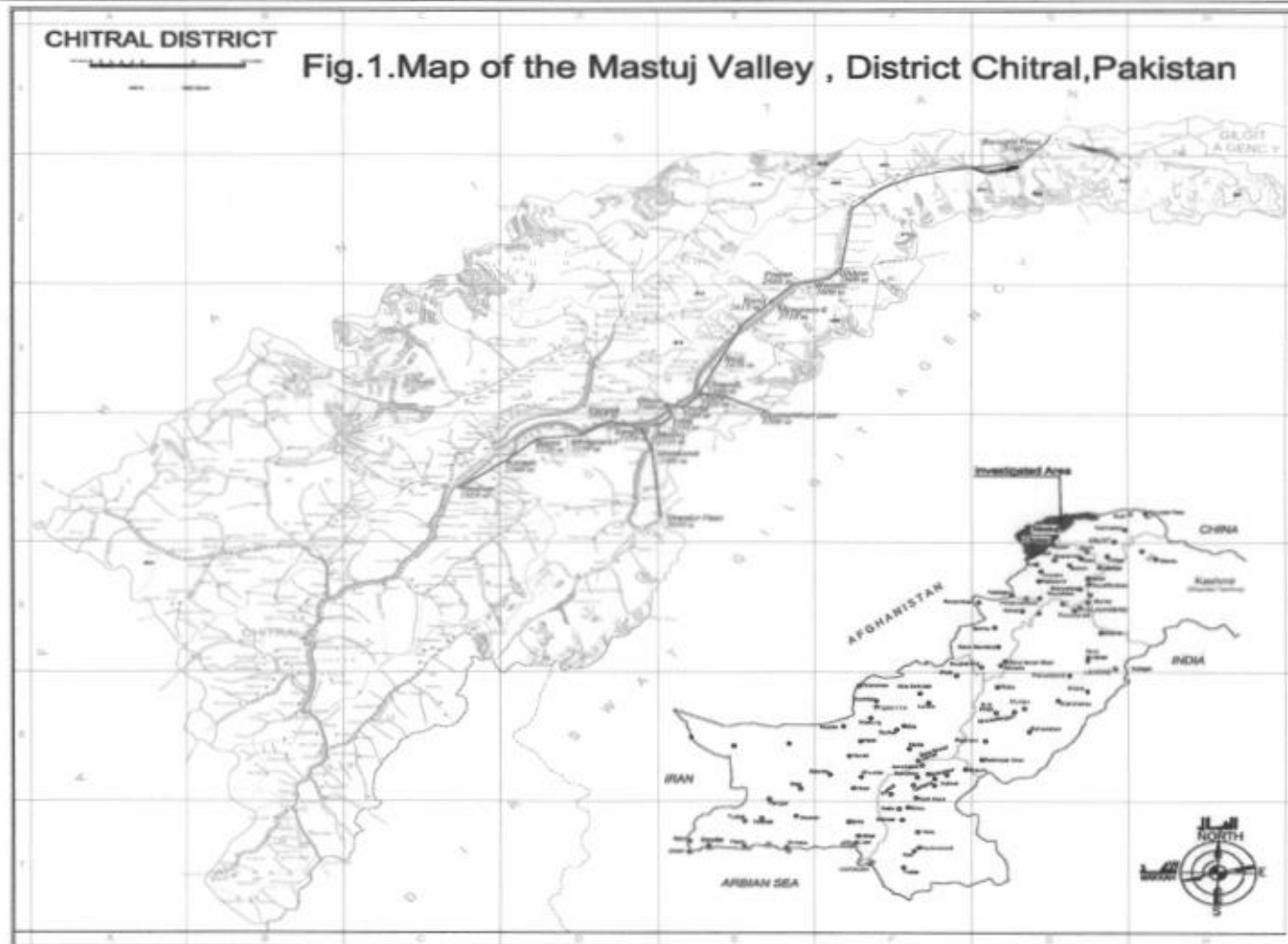
District of Chitral lies between $71^{\circ}-12'$ and $73^{\circ}-53'$ east longitude and $35^{\circ}-13'$ and $36^{\circ}-55'$ north latitude. It has an area of 14850 km^2 (Census report, 1998). The altitudinal range within the district varies from 1396 m to as high as 7685 m at Tirchmir. Mastuj Valley, District Chitral, lies in between $72^{\circ}-0'$ and $37^{\circ}-58'$ east longitude and $36^{\circ}-2'$ and $36^{\circ}-57'$ north latitude. The valley stretches about 110 km starting from Reshun up to Ghazin (Fig. 1). It is the northeastern part of district which is bounded on the north by Baroghil Pass (3600 m), on the south by Shandur Pass (3810 m), on the east by Chumarkhan Pass (4100 m) and on the west by Chitral sub-division (1500 m). The altitude of the Mastuj Valley varies from 2000 m to 4500 m.

History

District Chitral has always been a very important route for many invaders to South East Asia, including Alexander the Great, Scythians, Mongol Chagiz Khan and many others. Mastuj Valley formally became a part of Chitral state in 1895. Chitral was ruled by Mehtar as a princely state till 1969. Historically Chitral appeared with the Tibetans invading Yasin in the 8th century A.D, followed by the Chinese in 750 A.D, who were defeated by the Arabs. Buddhists followed in 900th A.D. Chitral became a unified independent kingdom in the 14th century which was ruled by Shah Nasir Rais. He was replaced by the Kator dynasty in 1570. The first Mehtar of Chitral Aman-ul-Mulk ruled from 1857 to 1892. During the great siege of Chitral fort in 1895 which lasted for months Nizam-ul-Mulk was killed by his half brother. In 1947, the Mehtar Amir-ul-Mulk acceded Chitral state to the Pakistan. In 1969, Chitral State was formally merged into Pakistan (Meadows & Meadows, 2000).

Religion

The main religious groups in the area are Ismaili and Sunni Muslims. The later being in majority. The followers of both these sects are open minded and live in complete harmony with each other. There are separate places of worship of Shia Imami Ismaili Muslims called Jammats and Mosques for Sunni Muslims. The main minorities in Chitral are the Wakhi in the Pamir and the Kalash in the Kalash Valleys.



Traditions

The people are hospitable, liberal and sincere. Traditionally, the people wear shalwar kameez, woolen caps, waskat and cloak. All the Islamic traditions including Eids, Namaz-e-Barat and Youm-e-Immamat are celebrated with great respect and enthusiasm. Descending of ranchers after summer grazing from alpine pastures are also celebrated with distribution of dairy products and rehabilitation of ranchers. Some of the traditions such as Phindek and Salgharak which were the sign of fruiting of new crops and commencement of new year have been ignored by the new generation.

Education

Primary, middle, matric and intermediate levels of education constitute 54.17%, 18.82%, 16.58% and 5.39%, respectively. The percentage of the population with graduate and above is hardly 5% of the total educated people of the district. The literacy increased after establishment of AKESP school systems and participation of private sector. Aga Khan Education Service has educational institutions and programmes in Pakistan including Chitral.

Climate

The Climate of District Chitral varies due to altitudinal differences from subtropical to alpine. It is distinctly continental type with hot summers ranging from very hot in lower altitudes (Drosh, Chitral), cool at high elevations and ultimately alpine type above 3000m. The extreme maximum temperature recorded in Chitral city in July is 36°C and minimum is -0.9°C for the months of January. The district receives rainfall between 250 to 1000 mm depending on the aspect and location. The summer and autumn season receives about 32% of the total annual rainfall. Rainfall is less with seldom torrential rains in spring and summer. Autumn are windy and cold while winters are snowy. Snowfall starts from December to March burying the vegetation in most parts of Chitral especially at high altitude like Mastuj. During winters the water bodies become frozen in the upper reaches. The recorded climatic data during the research period in the

investigated area is presented in Tables (1, 2). Maximum soil temperature recorded was 46 °C at Reshun while minimum soil temperature remained 2 °C at Baroghill Pass. Maximum air temperature was 42 °C at Reshun while minimum air temperature was 7 °C at Chapali and Ghazin. Maximum humidity was 80 % at Chapali while minimum humidity remained 49 % at Booni. Maximum light intensity was 1808 at Brep while minimum was 103 at Koragh. pH indicated that all the soils were acidic except Chapali and Baroghill Pass which have basic soils. Maximum wind chill was 44.3 % at Chumarkhan Pass while minimum wind chill was -0.8 % at Yarkhun. Maximum heat index recorded was 42.1 °C at Chumarkhan Pass and minimum heat index was -0.8 °C at Yarkhun. Maximum dew point was 33.8 % at Koragh while minimum was -9.9 % at Bang. Maximum baro metric pressure was 812 % at Booni while minimum was 620 % at Shandur Pass.

Geology

The entire terrain is mountainous composed of igneous, sedimentary and metamorphic rocks. The rocks undergo successional processes and are ultimately converted into soil with specific texture and structure. A Devonian laterite has been discovered near Reshun in the Mastuj valley. It is belived to be the fourth recorded Paleozoic laterite in the world (Stauffer, 1969).

Edaphic factors

Soils of varying texture and structures are found in the area. The soils are mostly sandy and stony along the water courses and in the foot hills. The upper part of mountains has thin soils and is comprised of bare rocks with some soil in cracks and crevices. The valley floor has alluvial soil mainly transported and deposited by the hill torrents, avalanches and glaciers. Soils have different colours like white, dark, red and yellow at various places depending upon the parent material and weathering processes. The amount of organic matter is comparatively poor due to sparse vegetation, erosion and degradation processes. The physico-chemical characteristics of soil determines the vegetation type and its productivity.

Table 1. Climatic data of soil temperature, air temperature, humidity and light intensity in different sites of Mastuj Valley, Pakistan.

Sites	pH	Soil Temperature (°C)						Air Temperature (°C)			Humidity (%)			Light intensity (L)		
		Surface Soil			Below Soil											
		Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
1.Reshun	7	46	25	31.5	45	24	30.8	42	32	36.4	66	58	61.9	962	293	686
2.Koragh	6	37	23	28.4	36	22	27.4	36	23	29.3	90	56	70.9	965	103	803
3.Booni	6	43	18	29.5	38	17	27.8	39	26	30.3	72	49	56.8	1794	655	992
4.Parwak	7	42	23	32.9	41	22	31.7	39	24	32.2	80	52	63.3	1003	717	945
5.Shandur Pass	6	37	22	28.9	36	21	27.5	30	17	22.3	65	51	57.6	1003	970	996
6. Chuing	6	29	10	18.5	28	11	17.6	32	12	22.2	89	54	65.3	1001	365	902
7. Chapali	8	24	6	14.9	23	5	13.9	26	7	19.1	100	60	76.4	1003	385	831
8.Chumarkhan Pass	7	20	12	15.5	19	13	15.3	17	9	12.3	80	59	67.8	1335	515	106
9.Brep	6	34	19	25	32	18	24.2	23	18	20.8	69	51	57.2	1808	301	900
10.Bang	6	40	15	30.6	37	13	29.5	26	19	21.5	66	52	56.7	1001	404	813
11.Power	6	25	6	10.1	23	6	9.5	18	12	15.4	98	80	91.8	1776	232	774
12.Wasum	5	12	10	10.9	12	9	10.4	13	8	11	84	66	71.9	1792	530	1116
13.Ghazin	7	14	8	1.7	14	9	11.1	14	7	10.5	75	66	71.7	1728	224	735
14. Baroghill Pass	8	14	2	7.4	14	1	6.7	18	9	12.2	76	62	66.1	853	233	582

Table 2. Climatic data of wind chill, heat index, dew point and barometric pressure in different sites of Mastuj Valley, Pakistan.

Sites	Wind chill (ms ²)			Heat index (°C)			Dew point (°C)			Barometric pressure		
	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
1. Reshun	31	26.9	29	41.6	26.2	32	27.3	10.3	19	807	800	802
2. Koragh	36	24	30	40.7	23.1	28	33.8	8.3	16	806	762	800
3. Booni	39.9	20.6	33	40.1	19.4	34	22.5	7.8	15	812	768	786
4. Parwak	34	26.3	30	37.4	25.8	30	19.4	6.9	13	774	763	768
5. Sarghuz	31.7	31.6	32	30.8	29.7	31	10	3.2	4	765	758	761
6. Shandur Pass	33.7	17.4	26	31.1	14.9	24	12.8	0.7	5	730	620	671
7. Mastuj	33.1	18.4	28	40.3	20.4	28	24.6	3.9	14	774	753	672
8. Toq	33.7	21.3	26	37.1	17	24	24.5	3.7	11	776	757	785
9. Chinar	29.9	29.8	30	30.2	28.8	29	13.5	8.3	11	761	760	760
10. Ghuru	34.8	26.3	31	39.4	25.6	31	24.1	7.5	14	768	760	762
11. Chuving	26.5	19.2	23	26.4	16.9	22	12.7	-0.1	5	771	756	662
12. Chapali	26.6	8.6	19	26.1	8.1	18	10.7	-0.5	2	779	759	771
13. Chumarkhan Pass	44.3	5.2	18	42.1	5	17	17.9	-2.4	5.24	773	647	710
14. Brep	17.8	4.4	10	16.2	4	9	4	-8.5	5.96	762	759	760
15. Bang	3.6	2.9	4	3.1	2.6	3	-12.7	-9.9	-11.3	760	752	765
16. Power	30.6	10.4	20	32.6	9.6	21	18.1	-0.8	10	756	741	749
17. Wasum	14.7	9	12	13.5	8.6	11	2.9	1.8	2.35	746	745	745
18. Ghazin	35.7	8.7	21	39.2	8	20	20.5	-9.4	7.22	768	710	632
19. Yarkhun	23.3	-0.8	10	23.5	-0.8	9	15.7	-14	6.01	731	695	701
20. Baroghill Pass	22.3	2.1	12	21	1.8	11	13.5	-14	5.39	694	687	691

Topography

Topography determines the structure of vegetation and its productivity. Generally the valley floors are more productive than the eroded slopes. The south and west facing slopes are hot and dry having poor vegetation. The east and north facing slopes are cool with thick vegetation. The alpine regions have their own characteristic vegetation type due to snow bound soil, chilling temperature and short growing season. The tree line lies above 3500 m, where trees are absent.

Hydrology

The Chitral river runs over a total length of 300 km. The vegetation and human settlements directly or indirectly depend on rivers and their tributaries. The Yarkhun River joins the Laspur River near Mastuj to form the Mastuj River. It is major source of agriculture, domestic supply and generation of hydroelectricity and running of watermills. The water discharge increases during summer due to melting of glaciers.

Deforestation

The harsh environmental conditions and lack of alternate energy resources have resulted in extensive deforestation of vegetation in the area. Collection of plants for fuel wood, medicines, fodder and timber wood are some of the serious problems. The mountains are barren with low scrubby and herbaceous growth. Deforestation is the cause of many ecological problems in the area which ultimately adversely affect socio-economic status.

Livestock and Grazing

Livestock herding is one the major sources of earning livelihood in Mastuj Valley. Alpine and dry temperate environmental conditions provide insufficient forage during short growing season. During winter the livestock entirely depends on stored fodder. Scarcity of forage production is the major limiting factor for increasing livestock production in Pakistan (Amanullah *et al.*, 2005) and in the alpine vallies. Alpine pastures and lower grazing lands are heavily grazed during growing summer season by livestock

and wild animals. The increase in the population size of grazing animals result in overgrazing of palatable plant species. Grazing is often cited as one of the main factors of forest degradation in the mountains of HinduKush Himalayas (Ali & Shah, 2004). Mostly cows, goat, sheep are reared in the valley.

Wildlife

Wildlife including the non- domesticated animal species, is one of the natural resources, inhabiting in microhabitats and maintaining the ecological balance. Conservation strategies and sustainable use increase the population of wild animals. The wildlife animals have been traditionally exploited and lavishly killed by the influential personalities and local hunters. The wildlife include annelids, arthropods, amphibians, aves, pisces, reptiles, deer, ibex, markhor, leopard, bear, wolf, foxes and Himalayan pit viper, etc which are near extinction due to overhunting (Table 3). Many migratory and residential birds including chukar, brown and black partridges, snow partridge, pigeon, ducks and cranes are also hunted. The migratory birds have declined in the area over the years.

Agriculture

Agriculture is possible only where soil is suitable. Almost every house hold has small farms for cultivation where irrigation from rivers and springs is possible. The traditional bullocks ploughing have been replaced by mechanical ploughing by tractors. The crops include wheat, maize, barley and rice.

Horticulture

The valley is known for variety of fruits which are grown in house gardens, orchids and are also found wild. Besides providing fruits they are also source of fuel wood, timber wood and fodder. The fruits are used both in fresh and dried form and are locally sold. Cultivation, collection, drying and packaging based on proper techniques increase the productivity and marketing. Some of the fruits are medicinally effective and

edible oil is extracted from the seeds of some fruits. Apples, apricots, mulberry, plum, grapes, peach, walnut and pears are widely grown.

Afforestation

Afforestation includes the cultivation and propagation of plants such as *Populus*, *Salix*, *Elaeagnus* and *Ailanthus* at certain suitable places mainly to meet the fuel wood and timber wood requirement of the locals.

Rangeland resources

Land that is not farmed, forested or irrigated is called rangeland. Rangelands are mostly privately owned and are used for seasonal grazing and for collection of plants for domestic and commercial uses. Alpine areas, piedmonts and eroded lands are used as rangeland. Major portion of the valley comprising upto 90% land is classified as rangeland. The grazing starts from early spring (April) to the beginning of snowfall (November) in the area. The rangelands in Mastuj Valley are highly degraded and deteriorated that calls for quick ameliorative measures to rehabilitate deteriorated range ecosystem. The most important activity in range improvement is enhancement of forage production through introduction and establishment of ecologically suitable and high yielding forage species.

Ecological Problems

Erosion

Erosion is one the major problems. Soil is eroded by water, land sliding, melting of glaciers, out flowing of rivers during summer, torrential rains and wind. River erosion as a hazard has been considered as second most important ecological problem of the area that was reported from 22 villages: 5 in Chitral valley and 17 in Mastuj (Nasir *et al.* 2003).

Water logging and Salinity

Water logging and salinity are the twin ecological problem hindering agricultural and constructional practices. The low laying areas adjacent to water bodies suffer the problem of water logging and salinity in the investigated area.

Table 3. Wildlife animals of Mastuj Valley, District Chitral, Pakistan.

S.No.	Animal species	Local names	Zoological names	Status
A. Annelids				
1.	Earthworm	Machighough	<i>Eisenia felida</i>	Common
B. Arthropod				
2.	Ant	Pelele	<i>Lasius niger</i>	Dominant
3.	Butterfly	Phoulmunduk	<i>Lycaeides argyrognomon lotis</i>	Common
4.	Dragonfly	Ghachodayk	<i>Libellula aenea</i>	Common
5.	Housefly	Magas	<i>Musca domestica</i>	Frequent
6.	Honeybee	Macheghough	<i>Apis mellifera</i>	Rare
7.	Praying mantis	Shalako	<i>Mantis religiosa</i>	Rare
8.	Scorpion	Zinghough	<i>Hemiscorpius lepturus</i>	Common
9.	Silkworm	Kachghough	<i>Bombyx mori</i>	Rare
10.	Spider	Shobenak	<i>Nephila clavipes</i>	Common
11.	Wasp	Bespe	<i>Vespa vulgaris</i>	Common
C. Amphibian				
12.	Frog	Boughuzu	<i>Rana tigrana</i>	Frequent
D. Aves				
13.	Chukar partridge	Kolu	<i>Alectoris chukar</i>	Endangered
14.	Dove	Kalkor	<i>Columbia talpacoti</i>	Rare
15.	Golden oriol	Mayoon	<i>Oriolus oriolus</i>	Rare
16.	Hoopoe	Bubuk	<i>Upupa epops</i>	Rare
17.	House sparrow	Chilebouthu	<i>Passer domesticus</i>	Dominant
18.	Jungle crow	Kagh	<i>Corvus macrorhynchos</i>	Rare
19.	King fisher	Oughale	<i>Alcedo atthis</i>	Rare
20.	Magpie	Keshepe	<i>Pica pica</i>	Dominant
21.	Myna	Myna	<i>Sturnus pagodarum</i>	Dominant
22.	Owl	Bou	<i>Bubo Sp.</i>	Rare
23.	Pigeon	Kovour	<i>Columba livia</i>	Endangered
24.	Quail	Bahati	<i>Ophrysia superciliosa</i>	Rare
25.	Shrike	Toufe	<i>Lanius tephronotus</i>	Common
26.	Snow partridge	Toteru	<i>Lerwa lerwa</i>	Endangered
27.	Swallow	Shrophelong	<i>Hirundo rustica</i>	Common
28.	Wood pecker	Kanchouch	<i>Melanerpes aurifrons</i>	Rare
E. Pisces				
29.	Trout	Machi	<i>Salmo Sp.</i>	Common
F. Reptile				
30.	Agama lizard	Dodor	<i>Agama causasica</i>	Common
31.	Himalayan pit viper	Ayee	<i>Agkistrodon himalayanum</i>	Rare
G. Mammal				
32.	Bat	Poastwazur	<i>Lasiurus sp.</i>	Rare
33.	Bear	Oush	<i>Ursus arctos</i>	Rare
34.	Deer	Tonesho	<i>Cervus Spp.</i>	Endangered
35.	Fox	Lowe	<i>Vulpes bucopus</i>	Common
36.	Ibex		<i>Capra ibex</i>	Endangered
37.	Jackal	Gedel	<i>Canis aureus</i>	Rare
38.	Leopard		<i>Panthera uncia</i>	Rare
39.	Markhor		<i>Capra falconeri</i>	Endangered
40.	Rabbit	Ghoali	<i>Lepus sinensis</i>	Rare
41.	Wolf	Shapeer	<i>Canis lupus</i>	Frequent

REVIEW OF LITERATURE

Floristic composition and its characteristics

Angassa & Baaras (2000) assessed the range condition in six communal grazing areas and recorded 41 grasses, 4 legumes, 3 sedges and 28 trees / shrub species. Gutkowska *et al.* (2002) presented data on the distribution of 69 interesting and geobotanically important species from the Dynow Foothills (Western Carpathians), including 14 mountain species and 7 species not native to the area. Mark *et al.* (2001) while describing the vegetation and life-forms in the alpine zone in southern Tierradel Fuego recorded 80 vascular plants. Of them, 59% were hemicryptophytes and 38% were chamaephytes. Musila *et al.* (2001) recorded 156 plant species of 60 families. Gramineae and Papilionaceae were the dominant families. Batalha & Martins (2002) prepared Raunkiaerun life-form spectra from Cerrado sites and from other vegetation types which was dominated by hemicryptophytes and phanerophytes. Catarino *et al.* (2002) studied the flora of Cufada lagoon and recorded 46 vascular plant species.

Burke *et al.* (2003) investigated the floristic composition of southern African Nama Karoo. Changwe & Balkwill (2003) reported 254 plant species from South Africa. Dar & Christensen (2003) recognized seven taxa of *Juniperus* from the Western Himalayas. Lehnebach (2003) listed seven genera and 50 species of orchids including 25 endemic to Chile. Melendo *et al.* (2003) investigated the taxonomic composition and four ecological characteristics (life-form, seed dispersal, pollination and reproductive mode) of 553 endemic species occurring in the south of the Iberian Peninsula. Predominant life-forms were chamaephytes (45%) and hemicryptophytes (33%). Zhu *et al.* (2003) reported 1394 vascular plants of 642 genera and 153 families from China. Devi & Sharma (2004) studied the life-form and biological spectrum of the macrophytes in the Loktak lake, Manipur. Of the total 86 species, 36 were therophytes, 16 were hemicryptophytes, 11 were geophytes, 7 each were hamaephytes and errant vascular, 8.14% hydrophytes and 1.16% were phanerophytes. Eilu *et al.* (2004) reported 53 families, 159 genera and 212

species from forest of Albertine Rift, Western Uganda. Heinrich & Hurka (2004) investigated floristic composition and life-form in northwestern Costa Rica. They reported 328 plant species of 79 families and 247 genera.

Burke (2005) investigated the Isenberg flora in relation to environmental variables and landscape levels. Cramer (2005) revisited the flora of Sri Lanka. Golluscio *et al.* (2005) reported the phenological patterns of plant species of a Patagonian steppe, which are composed of perennial grasses, shrubs, and herbs. Muoghalu & Okeesan (2005) worked on species composition, abundance and tree relationship of climbers along altitudinal gradient at Ile-Ife, Nigeria. Nusbaumer *et al.* (2005) described the structure and floristic composition of 534 species of forest of Scio, Coted Ivoire. Estrella *et al.* (2006) prepared a checklist of 52 genera and 124 taxa of Caesalpinoideae from Equatorial Guinea. Poulsen *et al.* (2006) studied the edaphic and floristic variation within a 1-ha plot of lowland Amazonian rain forest. They documented soil characteristics and compared them to the distribution patterns of terrestrial pteridophytes, angiosperms, ground herbs and palms. Ssegawa & Nkuutu (2006) while working on floristic richness and composition, recorded 179 species belonging to 70 families and 146 genera from forests in the Ssesse Islands of Lake Victoria, Central Uganda.

Alelign *et al.* (2007) recorded 113 woody plant species, their composition, density, diversity and population structure. Costa *et al.* (2007) reported 133 plant species of 47 families. There were 42.9% therophytes, 26.3% phanerophytes, 15.8% chamaephytes, 12.8% hemicryptophytes and 2.3% cryptophytes. Davidar *et al.* (2007) prepared floristic inventory of plant species in the Palni hills, India. He recorded 83 species belonging to 68 genera and 40 families. Devineau & Fournier (2007) reported 130 herbaceous plant species from west Africa. Laidlaw *et al.* (2007) described the floristic and structure of tropical rain forest at cape tribulation, Queensland. The most abundant families were Meliaceae, Euphorbiaceae, Lauraceae, Myrtaceae and Apocynaceae. Yadav & Gupta (2007) recorded 82 plant species in Sariska Tiger Project,

India. Shukla (2009) determined plant species diversity along Terai landscape in Northeastern Uttar Pradesh and reported 615 species of angiosperms within an area of 10,000 km. Ray & George (2009) reported 85 species of 27 families during floristic survey and phytosociological analysis in South India. Al-Yemeni & Sher (2010) reported 189 plant species of 74 families from Asir Mountain Saudi Arabia. Djuikouo *et al.* (2010) recorded 281 plant species in the Dja Biosphere Reserve, Cameroon. Gwali *et al.* (2010) recorded 2745 trees and shrubs in Kasagala woodland, Uganda. Parswan *et al.* (2010) studied the floristic composition and biological spectrum of vegetation of alpine meadows of Kedarnath and reported 80 species of 36 families. Almeida Jr *et al.* (2011) identified 51 species of 36 genera and 31 families in restinga, Brazil. Myrtaceae was the leading family followed by Fabaceae. Kotresha *et al.* (2011) reported 303 plant species of 238 genera and 75 families from Karnataka, India. Fabaceae was the dominant family with 44 species.

In Pakistan following studies on floristics and their characteristics are available.

Hussain *et al.* (2000) reported 92 species of 56 families from Ghalegay Hills, District Swat. Marwat & Qureshi (2000) recorded 383 species of 110 families including 5 conifers, 43 were broad leaved trees, 56 shrubs and 279 herbs from upper Siran Reserved and Guzara forests. Bhatti *et al.* (2001) reported 150 plant species from the Nara Desert, Sindh. Ahmad *et al.* (2005) recorded 29 aquatic vascular plants of Islamabad. Durrani *et al.* (2005) while describing ecological characteristics of plants of Harboi rangeland reported 202 plant species of 45 families. Qureshi & Bhatti (2005) reported 160 plant species belonging to 118 genera and 45 families from Nara Desert, Pakistan. Qureshi & Bhatti (2006) reported 25 species of monocot families from Nara Desert, Pakistan.

Shah & Hussain (2007) reported 42 plant species of 31 families in the salt-affected and waterlogged habitats around Chamkani, District Peshawar. Therophytes were dominant followed by chamaephytes. Leptophylls were leading leaf-size class

followed by nanophylls. Sher & Khan (2007) reported 222 plant species of 88 families from Chagharzai Valley, District Buner. They stated that therophytes and nanophanerophytes were dominant life-forms while microphylls and mesophylls were important leaf-size classes. Zabiullah *et al.* (2007) reported 279 species of 81 families from Manzaray Baba Valley. Khan & Sardar (2008) reported 317 species of 245 genera and 83 families from Shakargarh, District Narowal. Perveen *et al.* (2008) reported 79 plants from Dureji game reserve with chamaephytes as the dominant life-form. Hussain & Perveen (2009) reported 70 species of 59 genera and 31 families from Tiko Baran, Khirthar Range. Durrani *et al.* (2010) reported 123 plant species of 36 families from protected sites and 28 species from unprotected sites from Aghberg rangeland, Balochistan. Khan *et al.* (2011) reported 54 plant species of 30 families from coal mine area of Darra Adam Khel. Saima *et al.* (2010) reported 167 plant species of 65 families from Ayubia National Park, District Abbottabad. Asteraceae was dominant followed by Lamiaceae. Qureshi *et al.* (2011) identified 62 plant species belong to 45 genera and 25 species while studying the Khunjerab National Park. Shaheen & Qureshi (2011) reported 114 species of 28 families, while studying the vegetation of Sheosar Lake and surrounding landscape. Asteraceae was the leading family followed by Ranunculaceae.

The available references on floristics of Mastuj are reviewed as follows.

Shah *et al.* (2006) reported 218 plant species of 63 families from Mastuj, District Chitral. Therophytes were dominant followed by hemicryptophytes while leptophylls were leading leaf size class.

No other reference on plants of Mastuj Valley can be traced, therefore there is need to bring on record the flora and its ecological features.

Ethnobotany

Ethnobotanical informations are the basis of many noval products especially from medicinal point of view. Thus lot of studies have originated in this field.

Kappelle *et al.* (2000) carried out ethnobotanical survey in a Costa Rican montane cloud forest. Of the recorded 590 species, 39.7% were used for food, 24.3% for construction and 23.8% were used for medicinal purposes by the Campesino community. Mathooko & Kariuki (2000) reported the ethnobotany of riparian vegetation which were mostly used as medicine. Olsen & Larsen (2003) investigated the importance of alpine medicinal plants in Nepal. The annual Nepalese alpine and sub-alpine medicinal plants trade is conservatively estimated to vary from 480 to 2500 tons with a total harvest value of US\$ 0.8-3.3 million. Basnet & Chhetri (2004) reported 32 species of fiber yielding plants used by the local people from Darjeeling Himalaya. Kakudidi (2004) recorded 89 plant species used for cultural and social purposes in Western Uganda. Majority of the plants were used in wedding ceremonies. Macia (2004) described the uses of palm in Amazonian Ecuador. Naika & Govindan. (2004) described many pharmaceutical values of mulberry. Omeja *et al.* (2004) reported that tree species were used in making drums in central Uganda. Rathod & Chaudhary (2004) described the biodiversity of 40 medicinal plants from Patnadevi forest of Maharashtra, India. Turkmen *et al.* (2004) reported 37 dye yielding plant species of Turkey. Yuming *et al.* (2004) described the diversity and traditional uses of Bamboo in Yunnan, China.

Kala (2005) described the ethnobotany of 60 threatened medicinal plants of Indian Himalayas. Alm (2006) presented the ethnobotany of *Linnaea borealis* (Linnaceae) in Norway which has a long standing reputation as a cure for shingles (*Herpes zoster*) in Norwegian folk tradition. Tardio *et al.* (2006) recorded 419 plant species belonging to 67 families and ethnobotanically review wild edible plants from Spain. Adhikari *et al.* (2007) reported 222 medicinal and aromatic shrub species used in Uttaranchal State, India. Arenas & Scarpa (2007) described 57 edible wild plants of the

Chorote Indians being used as a source of food in 118 different ways. Bebbber *et al.* (2007) described the ethnobotany and the first printed records of British flowering plants. Okello & Ssegawa (2007) described the ethnobotany of 88 medicinal plants from Ngai subcounty in Apac District, Uganda. Roots were the most commonly harvested parts.

Addo-Fordjour *et al.* (2008) reported 52 medicinal plants from Aparapi Forest Reserve at Bomaa, Ghana. Leaves were the most commonly harvested plant parts. Poonam & Sing (2009) reported 116 medicinal plant species from Terai Arc Landscape, India. Twenty three species were used for curing skin diseases, 16 for rheumatism and 14 against fever. Oryema *et al.* (2010) reported 180 medicinal plants belonging to 144 genera and 57 families from Erute County, Lira district, Uganda. Cheikhoussef *et al.* (2011) reported 61 medicinal plants of 25 families from Oshikoto region, Namibia. Kumar *et al.* (2011) described 61 medicinal plants of 32 families from Garhwal Himalaya, India. Mwine *et al.* (2011) reported 34 pesticidal plants from South Uganda. Most useful species were *Azadirachta indica* and *Tagetes minuta*. Uysal *et al.* (2012) reported 43 medicinal plants from Ayvacik, Turkey. The plants were mostly used for cough, stomach ache and kidney ailments.

Many studies on the ethnobotany of plants from various parts of Pakistan have also been made. Some of the recent studies are summarized as follows:

Sheikh *et al.* (2002) reported 24 species from Naltar Valley which are valued for local medicinal uses and other commercial uses. Ahmad *et al.* (2003) reported that 30 cultivated species are used by the locals for medicinal, shelter, food, ornamental, fuel and fodder purposes in Chhuchh region, District Attock. Gillani *et al.* (2003) reported 54 ethnomedicinal plants used by the local people for different diseases from Kurram Agency. Sher *et al.* (2003) documented 78 medicinal plants from Udigram, Swat. They stated that some of the species have been over harvested. Ahmad *et al.* (2004 a) studied the antidiabetic efficacy of fresh leaves extract of *Adhatoda vasica*. Ahmad *et al.* (2004

b) stated that 41 wild plants are used by the local inhabitants for medicinal purposes in Galliyat areas, District Abbotabad. Aman & Khan (2004) listed 60 medicinal plants from Sama Ranizai, Malakand Agency. Awan *et al.* (2004 a) described 16 spice plants of 12 families that have traditional and medicinal uses in Neelum Valley, Azad Kashmir. Awan *et al.* (2004 b) described folk use of medicinal plants of Daokhun and allied areas of Jhelum Valley. Badshah *et al.* (2004) reported 187 species of 66 families of various traditional uses. Dastagir & Abbasi (2004) documented 13 plants used for the treatment of jaundice in District Haripur. Hussain *et al.* (2004 a) reported 258 species of ethnobotanical importance from various parts of District Swat. Sher *et al.* (2004) reported 29 ethnoveterinary medicinal plants that were used for treatment of livestock ailments in Shawar Valley, District Swat. Wazir *et al.* (2004) reported 41 medicinal plants from Chapursan Valley, Gilgit, having various uses.

Abbasi *et al.* (2005) recorded 32 species of ethnomedicinal importance of District Haripur. These plants are being used for curing asthma, jaundice, rheumatism and indigestion. Hussain *et al.* (2005) reported 253 medicinal plants from District Swat. Majority of the plants (55%) were used for gastrointestinal disorders. Khan *et al.* (2005) noted 16 medicinal plants from Naltar Valley, District Gilgit. Badshah *et al.* (2006) observed that 26 plants are used as fuel wood in Ladha, South Waziristan. Durrani & Manzoor (2006) reported 110 species of ethnobotanical importance found in S.B.K Women University, Quetta, which were used for different purposes. Hussain *et al.* (2006 a) while preparing ethnobotanical profile of plants of Shawar Valley reported 121 plants used for various purposes. Hussain *et al.* (2006 b) described 67 medicinal plants used in traditional health care system in Ladha, South Waziristan. Sher & Khan (2006) reported 87 plants of medicinal and economic plants from Malam Jabba Valley, District Swat. Sultana *et al.* (2006) documented 38 species used by local inhabitants for the treatment of various diseases in District Chakwal.

Manan *et al.* (2007) described 52 medicinal plants of 35 families from Wari, District upper Dir. Wazir *et al.* (2007) reported 30 medicinal plants of salt range in District Karak and its surrounding areas, which were used for treating various diseases. Badshah & Hussain (2008) reported 20 species of 18 families of ethnomedicinal value from village Tabai, South Waziristan. Ten species were effectively used for women diseases and the 10 species were used for curing different diseases in children. Khan & Khatoon (2008) reported 98 herbaceous medicinal plants of Haramosh and Bugrote Valleys in Gilgit. Shah & Hussain (2008) described the ethnobotany of 76 plant species of 52 families from Mount Elum, District Bunir, Pakistan. Most of the plants were used as medicinal, fuel wood and as timber wood. Durrani *et al.* (2009) reported 124 plant species of ethnobotanical importance from Quetta. Most of the plants were used as fodder and medicinal. Jan *et al.* (2009a) described the medicinal and economic uses of gymnosperms of Dir Kohistan Valleys. 11 species of four families were recorded. Jan *et al.* (2009b) reported 42 plant species used for the treatment of jaundice in Dir Kohistan. Taj *et al.* (2009) recorded 29 medicinal plants from Godi Khel, District Karak. The traditional uses of 52 plant species from Darra'e Pezo, District Lakki Marwat is reported by Zahoor *et al.* (2009). Most of the plants were used as medicinal. Ajaib *et al.* (2010) reported 38 ethnobotanically important plants from Kotli, Azad Jammu and Kashmir. Attaullah *et al.*, (2010) reported 27 medicinal plants from Kurram River beds of District Bannu. Hazrat *et al.* (2010) reported 50 medicinal plants from Usheraï valley, Dir. Qasim *et al.* (2010) described the ethnobotany of 48 coastal plants which were used for 12 different purposes in Hub, Balochistan. Tareen *et al.* (2010) reported 61 medicinal plants from Balochistan. Mahmood *et al.*, (2011) reported 25 medicinal plants of 17 families from District Sialkot. Noor & Kalsoom (2011) conducted ethnobotanical survey in Ratwal village and reported 43 ethnobotanically important species belonging to 33 families. Qureshi *et al.* (2011) reported 48 medicinal plants from arid areas of Khushab, Punjab, which were used for treating 45 different diseases in the area. Qureshi (2012)

reported 39 medicinal plants from Hingol National Park, Baluchistan. Most of the plants were used as tonic, wound healing and cooling agents. Shaheen *et al.* (2012) reported 71 herbs of ethnobotanical importance from alpine pastures of District Bag Azad Kashmir. The study revealed that 45 herbs had medicinal values.

Study made on ethnobotany of Chitral includes following work.

Hussain *et al.* (2004 b) described the ethnobotany of 17 species of fruit plants from Mastuj, District Chitral. Khan *et al.* (2005) conducted an ethnobotanical studies on some medicinal and aromatic plants in District Buner, Swat and Chitral. Ahmad *et al.* (2006) reported 75 medicinal plants of 43 families of ethnobotanical importance from Boooni Valley, District Chitral. Hussain *et al.* (2007) described the traditional uses of 111 species of 46 families from Mastuj, District Chitral. Most of the plants were used as fodder, medicinal and firewood. Ali & Qaiser (2009) reported 83 taxa of medicinal plants from Chitral Valley and found that roots were used in most of the recipes. Khan *et al.* (2011) conducted ethnobotanical survey of Chitral Gol National Park and reported 31 plant species of 21 families.

The review suggests that this area needs more work on the ethnobotany.

Vegetation structure / Phytosociology

Many studies have been made worldwide on the phytosociology and vegetation structure. A brief review is produced below.

Augusto *et al.* (2000) recognized four physiognomic units while studying the forest structure in southeastern Brazil. Broersma *et al.* (2000) described the vegetation structure and soil features of rangelands in British Columbia, Canada. Grillini *et al.* (2000) analyzed structural of the Chambura Gorge forest and found that none of the species reached their maximum height. Shrestha (2000) analyzed aquatic macrophytes by using line intercept method in lake Phewa, Nepal. Shrestha *et al.* (2000) described

vegetation distribution in relation to soil characteristics in Shivapuri Watershed, Nepal. The correlation analysis between the soil parameters and plant species revealed that the variation observed in the vegetation distribution correlates with the variation in the edaphic factors. Yong *et al.* (2000) carried out investigation of the vegetation of Heishiding Nature Reserve in Guangdong and established thirty plant associations under five vegetation types with ten formations. Musila *et al.* (2001) described the composition, structure and distribution of coastal dune vegetation. They recorded 156 plant species of 60 families. Gramineae and Papilionaceae were the dominant families. Mosugelo *et al.* (2002) recorded changes in vegetation cover in northern Chobe National Park, Botswana.

Claros (2003) studied changes in forest structure and species composition in the Bolivian Amazon. Kennedy *et al.* (2003) investigated the relationship between grass species richness and ecosystem stability in Savanna biome. Brown & Bredenkamp (2004) investigated the vegetation of Borakalalo Nature Reserve. Dondeyne *et al.* (2004) studied soils and vegetation of a woodland in southeastern Tanzania and established soil-vegetation relationship. Eilu *et al.* (2004) worked on the distribution of tree species and reported 212 species of 159 genera and 53 families in Albertine Rift forest, Western Uganda. Katende (2004) worked on the vegetation of various lakes and rivers in Uganda and reported 77 macrophytes. Namaganda *et al.* (2004) worked on the distribution of grass species in Uganda and tried to establish ecological link between habitat and grasses. Walpole *et al.* (2004) examined the current status of the woodlands of Masai Mara National Reserve in Kenya and identified 62 woody species.

Fleischmann *et al.* (2005) studied the species composition of an endemic palm forest in Seychelles. Geerken *et al.* (2005) using FFCS classification differentiated five rangeland vegetation types for Syria including their intra-class coverage variation. Mendez (2005) established 33 plant communities in Laguna de Llanqueto Provincial Reserve. Ruiz *et al.* (2005) compared vegetation structure and species richness of Providencia, Columbia. Srivastava *et al.* (2005) conducted vegetation analysis of tree

species in the moist temperate forest of Kewars area. Wesche *et al.* (2005) stated that phytosociological classification of 549 releves yielded 4 community groups with 39 communities in the southeastern Gobi Altay. Costa (2006) measured herbaceous flora in Reserva Ducke, Manaus. Dharani *et al.* (2006) studied the *Acacia xanthophloea* woodland in Lake Nakuru National Park, Kenya. Gould *et al.* (2006) recorded the species composition and ecological attributes of 8 tropical forest plant communities along an elevational gradient. Kumar *et al.* (2006) studied changes in plant diversity and community composition in India. Lovett *et al.* (2006) described the changes in woody vegetation over an altitudinal range of 470–1700m in the Mwanihana forest, Udzungwa Mountains National Park, Tanzania. Poelchau & Mistry (2006) analyzed differences in species composition of plant communities. Devineau & Fournier (2007) assessed the composition and richness of herbaceous species of Western African Sudan Type Savanna. They identified 130 herbaceous species from the study area.

Tripathi & Sing (2009) studied the species diversity, structure and concentration of dominance of woody plants at various strata of natural and plantation forests within the wildlife sanctuary, North India. Kegler *et al.* (2010) conducted phytosociological survey of the primary forests of different areas in Brazil. They proposed five associations, five sub-associations, three alliances, two orders and one phytosociological class. Indreica & Keleman (2011) carried out phytosociological studies in southeastern Transylvania. The canopy cover of the stands ranged from 60-90 %. The shrub layer was always present covered 5-75 %, while herb layer was 5-80 % and was rich in species composition. Altay *et al.* (2012) established thirteen plant communities in Anatolian side of Istanbul, Turkey.

In Pakistan following work is summarized.

Hussain *et al.* (2000) reported 92 species of 56 families distributed among seven plant communities and three major vegetation types from Ghalegay Hills, District Swat. Malik *et al.* (2000) established *Acacia nilotica*-*Haloxylon recurvum* and *Acacia nilotica*-

Calotropis procera at B.Z. University, New Campus, Multan. Chaudhry *et al.* (2001) carried out phytosociological survey of Chumbi Surla wildlife sanctuary, Chakwal and reported 41 grass species. Awan *et al.* (2002) studied the soil and vegetation relationship in District Swat.

Malik & Malik (2004) recognized seven plant communities and reported 58 plant species from Kotli Hills, Azad Jammu and Kashmir. Nazir & Malik (2006) established ten plant communities in Sarsawa Hills, District Kotli and reported that nanophanerophytes were dominant followed by therophytes, hemicryptophytes and megaphanerophytes. Shah & Hussain (2008) conducted ecological investigation of vegetation of Akbarpura and established six plant communities in different seral stages. Abbas *et al.* (2009) established eight plant communities while conducting phytosociological studies within the range of grey goral. Shah & Hussain (2009) conducted phytosociological study of vegetation of Hayatabad and established 5 plant communities. Farooq *et al.* (2010) conducted phytosociological studies in Push Ziarat, Waziristan and established 5 plant communities. The communities reflected the characters of dry temperate entities. Hussain *et al.* (2011) conducted phytosociological study of some selected graveyards of Tehsil Peshawar and established six plant communities. Ullah *et al.* (2011) established five plant communities while conducting phytosociological survey of Tehsil Manki Sharif, District Nowshera. Saeed *et al.* (2012) conducted phytosociological studies to record chasmophytic and epiphytic vegetation in Lahore. 52 chasmophytes and 35 species of epiphytes were recorded.

In Chitral following studies have been made.

Beg & Baksh (1974) recognized five plant communities while studying the vegetation of scree slopes in the Chitral Gol Valleys, Pakistan. Khan (1978) studied the vegetation of Chitral Gol and established five plant communities. Khan *et al.* (2010)

studied the *Quercus* forests in Chitral and found that *Quercus baloot* formed pure vegetation in 5 stands while in 3 stands at high altitude it was co-dominant.

No other reference on the vegetation is available on this area.

Palatability and Animal Preferences

Angassa & Baaras (2000) assessed the range condition in six communal grazing areas and recorded 41 grasses, 4 legumes, 3 sedges and 28 trees or shrub species. Karki *et al.* (2000) compared the nutritive quality and above ground biomass of grazing lawns to neighboring grasslands in Nepal. Mapfumo *et al.* (2000) investigated the impacts of three grazing intensities on four forage species on selected soil physical and chemical parameters of a typical Haplustoll at Lacombe, Alberta. Reed & Clokie (2000) assessed the impact of grazing and cultivation on plant communities. Steinheim *et al.* (2000) analyzed sheep production data for the 10 agricultural landscape regions of Norway and developed a model for explaining variation in autumn weight in terms of environment and breed. Watson & Owen-Smith (2000) investigated the diet composition and habitat selection of eland in a semi-arid shrub land. Baron *et al.* (2001) studied the effects of grazing intensity and pasture species on soil macronutrient status in a typical Haplustoll at Lacombe, Alberta. McIntyre & Lavorel (2001) analyzed plant communities from a cattle grazing experiment conducted in grassy *eucalyptus* woodland in subtropical Queensland, Australia. Salvatori *et al.* (2001) studied the vegetation changes as a consequence of fire and grazing pressure inside the Maasai Mara National Reserve, Kenya. Brits (2002) studied the impact of herbivores on the vegetation in Kruger National Park.

Mapfumo *et al.* (2002) evaluated the effect of grazing intensity on litter and root mass, C and N pools of perennial and annual grasses. Litter, C and N pools generally decreased with increase grazing intensity. Holechek *et al.* (2003) evaluated vegetation changes over a 13 year period on moderately grazed and highly grazed rangelands in the Chihuahuan Desert of South Central New Mexico. Mapinduzi *et al.* (2003) assessed the

effects of grazing and cropping on rangeland biodiversity at macro- and micro-landscape scales in Northern Tanzania. Dyer *et al.* (2004) determined the effects of natural and artificial herbivory on plant fragments. Evans *et al.* (2004) determined seasonal changes in diet selection of cattle in a montane riparian community in Northern Colorado. Giuliano & Homyack (2004) studied the effects of short term grazing exclusion on riparian small mammal communities. Hickman *et al.* (2004) assessed the effect of grazing management on plant communities in a tall grass prairie. Lucas *et al.* (2004) compared effects of different seasons of use and grazing intensities of cattle on young narrow leaf cottonwood (*Populus angustifolia* James) populations and herbaceous vegetation in two adjacent southwestern riparian areas. They stated that increased grazing pressure had no impact on cottonwood population but the effects of season of use were significant on herbaceous species richness and diversity. Volesky *et al.* (2004) evaluated the effects of stocking rate and grazing frequency on herbage dynamics, disappearance and composition of a wet meadow dominated by cool season vegetation. Wang (2004) studied the responses of *Leymus chinensis* to long term grazing disturbance in China. Brereton *et al.* (2005) presented a model that describes the utilization of herbage by cattle in a rotational grazing system. The model considers swards as being structured into two phases: a long phase associated with old during patches and a short phase Chocarro *et al.* (2005) studied the effects of one severe winter grazing of lucerne first harvest in spring by 200kg dry matter (DM) ha⁻¹. Hirata *et al.* (2005) assessed the total available forage and grazing impact over an area of 95034 ha in northeastern Syria. Miller & Thompson (2005) measured the diet of a 1-year old weaner sheep in the Falkland Island. Ross *et al.* (2005) investigated the annual forage yields of intercrops of berseem (*Trifolium alexandrinum* L.) and oats (*Avena sativa* L.) as affected by timing of initial harvest and sowing rate of oats.

Dalle *et al.* (2006) studied the effect of encroachment of woody plants on pastoral livestock production in the Borana lowlands, southern Oromia, Ethiopia. Jackson & Diaz

(2006) experimentally tested plant community responses of spring fed wetlands to two levels of grazing intensity (high and moderate) and no grazing over 10 years. Knoop & Smith (2006) recorded changes in the extent of grazing of different grasses by large African herbivores. Pavlu *et al.* (2006) evaluated changes in plant species composition after imposing different grazing management in the Czech Republic.

Rakotoarimanana & Grouzis (2006) evaluated the combined and separate effects of fire and grazing on botanical composition, species richness and diversity of *Heteropogon contortus* and *Poupartia caffra* dominated savanna. Smit *et al.* (2006) described that unpalatable plant species facilitates tree sapling survival in wooded pastures. Jha (2007) studied the effect of grazing, clipping and altitude on dry matter production and partitioning in some herbaceous forage species. Loeser *et al.* (2007) studied impact of grazing intensity during drought in an Arizona grassland. Peters (2007) used animal enclosures to examine the effect of herbivores on plant species in an intact annual grassland. Tripathi & Shukla (2007) studied the effects of clipping and grazing on various vegetational parameters of grassland communities of Gorakhpur, India. On managed site few species showed high values of phytosociological indices while open natural and moderately grazed sites showed more even distribution of values. Holland *et al.* (2008) studied the effects of grazing management on herbage mass of a *Nardus stricta* grassland in United Kingdom. Glindemann *et al.* (2009) determined the effects of grazing intensity of sheep on herbage mass in China. McEvoy *et al.* (2010) investigated the effect of herbage mass and daily herbage allowance on animal performance. Mohammed & Bekele (2010) reported 213 forage plant species from the main Ethiopian Rift. Bailey & Brown (2011) investigated the effect of grazing systems and grazing behavior on rangelands. Foguekem *et al.* (2011) studied the utilization pattern of wild plant species by elephants in relation to their nutritive values in Waza National Park, Cameroon. Elephants foraged more on nutritionally rich plants. Martens & Entz (2011) reviewed

integrating green manure and grazing system in Canada. Miranda *et al.* (2011) assessed plant palatability according to herbivore foraging decision.

In Pakistan following studies on palatability are important.

Peer *et al.* (2001) studied the effect of grazing on vegetation and altitudinal zonation in Hindu Kush Range. Rafique (2005) described the current use of forage resources and its implications for sustainable development of the northern mountainous region of Pakistan. Sher *et al.* (2010) studied the impact of nomadic grazing on medicinal plants diversity in Miandam, Swat. Results showed that nomadic grazing poses serious threat to the occurrence and the distribution of medicinal flora. Rahim *et al.* (2011) suggested the importance of indigenous fodder trees for landless and mobile pastoralists in Northern Pakistan.

Rangeland productivity

Bork *et al.* (2001) evaluated the dependence between grassland herbage production and precipitation within the Boreal region of Central Alberta, Canada. Bebika & Sharma (2004) noted variations in the values of net primary production of the different macrophytic species in the Sanapat lake Manipur for a period of one year at monthly intervals in 5 different sites. The heighest production was exhibited by *Alternanthera philoxeroides* which was followed by *Nelumbo nucifera*, *Ludwigia adscendens* and *Eichornia crassipes*. The lake exhibited the occurrence of 34 different macrophytic species during the study period. Beck & Peek (2004) estimated the herbage productivity and ungulate use of northeastern Nevada mountain meadows. DeWalt & Chave (2004) investigated the structure and biomass production of four neotropical forests. Okumu (2004) assessed the primary production and biomass decomposition process in the wetland of the dominant grass species *Loudetia phragmitoides*. Angassa (2005) assessed

the ecological impact of woody encroachment and the responses of herbage yield due to encroachment at three locations in Borana rangeland at the end of the growing season.

Maestre *et al.* (2006) evaluated individual plant and whole community responses to species richness, species composition and soil nutrient heterogeneity. Communities containing *Plantago lanceolata* and *Lolium perenne* responded to nutrient heterogeneity by increasing above and below ground biomass. Starks *et al.* (2006) determined the herbage mass, nutritive value and canopy spectral reflectance of Bermuda grass (*Cynodon dactylon* (L.) Huds.) pastures. Three bermudagrass pastures of varieties Midland and Ozarka and an experimental hybrid received the same field management and stocking rate. Zheng *et al.* (2006) estimated forest biomass production and its allocation patterns in Xishuangbanna. Liddell *et al.* (2007) assessed the above ground biomass of a complex tropical rain forest using a canopy crane and the crown and stem biomass of six major species of tree and palm were measured and calculated. Miyamoto *et al.* (2007) estimated the forest biomass and primary productivity in Indonesian Borneo. Dishi & Daniel (2010) carried out field experiment to evaluate the yield and productivity of forage in Gongoshi grazing reserve, Nigeria. The total forage productivity was found to be 2130 Kg DM/ha. Idi *et al.* (2010) estimated above ground biomass of *Echinochilon fruticosum* and *Helianthemum kahiricum* in the arid zone rangeland of Tunisia. There was a significant relationship between the total biomass production and the mean diameter of the species. Ash *et al.* (2011) measured the influences of utilization rate and resting pastures from grazing on vegetation dynamics at three sites in northeast Queensland, Australia. The reduction in biomass was due to high consumption and decreased primary production. Mousel *et al.* (2011) determined the herbage production response to summer grazing date and October stocking rate on two different sites in Nebraska. Herbage production was not affected by summer or October grazing treatments on the warm season grass dominated site. Increased October stocking rate reduced cool season graminoid production. Pantel *et al.* (2011) determined above ground

net primary production of *Elymus lanceolatus* and *Hesperostipa curtiseta* after defoliation on five land form elements in the northern mixed Canadian Prairie. The productivity varied among land form elements but not with the month of defoliation. Torell *et al.* (2011) estimated grass yield on Blue Gana range from seasonal rainfall and moisture measurement. Volesky *et al.* (2011) determined the effects of defoliation intensity and frequency on root characteristics and herbage production of *Elymus trachycaulus*, *Carex nebrascensis* and *Lotus corniculatus*. Defoliation did not affect root growth and herbage production.

In Pakistan some studies in these respect have been made.

Abbasi & Khan (2004) determined the vegetative growth, herbage yield and nitrogen uptake of white clover in the hilly areas of Azad Jammu and Kashmir. Hussain & Durrani (2007) determined forage productivity Kalat, Baluchistan. Ahmad *et al.* (2009) evaluated dead biomass of *Chrysopogon aucheri* and *Cymbopogon jwarancusa* in Balochistan. Mirza *et al.* (2009) observed that the annual range productivity has declined from an average of 150-180 kg/ha dry matter of forage biomass to 30-45 kg/ha as a result of continuous drought in most part of Balochistan. Chaudhry *et al.* (2010) measured forage production on reseeded/treated and untreated areas in Mari reserve forest, Pothwar tract. The reseeded area produced 7733 Kg/ha forage while untreated area produced 491 Kg/ha forage. Haq *et al.* (2011) carried out vegetation analysis and determined winter season carrying capacity of Dhrabi Watershed, Chakwal. The range was found in good condition with overall carrying capacity of 2.14 ha/AU/4 months.

Chemical Evaluation of Forage Plants

Jiang-ming *et al.* (2000) determined of nutrient elements in plants of Dinghushan forest. Nutrient elements varied at various layers in the forest. Xia-hong *et al.* (2000) reported several chemical constituents such as alkaloids, volatile oils, fatty acids and

others from *Litsea* plants. Bhatta *et al.* (2001) monitored dietary preference and grazing behavior of male Kutchi goats and determined nutritional value of pasture. Sawyer *et al.* (2001) evaluated the nutritive quality of cholla cactus (*Opuntia imbricata*) after removal of spine in New Mexico, USA. Ucar & Blaban (2002) determined over 140 compounds from the wood chips of three important *Juniper* species of Turkey. Monoterpenes exists in minor amounts while the sesquiterpenes with their oxygenated members and sesquiterpenes alcohols consist of the majority of the whole substance.

Ganskopp & Bonnert (2003) carried out elemental analysis of cool season grasses at six sites. Cu, Zn and Na concentrations were below the required levels for beef cattle among all the grasses for all sampling periods. Coskun *et al.* (2004) conducted a study to determine the chemical composition and nutritive value of *Prangos ferulacea*, a fodder plant in the Mediterranean and Middle east regions. Sahito *et al.* (2004) analyzed mineral elements of *Moringa oleifera* and reported that each part of this medicinal plant contains considerable amount of K, Mg, Zn and Ca. Udayakumar & Begum (2004) carried out elemental analysis of medicinal plants used in controlling infectious diseases. Calcium was highest in *Adhatoda vasica* and magnesium was high in *Achyranthus aspera*. Carvalho (2005) compared proximate composition and mineral profile of seeds of lupinus. Rothschild *et al.* (2005) identified 68 compounds from two varieties of *Cannabis sativa*. Bell *et al.* (2006) investigated the effect of cutting height on nutritive value of forage of *Dorycnium* species. Marley *et al.* (2006) investigated the yield and chemical composition of thirteen *Lotus corniculatus* varieties and one *Lotus uliginosus* variety in UK and found that the variety of Oberhaun staldter was most suitable variety for silage production. Andueza *et al.* (2010) compared the nutritive value of two permanent grasslands. Grassland rich in forbs showed higher organic matter digestibility than grassland rich in grasses. Jha (2010) evaluated the seasonal changes in physiochemical properties of soil and forage nutrient in a lowland Nepalese grassland. Jensen *et al.* (2010) compared the nutritive value of herbage of five semi-irrigated pasture species

across an irrigation gradient. Al-Omari (2011) determined 19 essential and toxic trace elements in ten herbal medicines. K, Ca, Fe and Sr were present in all the samples. Gjorgieva *et al.* (2011) determined 9 elements in 4 medicinal plants from Macedonia. All the plant species had large amounts of nutrients and were rich in Mg, Ca and K. Imelouane *et al.* (2011) analyzed four medicinal and aromatic plants for mineral composition in Eastern Morocco. The concentration of macronutrients varied from 0.36 to 46.87 %. Li *et al.* (2011) determined trace elements and heavy metals in *Rabdosia rubescens*. The results showed that the amount of trace elements were high and among heavy metals the amount of Pb was little higher ($4.85 \mu\text{g g}^{-1}$).

In Pakistan few studies have been made on the mineral and nutritional status of fodder plants which are summarized below.

Dastagir & Pervez (2004) presented elemental composition of *Alstonia scholaris*. C, O, K and Ca were present in all parts while the rest of the elements varied in different parts of the plant. Hameed & Dastagir (2004) described the elemental composition of *Polygonum plebejum* and *Polygonum persicaria*. In both the plants carbon and oxygen were present in higher quantities. Pirzada *et al.* (2005) analyzed essential elements and antifungal activity of *Fagonia critica*. Bibi *et al.* (2006) carried out elemental analysis of *Viola odorata*. Kayani *et al.* (2007) investigated the distribution of secondary metabolites in plants of Quetta-Balochistan. Out of 37, only 4 plant species namely *Caragana ambigua*, *Clematis graveolens*, *Juniperus excelsa* and *Pistacia khinjak* contained alkaloids, tannins, saponins and their total phenolic contents were 440, 120, 176 and 230 $\mu\text{g g}^{-1}$. Sultan *et al.* (2007) determined the nutritive value of locally available marginal land grasses in District Bunair. Bano *et al.* (2009) evaluated variation in nutritive value of *Chrysopogon aucheri* and *Cymbopogon jwarancusa* in highland Balochistan. Both the grasses were low in nitrogen, phosphorus and other nutrients except sodium and calcium. Hussain & Durrani (2009) investigated the nutritive value of forage plants at three

phenological stages from Harboi rangeland, Kalat, Balochistan. Ahmad *et al.* (2010) evaluated trace mineral contents of soil, forages and blood plasma of dairy buffoles from five different rural livestock farms in Sargodha. Sultan *et al.* (2010) determined the nutritive value of *Indigofera gerardiana*, *Marisine affricana*, *Impashion bicolor* and *Adhatoda vesica*. It was found that maximum crude protein and ash contents were found for *Marisine affricana*. Bahadur *et al.* (2011) evaluated the nutritional value and elemental composition of five fodder plant species. Among the 16 measured elements, Ni and Cu were found only in *Amaranthus viridis* and *Medicago denticulata*. The ash content was highest in *Sonchus arvensis* and lowest in *Medicago denticulata*. Cheema *et al.* (2011) analyzed mineral profile and nutritive quality of *Morus alba*, *Acacia nilotica*, *Syzygium cumuni* and *Zizyphus jujuba*. Hussain *et al.* (2011) assessed the nutritional value and mineral contents of four medicinal plants. Ismail *et al.* (2011) determined ten trace elements in 15 vegetable and fruits in Hyderabad. Minerals were found in comparatively low concentration. Khattak & Khattak (2011) analyzed 35 medicinal plants for heavy trace metals. Result showed the presence of variable amount of metals in the samples. Moinuddin *et al.* (2012) evaluated 4 grasses for biomass production, mineral composition and forage quality. Inland grasses showed higher biomass, DMD, ME and CF and low ADF and sulphur than the coastal grasses. Sher *et al.* (2012) evaluated macro-mineral status of 8 forage shrubs at three phenological stages in Gadoon hills, District Sawbi. The mineral contents differed significantly among the shrubs except Ca contents.

The only available reference on chemical evaluation of plants of Mastuj Valley is that of Dastagir & Shah (2010) who evaluated *Hippophae rhamnoides* from two different soils for P content. Phosphorus content varied from 0.22 % to 0.16 % in the leaf of Seabuckthorn.

Conservation status of species

Nickel (2002) reported a list of 53 rare, threatened and legally protected species of vascular plants, 19 of them are legally protected and 37 are threatened or rare. Giuliotti *et al.* (2005) described the biodiversity and conservation of plants in Brazil. Sayre (2005) assessed the interacting effects of landownership, land use and endangered species on conservation of U.S. rangelands. Al-Khalifah & Shanavaskhan (2007) evaluated the distribution and status of *Haloxylon persicum* for the Arabian Peninsula. The species is conservation dependent. Eilu *et al.* (2007) determined the conservation status of plants of Uganda. Raimondo *et al.* (2007) described the conservation status of south African plants from the Fynbos biome. Addo-Fordjour *et al.* (2008) studied the diversity and conservation status of medicinal plants in Ghana and reported a decrease in the richness and abundance of some of the plant species including treated ones. Fischer & Bliss (2008) examined forest owners knowledge to conserve *Quercus garryana* in U.S.A. Bulut & Yilmaz (2010) reported the current situation of threatened endemic flora in Turkey. Of 3504 endemic plants in Turkey, 12 are known to have been extinct and 3452 are still being threatened. Of 61 endemic plants in Kemaliye region, 5 are known to have been extinct and 54 to be threatened. Schlaepfer *et al.* (2011) examined the ways in which non-native species currently contribute to conservation objectives.

In Pakistan the available references on the conservation ecology of plants is reviewed below.

Ahmad & Waseem (2004) described conservation status of some medicinal plants of the salt range. Abbas *et al.* (2010) described conservation status of *Cadaba heterotricha*. Alam & Ali (2010) reported conservation status of *Androsace russellii*. Zaidi *et al.* (2012) started large scale micropropagation, regeneration and conservation of *Juniperus excelsa* M. Bieb, *Juniperus horizontalis* Moench and *Juniperus chinensis* L in Baluchistan.

AIMS AND OBJECTIVES

In view of complete dearth of ecological knowledge on the floristics, ecology, conservation and importance of Mastuj Valley as one of the endemic spots with rich plant resources and traditional knowledge. This study was carried out to achieve the following aims and objectives:

- i. To record the floristic diversity and its ecological characteristics.
- ii. To prepare ethnobotanical profile of plants.
- iii. To workout the vegetation diversity and its ecological characteristics.
- iv. To determine the rangeland productivity.
- v. To know the grazing preferences of cattles and availability of palatable plant species.
- vi. To analyze the mineral composition and nutritional status of some key palatable plant species.
- vii. To determine the conservation status of plants

MATERIALS AND METHODS

1. Floristic composition and its ecological characters

1. Floristic composition

Plants from Mastuj Valley were collected from 2006-2009. They were dried, identified with the help of Flora of Pakistan (Nasir & Ali, 1971-1994; Ali & Qaisar, 1995-2009) and confirmed at National Agriculture Research Council Herbarium, Islamabad and Herbarium Department of Botany, University of Peshawar. A complete floristic list was compiled. Plants were arranged alphabetically within each family.

1.1. Biological Spectra

a. Life-form classes

Life-form classes were assigned to plants by following Raunkiaer (1934) and Hussain (1989) as follows:

i. Therophytes (Th)

Therophytes are the annual seed bearing plants which complete their life cycles in one year and over winter the unfavorable seasons by means of seeds and spores.

ii. Geophytes (G)

The geophytes have perennating buds located below the surface of soil. They include plants with deep rhizomes, bulbs, corms, tubers and water plants which may be submerged, partly submerged, free-floating and leaf-floating.

iii. Hemicryptophytes (H)

These are the herbaceous perennials in which perennating buds lie at or just below the ground surface.

iv. Chamaephytes (Ch)

The perennating buds in chamaephytes are located close to the ground surface not extending above 25 cm from ground level.

v. Phanerophytes

a. Megaphanerophytes (MgP)

These are tree species in which the perennating buds are located above the height of 30 m (100 ft).

b. Mesophanerophytes (MesP)

The perennating buds in mesophanerophytes are located between 7.5 m to 30 m (25 ft to 100 ft) height.

c. Microphanerophytes (MicP)

These are those plant species in which perennating buds are located above 2 m to 7.5 m (6 ft to 25 ft) height.

d. Nanophanerophytes (NP)

The perennating buds in these plants are borne on aerial shoots between 0.25 m to 2 m (0.8 ft to 6 ft) above the ground surface.

Raunkiaerian life-form spectra was prepared as follows:

$$\frac{\text{No. of species in each life-form class} \times 100}{\text{Total Species}}$$

1.2. Leaf-size classes

Plants were classified into Raunkiaerian leaf-sizes classes as follows:

- i. Leptophyll (L). Leaf area upto 25 mm².
- ii. Nanophyll (N). Leaf area from 25 to 225 mm².
- iii. Microphyll (Mic). Leaf area from 225 to 2025 mm².
- iv. Mesophyll (Mes). Leaf area from 2025 to 18225 mm².
- v. Macrophyll (Mac). Leaf area from 18225 to 164025 mm².
- vi. Megaphyll (Meg). Leaf area larger than class v.

Raunkiaerian leaf-size spectrum was calculated as follows:

$$\frac{\text{No. of species in each leaf size class} \times 100}{\text{Total No. of species}}$$

1.3. Ecological characteristics

Leaf persistence, spiny nature, habitat, light requirement, cultivation/wild and leaf shape of species were observed in the field.

2. Ethnobotanical Profile

Field trips were undertaken in the study areas during the years 2006 – 2009 to collect plants of ethnomedicinal value for documenting the indigenous knowledge. Information were gathered from traditional healers, experienced elders including midwives and by personal observations. Botanical names, local names, collectors, part used, disease / health problems and preparation of the plants are given. Plants were identified and named after (Nasir & Ali, 1972 – 1995, Ali & Qaisar, 1995 – 2011).

3. Vegetational structure/ Phytosociology

Phytosociological studies were conducted in different parts of Mastuj Valley (Fig. 1). These areas were selected based on species composition, habitats, altitude and physiognomic contrasts. Vegetation was analyzed by using quadrat method. Density and cover were determined by using mid point values of a 10-point scale. Frequency was calculated by recording the presence / absence of species within quadrat.

i. Density

Density is the average number of individual of a species per unit area.

$$\text{Density} = \frac{\text{No. of individuals of a species}}{\text{Total No. of Quadrats}}$$

$$\text{RD} = \frac{\text{Density of a species}}{\text{Total densities of all species}} \times 100$$

Ten density and cover classes were established for rapid estimation and saving time as follows:

The mid values were used for calculation.

Range of cover/Density	Mid point value
1- 10	5
11-20	15
21-30	25
31-40	35
41-50	45
51-60	55
61-70	65
71-80	75
81-90	85
91-100	95

ii. Cover

Cover is the vertical projection of crown or shoots of a species to the ground surface expressed as fraction or percent of a surface area.

$$\text{Cover} = \frac{\text{Cover of a species}}{\text{Total No. Quadrats}}$$

$$\text{RC} = \frac{\text{Cover of a species}}{\text{Total Cover of all species}} \times 100$$

iii. Frequency

Frequency is the percentage of quadrats in which a species is recorded.

Frequency is determined as follows:

$$\text{Frequency} = \frac{\text{No. of quadrats in which a species occur}}{\text{Total No. of quadrats}} \times 100$$

$$\text{RF} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}} \times 100$$

iv. Importance value

The relative values were added to get the importance values. Plant communities were established on the basis of highest importance values and named after the three leading species.

$$\text{IV} = \text{RD} + \text{RC} + \text{RF}$$

Cluster analysis

Cluster analysis (CA) is a classification method for placing similar objects into clusters or groups. The arrangement is a hierarchical tree like structure is called a dendrogram. The clusters of sampling units may represent different biotic communities. The community classification was performed following programme Multivariate Statistical Package (MVSP). The classification as based on compositional dissimilarity among stands and dendrograms were constructed for vegetational stands of the research area.

Principal Coordinate Ordination

Principal coordinate analysis is the most widely used ordination procedure in ecology and is available in computer statistical packages (MVSP). It is basically a multivariate statistical technique that deals with the internal structure of matrices. Principal coordination analysis is a method of breaking down a resemblance matrix into a set of orthogonal axes. The ordination provide information about the ecological resemblance between communities. Cluster analysis and DCA was applied to dissimilarity data of 43 stands.

4. Edaphology

Soils were collected from all investigated sites and analyzed for following physico-chemical characteristics.

i. Soil Texture

Soil textures was determined by hydrometer method (Bouyoucos, 1936). Textural classes were determined with the help of textural triangle (Brady, 1990).

ii. Organic matter

Soil organic matter was determined by Walkley & Black method (Black, 1965).

iii. Calcium carbonate

Calcium carbonate was determined by acid neutralization method (Rayan *et al.* 1997).

iv. Nitrogen (N)

Nitrogen contents were determined by the Kjeldahl method (Bremner & Mulvaney 1982).

v. Phosphorus (P)

Phosphorus was determined after Chapman & Pratt (1961).

vi. Potassium (K)

Potassium was determined by flame emission spectroscopy (Roades, 1982).

vii. pH and EC

Soil pH and EC were measured with a pH meter and conductivity meter (Richard, 1954).

viii. Total Soluble Salts (TSS)

TSS was determined by AOAC (1984).

5. Degree of Palatability of Rangeland Plants

The degree of palatability of plant species was recorded by observing the grazing cattle, goats and sheep in the field and determine their preferences. Information was also gathered from local herders. Plants were classified into palatable and non-palatable species. Palatable plant species were further classified into the following palatability classes following Hussain & Durrani (2009).

- i. Non-Palatable (NP): Not grazed by livestock.
- ii. Highly Palatable (HP): Plant species which were highly preferred by the livestock.
- iii. Mostly Palatable (MP): Plant species with average likeness by the livestock.
- iv. Less Palatable (LP): Plant species with less preference by livestock.
- v. Rarely Palatable (RP): Plant species grazed under compulsion in the absence of preferred species.

6. Measurement of Rangeland Productivity

Productivity was measured in different sites by harvest method as follows:

i. Herbaceous Biomass

Above ground herbaceous foliage of grasses and herbs was harvested by species at ground level using 10, 1x1m quadrat. The harvested material was weighed fresh in the field using a field balance (Hussain & Durrani, 2007).

ii. Shrub Biomass

The biomass of shrubs was estimated by Reference Unit Method (Andrew *et al.*, 1981). A representative branch / part of the plant was clipped and weighed. The branches / parts of the plant were counted and multiplied by the weight of the clipped unit to estimate shrub biomass (Hussain & Durrani, 2007).

7. Chemical Evaluation of some selected Forage Plants

Twenty eight species (Table 17) including 5 trees, 8 shrubs, 11 herbs and 4 grasses were collected at three phenological stages (Pre-reproductive /seedling stage, Reproductive /flowering stage and Post-reproductive dying/drying stage). The plant selection was based on the palatability. The samples were dried, powdered and stored in plastic bags for mineral and proximate analysis.

7.1. Secondary Metabolites

Twenty three plant species were analyzed for secondary metabolites. Secondary metabolites including alkaloid, saponin, tannin, cutin and oil were determined after Trease & Evans (1992).

7.2. Mineral Composition

Thirteen elements from 28 plant species were analyzed by atomic absorption spectrophotometer. 0.5 g plant samples were prepared for mineral analysis by the wet digestion method Air acetylene flame (2300 °C) was used for the detection of calcium, magnesium, manganese, cobalt, copper, chromium, cadmium, iron, strontium, potassium and zinc while $N_2O-C_2H_2$ (2600 °C) was used for the detection of aluminum and silicon.

7.3. Proximate Analysis

i. Dry Matter (%)

Dry matter (DM) the forage plants was determined by oven drying the samples at 65 °C for 72 hours following AOAC (1984) and percent dry matter was calculated as follows:

$$\text{Dry Matter (\%)} = \frac{\text{Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

ii. Ash Content (%)

One to two gm of plant sample was ignited in the Muffle furnace at 550 -600 °C for eight hours and ash contents were determined by AOAC (1984) method as follows:

$$\text{Ash contents (\%)} = \frac{\text{Weight of ash}}{\text{Weight of fresh sample}} \times 100$$

iii. Nitrogen / Crude Protein

Nitrogen was determined by micro Kjeldahl (AOAC, 1984) method. Nitrogen in the digested sample was collected in 4% boric acid solution by distillation. It was titrated against 0.02 normal standardized H₂SO₄ by a semi automatic titrator.

Crude protein was calculated as follows:

$$\text{Crude protein (\%)} = \frac{(\text{ml H}_2\text{SO}_4 - \text{blank}) \times \text{N} \times 6.25 \times 14.01}{\text{Sample weight} \times 1000}$$

iv. Crude Fiber

Crude fiber (CF) was determined following AOAC (1984) method. The sample was digested with 1.25% H₂SO₄ for 30 minutes followed by 30 minutes with 1.25% NaOH. The insoluble residues were dried, weighed, ashed and the insoluble organic matter was reported as crude fiber as follows:

$$\text{Crude fiber (\%)} = \frac{\text{Loss in weight in ignition}}{\text{Weight of Sample}} \times 100$$

v. Ether Extract (Crude Fat)

Ether extract (EE) involved a reflux apparatus which boiled ether, condenses it and allows it to pass through the sample (Galyean, 1985) Ether extract was calculated as follows:

$$\text{Ether extract (\%)} = \frac{\text{Weight of extract}}{\text{Weight of sample}} \times 100$$

vi. Nitrogen Free Extract

Nitrogen free extract (NFE) was calculated after Galyean (1985) as follows:

$$\text{NFE} = \text{Dry matter \%} (\% \text{ Ash} + \% \text{ Crude fiber} + \% \text{ Ether extract} + \% \text{ Crude protein}).$$

Nitrogen free extract represent highly digestible carbohydrates.

7.4. Cell Wall Constituents

i. Neutral Detergent Fiber (NDF)

One gm sample was placed in a beaker for refluxing. 100 ml cold neutral detergent solution and 2 ml of decalin was added to it. The solution was boiled for 10 minutes and refluxed for an hour. It was filtered through a previously tarred, sintered glass crucible using low vacuum. The filtered mat was broken up and washed twice with hot water and acetone. Crucible was dried at 100°C for eight hours and weighed (Van Soest, 1964., Goering & Van Soest, 1970). NDF was calculated as follows:

$$\text{NDF (\%)} = \frac{\text{Weight of treatment}}{\text{Sample weight}} \times 100$$

ii. Acid Detergent Fiber (ADF)

One gm plant sample was taken into a beaker for refluxing. 100 ml cold acid detergent solution and 2 ml decahydronaphthalene was added to it. The acid detergent solution was heated till boiling and refluxed for 60 minutes. The sample was then filtered on a previously tarred Gooch crucible. The filtered mat was broken up and washed with hot water twice followed by acetone until it become clear. The filtered was dried at 100°C for eight hours and weighed. ADF was calculated as follows (Van Soest, 1963; Van Soest & Wine, 1967):

$$\text{ADF (\%)} = \frac{W_o - W_t}{S} \times 100$$

Where:

W_o = Weight of oven dry crucible including fiber

W_t = Tarred weight of oven dried crucible

S = Oven dried sample weight.

iii. Acid Detergent Lignin (ADL)

Acid detergent lignin (ADL) was determined from lingo-cellulose (residue of ADF) following Georing & Van Soest (1970) and Waldern (1971).

iv. Hemicellulose

The difference between neutral detergent fiber (NDF) and acid detergent fiber (ADF) is an estimate of hemicelluloses (Van Soest & Robertson, 1985). It was calculated as follows:

$$\text{Hemicellulose} = \text{NDF} - \text{ADF}.$$

v. Total Carbohydrates

Total carbohydrates were calculated after Galyean (1985) as follows:

$$\text{Total carbohydrates} = 100 - \% \text{ Moisture} - (\% \text{ Ash} + \% \text{ Crude Protein} + \% \text{ Ether Extract}).$$

8. Conservation Status of Plants

Plants were classified into various conservation classes following IUCN (2001) criteria.

a. Availability

0- Uncommon or very rare

1- Less common or rare

2- Occasional

3- Abundant

b. Collection

0- More than 1000 kg/year

1- Consumed from 500-1000 kg/year

2- Consumed from 200-500 kg/year

3- Consumed from 100-200 kg/year

c. Part used

0- Root, whole plant

1- Bark

2- Seeds, fruits

3- Flowers

4- Gum, latex

d. Growth

4- Re-growth in a season

3- Re-growth in one year

2- Re-growth in two years

1- Re-growth in three years

0- Re-growth in more than three years

Total Score

0-4 = Endangered. 5-8 = Vulnerable. 9-12 = Rare. 12-14 = Infrequent.

15-16 = Dominant.

9. Determination of Growth behavior, Sex ratio and Seed output of *Juniperus excelsa*

Average height, diameter, density, sex ratio and seed output of different sexes were determined. Height was noted by using measuring tape, diameter was measured by dbh method and density was calculated by using mid point values as stated earlier. Seed output were determined by using the formula as follows:

No. of fruits in minor branch x No. of minor branches x No. of major branches.

RESULTS AND DISCUSSION

Floristic Composition and its characteristics

1. Floristic composition

The floristic list comprised of 386 species of 75 families (Table 4). It includes 60 dicots, 11 monocots, 2 gymnosperms and 2 pteridophyte families. There were 37 monocot genera and 205 dicot genera. Pteridophyte and gymnosperms had 3 and 2 genera respectively. Asteraceae (64 Spp., 16.58 %) and Poaceae (31 Spp., 8.03 %) were the leading families. They were followed by Papilionaceae (26 Spp., 6.73 %), Lamiaceae (23 Spp., 5.96 %), Apiaceae (18 Spp., 4.66 %), Brassicaceae (17 Spp., 4.40 %), Polygonaceae (16 Spp., 4.14 %), Rosaceae (16 Spp., 4.14 %), Boraginaceae & Chenopodiaceae (each with 12 Spp., 3.10 %), Caryophyllaceae, Scrophulariaceae & Solanaceae (each with 9 Spp., 2.33 %), Ranunculaceae (8 Spp., 2.07 %), Salicaceae (with 6 Spp., 1.55 %) & Rubiaceae (5 Spp., 1.29 %), Alliaceae, Amaranthaceae, Cyperaceae, Euphorbiaceae, Gentinaceae and Malvaceae each had 4 species representation. Five families: Berberidaceae, Cucurbitaceae, Geraniaceae, Onagraceae and Saxifragiaceae had 3 species each. Eighteen families had 2 species and the remaining 30 families had 1 species representation. Shah *et al.* (2006) reported 218 plant species of 63 families while studying the summer flora of Tehsil Mastuj, District Chitral and the present study recorded 386 species which is improvement over the past study. Most of the species are the same but have been reported from more localities. Sher & Khan (2007) reported 222 plant species belonging to 88 families from Chagharzai Valley, District Buner. Khan & Sardar (2008) reported 317 plant species belonging to 245 genera and 83 families from Shakargarh, District Narowal. Shah & Hussain (2008) described 51 plant species of 35 families while studying the wetlands of Akbarpura, District Nowshera. Addo-Fordjon *et al.* (2009) reported 108 plant species belonging to 37 families from Tinte Bepo forest reserve. Durrani *et al.* (2010) reported 123 plant species from Aghberg rangeland, Quetta and some of the species are common to the present study. Saima *et al.* (2010) recorded 167 plant species belonging to 65 families from Ayubia National Park, District Abbottabad. The present floristic list differs due to contrasting climatic conditions. Floristic list is ecologically important as it provides informations about natural resources

and association of plants with each other and their interaction with other biotic and abiotic factors. Floristic composition varies in response to altitudinal differences. Floristic diversity provides an idea about the life-form, stratification, habitat and related environmental condition. Floristic listing is easy to handle less time consuming (Saima *et al.*, 2010).

2. Biological Spectrum

Biological spectrum was dominated by therophytes (195 spp., 50.51%), followed by hemicryptophytes (66sp., 17.09%) and geophytes (61 spp., 15.80%). There 22 (5.69%) species of nanophanerophytes and 19 species (4.92%) of Chamaephytes. Megaphanerophytes had 12 (3.10%) species, mesophanerophytes had 8 (2.07%) species and macrophanerophytes had 3 (0.77%) species (Tables 4,5). The present findings agree with Shah & Hussain (2007), Sher & Khan (2007), Malik *et al.* (2007), Ajaib *et al.* (2008) and Al-Yemeni & Sher (2010). Parswan *et al.* (2010) reported Asteraceae as the dominant family in alpine meadows of Kedarnath. The arrangement of life-form of a species in a natural series is known as biological spectrum and is based on life-form and leaf spectra. It represents climatic, microclimatic and bioclimatic habitat conditions of particular area (Cain & Castro, 1959). Biological spectra are useful in comparing geographically widely separated plant communities and are also regarded as indicators of prevailing environment. Occurrence of similar biological spectrum in different regions indicates similar climatic conditions. Biological spectrum may be materially changed due to introduction of therophytes like annual weeds, due to biotic influences like agricultural practices and grazing, deforestation and trampling etc. (Malik *et al.*, 2007). The life-form of a plant species is a constant characteristic but sometimes it varies with different environmental conditions and species go through different life-form stages in its life cycle from seed to maturity (Ajaib *et al.*, 2008). The life-form of the vegetation is the product of their genetic pool and tolerance towards the climatic variation. Life-form reflects the environmental and biotic influences prevailing in a particular locality. The dominance of therophytes (50 %) and hemicryptophytes (17.09 %) indicated that the valley is under heavy biotic pressure due to deforestation and overgrazing. The degraded vegetation generally supports the therophytic and hemicryptophytic type of vegetation

(Malik, 1986). Sher & Khan (2007) also reported that therophytes were dominant (86 spp., 38.65 %) in Chagharzai Valley, District Buner.

3. Leaf size spectrum

Leaf-size spectrum showed that nanophylls were leading leaf-size class with 187 (48.44%) species followed by mesophylls (80 spp., 20.72%) and leptophylls 48 (12.43%) species. There were 31 (8.03%) microphylls, 28 (7.25%) macrophylls and 7 (1.81%) megaphylls (Tables 4, 5). Leaf-size classes have been found to be very useful for associations. The leaf-size knowledge may help in the understanding of physiological processes of plants and plant communities (Al-Yemeni & Sher, 2010). The reduction in size of leaf indicates dry and xeric conditions of Mastuj Valley.

4. Leaf appearance

The simple leaves were present in 289 (74.87%) species followed by dissected leaves in 49 (12.69%) species while 43 (11.13%) species had compound leaves. Only 5 (1.30%) were aphyllous species (Tables 4, 5).

5. Spiny nature

There were 349 (90.41%) non-spiny plants and 37 (9.58%) species were spiny (Tables 4, 5).

6. Habitat types

There were 297 (76.94%) species in terrestrial habitat and 89 (23.05%) were found in wet habitats. *Hippuris vulgaris*, *Mentha longifolia*, *Oxyria digyna*, *Phragmites karka*, *Primula denticulata*, *Nasturtium officinale* and *Utricularia australis* are some of the aquatic plants (Tables 4, 5). The findings are in agreement with the climatic conditions of the investigated area as few localized points have aquatic habitat.

7. Light/shade plants

Majority i.e. 354 (91.70%) species were heliophytes and only 32 (8.29%) species were sciophytes., *Adiantum venustum*, *Equisetum ramossimum*, *Colchicum aitchisonii*, *Geranium* sp., *Pteris* sp., *Swertia speciosa* and *Tussilago farfara* are sciophytes (Tables 4, 5). Since there is open tree less environment which is more suitable for sun loving plants.

8. Cultivation status

The flora include 337 (87.30%) wild species and 49 (12.69%) cultivated species. *Allium cepa*, *Allium sativum*, *Coriandrum sativum*, *Daucus carota*, *Foeniculum vulgare*, *Oryza sativa*, *Triticum aestivum* and *Zea mays* are cultivated in the area (Tables 4, 5).

9. Leaf persistence There were 351 (90.93 %) deciduous species and 31 (8.03 %) evergreen plant species. *Adiantum venustum*, *Bergenia* spp., *Ephedra gerardiana*, *Juniperus excelsa*, *Hippuris vulgaris*, *Nasturtium officinale*, *Pteris* sp. and *Typha angustata* are evergreen (Tables 4, 5).

Ethnobotanical profile

Ethnobotanical classification of plants indicated that all the 386 plant species (Table 6) had some kind of local uses in the valley. There were 366 (94.82%) species used as fodder, 88 (22.80%) species as medicinal, 58 (15.02%) species were used as fuel wood, 26 (6.73%) species yielded timber wood, 25 (6.48%) species were in use as vegetables, 17 (4.40%) species as condiment, 15 (3.88%) species as fruits, 13 (3.37%) species were used for thatching purposes and 5 (1.29%) species were used for making snuff. *Aristida cynantha*, *Artemisia* spp., *Cynodon dactylon*, *Medicago sativa*, *Phragmites karka*, *Rheum emodi*, *Saccharum spontaneum* and *Trifolium resupinatum* were important fodder species. *Berberis lycium*, *Capparis spinosa*, *Ephedra gerardiana*, *Foeniculum vulgare*, *Ferula jaeschkeana*, *Matricaria chamomila*, *Mentha longifolia*, *Paeonia emodi*, *Papaver somniferum* and *Thymus serpyllum* were important medicinal plants. *Ailanthus altissima*, *Platanus orientalis*, *Populus* spp., and *Salix* spp. were used as

timber wood. Among fuel wood species, *Artemisia brevifolia*, *Betula utilis*, *Colutea paulsenii*, *Fraxinus xanthoxyloides*, *Juniperus excelsa*, *Sophora mollis* and *Tamarix dioica* were important. *Brassica campestris*, *Beta vulgaris*, *Pisum sativum*, *Portulaca oleracea*, *Solanum melongena* and *Solanum tuberosum* are cultivated as vegetables. *Allium* spp., *Bunium persicum*, *Carum* spp., *Foeniculum vulgare*, *Lepidium sativum*, *Ocimum* spp. and *Lycopersicum esculentum* are used as condiments. *Artemisia scoparia*, *Phragmites karka*, *Saccharum spontaneum*, *Trachomitum venetum* and *Typha angustata* are used for thatching purposes. *Juniperus excelsa*, *Ephedra* spp. and *Nicotiana rustica* are used for making snuff. The results shows that the area is primarily an alpine grazing land as majority, i.e. 94.82% species were used as fodder. Durrani & Hussain (2005) also stated that in Harboi rangeland major utility was of fodder species and this agree with the present findings. Man is using plants since the dawn of civilization to treat various diseases and disorders. This interaction of man and plants led to the establishment of the traditional knowledge of plants. This traditional knowledge of ethnic groups around the globe forms the basis of modern plant based industry especially allopathic medicine (Ahmad *et al.*, 2006). In Chitral Valley the use of plant resources, besides fulfilling their various utilitarian needs is also a source of income. The local people are ignorant about the importance of these plants at global level. Sometimes, they collect plants in excess quantity and in most cases the whole plant is uprooted (Ali & Qaisar, 2009). The native inhabitants of northern areas have rich indigenous knowledge regarding the uses of medicinal and other beneficial plants (Khan *et al.*, 2009). By revealing historical and present plant uses, ethnobotany contributes to drug discovery and socioeconomic development (Upreti *et al.*, 2010). Since the beginning of civilization, people have been used plants as medicine for curing various diseases. In the present study 22.8% of the total plant species had some kind of medicinal uses. Most of the present drugs have been derived from plant sources. Durrani & Hussain (2005) also reported that medicinal plants were most important utility in Harboi rangeland. Likewise plants are used locally for medicinal purposes (Zahoor *et al.*, 2009). In Dir (Manan *et al.* 2007), Bunir (Shah & Hussain, 2008) and Swat (Hazrat *et al.*, 2010) plants are traditionally used for curing various diseases. All these workers support the present work. The traditional knowledge

of medicinal uses of plants is being transferred from generations to generations (Mahmood *et al.*, 2011). The commercial business of medicinal plants in Chitral is limited as only a few species are marketed out of the district (Khan *et al.*, 2011). These includes *Capparis spinosa*, *Carum carvi*, *Ephedra gerardians* and *Thymus serpyllum*. The inhabitant of Mastuj Valley depends on medicinal plants for treating various human and livestock ailments. At present 82 medicinal plants are used for curing various ailments in the study area (Table 7). Furthermore, they also get their needs of food, shelter, fodder, and other cultural purposes from plants. The plants and vegetation as whole are under immense biotic and abiotic pressure. Many plants have multiple uses and such plants are more vulnerable e.g. *Berberis lycium*, *Ferula jaeschkeana*, *Juniperus excelsa*, *Hippophae rhamnoides* and *Sophora mollis*. All these plants whose roots, underground parts have medicinal uses suffer the most. The collection of plants at wrong time and at wrong age offer serious problems in their regeneration. There is need to create awarness among locals, educate them about ecological consequences and convince them for conservation of valueable plants.

Traditional Medicinal Uses

Eighty two medicinal plants belonging to 74 genera and 42 families were identified from various villages of Mastuj valley (Table 7). The study showed that skin disease, fever, rheumatism, abdominal pain and toothache are the major health problems in the area that are being cured with plants. *Ephedra gerardiana* L, *Allium cepa* L, *Allium sativum* L, *Bergenia ciliate* (Haw.) Sternb, *Hippophae rhamnoides* L and *Sophora mollis* (Royle.) Baker are used for curing skin diseases. *Iris germanica* L, *Trachomitum venetum* (L.) Woodson, *Morus alba* L, *Datura stramonium* L and *Polygonum glabrum* Willd are being used against rheumatism. *Ferula jaeschkeana* Vatke, *Foeniculum vulgare* Miller, *Nepeta cataria* L and *Astragalus psilocentros* Fisch are used in case of toothache. *Zea mays* L and *Prunus persica* (L.) Batsch are used in kidney problems. *Trachydium roylei* Lindl is used as an antidote. During the traditional treatments various preparations were used. Herbs (56 spp, 68.29 %) had the major share, followed by trees (17 spp, 20.73 %)

and shrubs (9 spp, 10.97 %). Fruits were mostly used in (19 spp, 23.17 %), followed by shoots (17 spp, 20.73 %) and leaves (15 spp, 18.29 %).

Due to the lack of modern health and communication facilities, poverty and ignorance majority of the locals are still using traditional medicine system for most of ailments. In ancient times, people had knowledge of medicinal plants. Several hundred species were used as herbal remedies in indigenous system of medicines that used the whole plant or an extraction (Hussain *et al.*, 2008). In Mastuj valley, plant resources are source of income as well as fulfilling their own needs. The plant collectors are often herders, shepard or poor village dwellers of the population who collect plants. The locals sometimes collect plants unscientifically (Ali & Qaisar, 2009). Majority of the people in high altitude remote areas rely on medicinal plants for various diseases. In most instances, certain plant species are used specifically for a particular disease. However, mixture of two or more species are being used. Women followed by children are the principal collector of medicinal plants. Due to over-collection several species have gone extinction in the Hindukush Himalayan regions (Shinwari, 2010). Evaluation of therapeutic herbs has turned into a latent basis of biodynamic substances of curative value (Mahmood *et al.*, 2011). Rapid urbanization and unplanned exploitation have resulted in loss of medicinal plant species. It is therefore, imperative to encourage conservation of species. There is need of coordination and cooperation among various agencies such as forest department and the pharmaceutical firms interested in the utilization of these medicinal plants and to initiate regeneration work in degraded or areas devoid of vegetation. By doing so, we can change the economic and social conditions of the local inhabitants positively (Qureshi *et al.*, 2011).

The people of Mastuj valley have been using plant resources for their various ailments since time immemorial. The local people know the medicinal plants and preparation of raw drugs through personal experience and ancestral prescription. Mastuj valley is a remote area and therefore, people of the valley depend on plant resources. The present

study showed that the local people of the area are rich in indigenous knowledge of plants and their uses to treat many ailments.

Table 4. Floristic composition and ecological characteristics of plants of Mastuj Valley, District Chitral, Pakistan.

S.No.	Plant species	1	2	3	4	5	6	7	8
A. Pteridophyta									
1. Family Equisetaceae									
1.	<i>Equisetum ramosissimum</i> Desf.	G	Ap	E	-	Wet	S	W	Ap
2. Family Pteridaceae									
2.	<i>Adiantum venustum</i> D. Don.	G	N	E	-	Wet	S	W	Compound
3.	<i>Pteris</i> sp.	G	N	E	-	Wet	S	W	Compound
B. Gymnospermae									
3. Family Cupressaceae									
4.	<i>Juniperus excelsa</i> M.B.	MegP	L	E	-	D	L	W	Disec
5.	<i>Juniperus communis</i> L.	NP	L	E	-	D	L	W	Disec
4. Family Ephedraceae									
6.	<i>Ephedra gerardiana</i> L.	Ch	Ap	E	-	D	L	W	Ap
7.	<i>Ephedra intermedia</i> Schrenk & Meyer.	Ch	Ap	E	-	D	L	W	Ap
C. Monocotyledonae									
5. Family Alliaceae									
8.	<i>Allium carolinianum</i> DC.	G	Mes	Dec	-	D	L	W	Simple
9.	<i>Allium cepa</i> L.	G	Mes	Dec	-	D	L	C	Simple
10.	<i>Allium sativum</i> L.	G	Mes	Dec	-	D	L	C	Simple
11.	<i>Allium tuberosum</i> Rottler ex Spreng.	G	Mes	Dec	-	D	L	C	Simple
6. Family Amaryllidaceae									
12.	<i>Ixilirion montanum</i> (Labill.) Hab.	G	Mes	Dec	-	Wet	L	W	Simple
7. Family Araceae									
13.	<i>Arisaema jacquemontii</i> Blume.	G	Mic	Dec	-	Wet	L	W	Compound
8. Family Colchicaceae									
14.	<i>Colchicum aitchisonii</i> (Hook.) Nasir.	G	N	Dec	-	Wet	S	W	Simple
9. Family Cyperaceae									
15.	<i>Carex infusata</i> Nees.	G	L	E	-	Wet	L	W	Simple
16.	<i>Carex diluta</i> M. Bieb.	G	L	E	-	Wet	L	W	Simple
17.	<i>Schoenoplectus litoralis</i> (Schard.) Palla.	G	Mes	E	-	Wet	L	W	Simple
18.	<i>Scirpus planifolius</i> Grimm.	G	Mes	E	-	Wet	L	W	Simple
10. Family Iridaceae									
19.	<i>Iris ensata</i> Thunb.	G	Mes	Dec	-	D	L	W	Simple
20.	<i>Iris germinea</i> L.	G	Mes	Dec	-	D	L	W	Simple
11. Family Juncaceae									
21.	<i>Juncus articulata</i> L.	G	Mes	E	-	Wet	L	W	Simple
22.	<i>Juncus himalensis</i> K. L. & Gracke.	G	Mes	E	-	Wet	L	W	Simple
12. Family Juncaginaceae									
23.	<i>Triglochin palustris</i> L.	G	N	E	-	Wet	L	W	Simple
13. Family Orchidaceae									
24.	<i>Cyperipedium cordigerum</i> D. Don.	G	N	Dec	-	Wet	S	W	Simple
25.	<i>Dactylorhiza hatagirea</i> D. Don.	G	N	Dec	-	Wet	S	W	Simple
14. Family Poaceae									
26.	<i>Aeluropus macrostachyus</i> Hack.	Th	N	Dec	-	D	L	W	Simple

27.	<i>Alloteropsis crimicina</i> (L.) Stapf.	Th	N	Dec	-	D	L	W	Simple
28.	<i>Aristida cynantha</i> Ness. & Steud.	H	N	Dec	-	D	L	W	Simple
29.	<i>Avena sativa</i> Retz.	Th	N	Dec	-	D	L	W	Simple
30.	<i>Avena barbata</i> Polt ex Link.	Th	N	Dec	-	D	L	W	Simple
31.	<i>Bromus gracillimus</i> Bunge.	Th	Mes	Dec	-	D	L	W	Simple
32.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	G	Mes	E	-	Wet	L	W	Simple
33.	<i>Cynodon dactylon</i> (L.) Pers.	H	N	Dec	-	D	L	W	Simple
34.	<i>Dactylis glomerata</i> L.	Th	N	Dec	-	D	L	W	Simple
35.	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	H	N	Dec	-	Wet	L	W	Simple
36.	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	Th	N	Dec	-	Wet	L	W	Simple
37.	<i>Eragrostis minor</i> Host.	Th	N	Dec	-	Wet	L	W	Simple
38.	<i>Eragrostis nigra</i> Nees ex Steud.	Th	N	Dec	-	Wet	L	W	Simple
39.	<i>Eragrostis poaeoides</i> P. Beauv.	H	N	Dec	-	Wet	L	W	Simple
40.	<i>Hordeum spontaneum</i> C. Koch.	Th	N	Dec	-	Wet	L	W	Simple
41.	<i>Hyparrhenia hirta</i> (L.) Stapf.	H	N	Dec	-	D	L	W	Simple
42.	<i>Ischaemum timorense</i> Kunth.	Th	Mic	Dec	-	D	L	W	Simple
43.	<i>Koeleria gracilis</i> Pers.	H	N	Dec	-	D	L	W	Simple
44.	<i>Lolium rigidum</i> Guad.	Th	N	Dec	-	D	L	W	Simple
45.	<i>Lolium persicum</i> Boiss & Hohen ex Boiss.	Th	N	Dec	-	D	L	W	Simple
46.	<i>Melica jacqmontii</i> (Regd.) Bar ex Jacq.	H	N	Dec	-	D	L	W	Simple
47.	<i>Oryza sativa</i> L.	G (H)	Mic	Dec	-	Wet	L	C	Simple
48.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	Ch (H)	Mac	E	-	Wet	L	W	Simple
49.	<i>Poa bulbosa</i> L.	Th	N	E	-	D	L	W	Simple
50.	<i>Poa sinaica</i> Steud.	Th	N	E	-	D	L	W	Simple
51.	<i>Saccharum spontaneum</i> L.	Ch	Mac	E	-	D	L	W	Simple
52.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	Th	N	E	-	D	L	W	Simple
53.	<i>Setaria intermedia</i> Roem & Schult.	Th	N	E	-	D	L	W	Simple
54.	<i>Setaria viridis</i> (L.) P. Beauv.	Th	N	E	-	Wet	L	W	Simple
55.	<i>Triticum aestivum</i> L.	Th	Mic	Dec	-	D	L	C	Simple
56.	<i>Zea mays</i> L.	Th	Meg	Dec	-	D	L	C	Simple
15. Family Typhaceae									
57.	<i>Typha angustata</i> Borry. & Chaub.	G (H)	Meg	E	-	Wet	L	W	Simple
D. Dicotyledonae									
16. Family Amaranthaceae									
58.	<i>Amaranthus cruentus</i> L.	Th	Mes	Dec	-	D	L	W	Simple
59.	<i>Amaranthus hybridus</i> L.	Th	N	Dec	-	D	L	W	Simple
60.	<i>Amaranthus retrofractus</i> L.	Th	Mes	Dec	-	D	L	W	Simple
61.	<i>Amaranthus viridis</i> L.	Th	Mes	Dec	-	D	L	W	Simple
17. Family Anacardaceae									
62.	<i>Pistacia integerrima</i> (L.) Steward ex Brand.	NP	Mes	Dec	-	D	L	W	Simple
63.	<i>Pistacia khinjuk</i> Stock.	NP	N	Dec	-	D	L	W	Simple
18. Family Apiaceae									
64.	<i>Ammi visnaga</i> (L.) Lam.	Th	N	Dec	-	D	L	W	Disec
65.	<i>Anethum graveolens</i> L.	Th	N	Dec	-	D	L	W	Disec
66.	<i>Bunium persicum</i> (Boiss.) Fedtsch.	G	N	Dec	-	D	L	W	Disec

67.	<i>Carum capticum</i> L.	G	Mic	Dec	-	D	L	W	Disec
68.	<i>Carum carvi</i> L.	Th	N	Dec	-	D	L	W	Disec
69.	<i>Coriandrum sativum</i> L.	Th	N	Dec	-	D	L	C	Disec
70.	<i>Cortia schmidii</i> Nasir.	Th	N	Dec	-	D	L	W	Disec
71.	<i>Daucus carota</i> L.	G	Mes	Dec	-	D	L	C	Disec
72.	<i>Ferula jaeschkeana</i> Vatke.	G	Meg	Dec	-	D	L	W	Compound
73.	<i>Ferula</i> Sp.	G	Meg	Dec	-	D	L	W	Compound
74.	<i>Foeniculum vulgare</i> Miller.	Th	N	Dec	-	D	L	C	Disec
75.	<i>Pleurospermum stylosum</i> Clarke.	Th	N	Dec	-	D	L	W	Compound
76.	<i>Pimpinella stewartii</i> Dunn. Nasir.	Th	N	Dec	-	D	L	W	Compound
77.	<i>Prongus publaria</i> (Lind.) Hiroe.	H	N	Dec	-	D	L	W	Compound
78.	<i>Seseli libanotis</i> (L.) Koch.	Th	L	Dec	-	D	L	W	Compound
79.	<i>Torilis arvensis</i> (Huds.) Link.	Th	Mes	Dec	-	D	L	W	Compound
80.	<i>Trachydium roylei</i> Lindl.	H	Mic	Dec	-	D	L	W	Compound
81.	<i>Trachyspermum ammi</i> (L.) Spargue.	G	N	Dec	-	D	L	W	Compound
19. Family Apocynaceae									
82.	<i>Trachomitum venetum</i> (L.) Woodson	H	Mes	Dec	-	D	L	W	Simple
20. Family Asclepiadaceae									
83.	<i>Cynanchum acutum</i> L.	Ch (Cl)	Mes	Dec	-	D	L	W	Simple
84.	<i>Cynanchum arnottianum</i> Wight.	Ch (Cl)	Mes	Dec	-	D	L	W	Simple
21. Family Asteraceae									
85.	<i>Anaphalia gracilis</i> Haud & Mazz.	H	Mes	Dec	-	D	L	W	Simple
86.	<i>Anthemis cotula</i> L.	Th	N	Dec	-	D	L	W	Disec
87.	<i>Anthemis tinctoria</i> L.	Th	N	Dec	-	D	L	W	Disec
88.	<i>Artemisia brevifolia</i> Wall ex DC.	H	L	Dec	-	D	L	W	Disec
89.	<i>Artemisia maritima</i> L.	H	L	Dec	-	D	L	W	Disec
90.	<i>Artemisia parviflora</i> Roxb.	Th	Mes	Dec	-	D	L	W	Disec
91.	<i>Artemisia scoparia</i> Waldst. & Kit.	H	N	Dec	-	D	L	W	Disec
92.	<i>Artemisia rutifolia</i> Staph ex Spreng.	H	L	Dec	-	D	L	W	Disec
93.	<i>Artemisia laciniata</i> Willd.	H	L	Dec	-	D	L	W	Disec
94.	<i>Aster altiacus</i> Willd.	H	Mes	Dec	-	D	L	W	Simple
95.	<i>Aster amellus</i> auct.	H	Mes	Dec	-	D	L	W	Simple
96.	<i>Bidens tripartita</i> L.	H	N	Dec	-	D	L	W	Simple
97.	<i>Brachyactis roylei</i> Wendelbow.	H	Mic	Dec	-	D	L	W	Simple
98.	<i>Calendula officinalis</i> L.	Th	Mes	Dec	-	D	L	C	Simple
99.	<i>Centaurea calcitrapa</i> L.	Th	N	Dec	+	D	L	W	Disec
100.	<i>Chondrilla graminea</i> M.Bieb.	H	N	Dec	-	D	L	W	Disec
101.	<i>Chrysanthemum cinerariifolium</i> (Trev.) Vis.	H	N	Dec	-	D	L	W	Disec
102.	<i>Cirsium acaule</i> (L.) Scop.	Th	Meg	Dec	+	D	L	W	Simple
103.	<i>Cirsium argyacanthum</i> D.C.	Th	Mac	Dec	+	D	L	W	Simple
104.	<i>Cichorium intybus</i> L.	Th	Mes	Dec	-	D	L	W	Simple
105.	<i>Cnicus benedictus</i> L.	Th	Mes	Dec	+	D	L	W	Simple
106.	<i>Conyza bonariensis</i> (L.) Conquist.	Th	N	Dec	-	D	L	W	Simple
107.	<i>Conyza canadensis</i> (L.) Conquist.	Th	N	Dec	-	D	L	W	Simple
108.	<i>Conyza japonica</i> Less.	Th	N	Dec	-	D	L	W	Simple
109.	<i>Conyza stricta</i> Willd.	Th	N	Dec	-	D	L	W	Simple
110.	<i>Cosmos bipinnatus</i> Cav.	Th	N	Dec	-	D	L	W	Compound

111.	<i>Cousinia matfeldii</i> Bornm.	Th	Mes	Dec	+	D	L	W	Simple
112.	<i>Crepis sancta</i> (L.) Bab.	Th	N	Dec	-	D	L	W	Simple
113.	<i>Crepis thomsonii</i> Bab.	Th	N	Dec	-	D	L	W	Simple
114.	<i>Echinops echinatus</i> Roxb.	Th	Mac	Dec	+	D	L	W	Simple
115.	<i>Erigeron acer</i> subsp. <i>acer</i> L.	Th	Mic	Dec	-	D	L	W	Simple
116.	<i>Erigeron alpinus</i> L.	Th	Mic	Dec	-	D	L	W	Simple
117.	<i>Erigeron canadensis</i> (L.) Cronq.	Th	N	Dec	-	D	L	W	Simple
118.	<i>Erigeron acris</i> L.	Th	Mic	Dec	-	D	L	W	Simple
119.	<i>Filago germanica</i> L.	H	N	Dec	-	D	L	W	Simple
120.	<i>Gnaphalium luteo-album</i> L.	H	N	Dec	-	D	L	W	Simple
121.	<i>Gnaphalium thomsonii</i> Hkf.	H	N	Dec	-	D	L	W	Simple
122.	<i>Inula obtusifolia</i> Kerner.	Th	Mes	Dec	-	D	L	W	Simple
123.	<i>Lactuca clarkei</i> Hook.f.	Th	N	Dec	-	D	L	W	Simple
124.	<i>Lactuca orientalis</i> (Boiss.) Boiss.	Th	N	Dec	-	D	L	W	Simple
125.	<i>Lactuca sativa</i> L.	Th	Mac	Dec	-	D	L	C	Simple
126.	<i>Lactuca serriola</i> L.	Th	Mes	Dec	-	D	L	W	Simple
127.	<i>Lactuca tatarica</i> (L.) C. A. Mey.	Th	Mes	Dec	-	D	L	W	Simple
128.	<i>Lactuca undulata</i> Ladb.	Th	Mic	Dec	-	D	L	W	Simple
129.	<i>Lactuca viminea</i> (L.) F.W.Schmid.	H	N	Dec	-	D	L	W	Simple
130.	<i>Launaea polyclada</i> (Boiss.) Burkill.	Th	N	Dec	-	D	L	W	Simple
131.	<i>Launaea procumbens</i> Roxb.	Th	N	Dec	-	D	L	W	Disec
132.	<i>Matricaria chamomila</i> L.	Th	N	Dec	-	D	L	W	Disec
133.	<i>Matricaria disciformis</i> (C.A.M.) DC.	Th	N	Dec	-	D	L	W	Disec
134.	<i>Matricaria praecox</i> DC.	Th	N	Dec	-	D	L	W	Disec
135.	<i>Myriactis wallichii</i> Less.	Th	N	Dec	-	Wet	S	W	Simple
136.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	H	N	Dec	-	D	L	W	Simple
137.	<i>Senecio dubius</i> Ladeb.	Th	N	Dec	-	D	L	W	Simple
138.	<i>Solidago virgaurea</i> L.	H	N	Dec	-	D	L	W	Simple
139.	<i>Sonchus arvensis</i> Boiss.	Th	Mes	Dec	-	Wet	S	W	Disec
140.	<i>Sonchus asper</i> (L.) Hill.	Th	Mes	Dec	-	Wet	S	W	Disec
141.	<i>Sonchus maritimus</i> L.	Th	N	Dec	-	Wet	S	W	Disec
142.	<i>Sonchus oleraceus</i> L.	Th	N	Dec	-	Wet	S	W	Disec
143.	<i>Tagetes erecta</i> L.	Th	N	Dec	-	D	L	W	Disec
144.	<i>Taraxacum dealbatum</i> Haud & Mazz.	G	N	Dec	-	Wet	S	W	Simple
145.	<i>Taraxacum officinale</i> Weber.	G	Mes	Dec	-	Wet	S	W	Simple
146.	<i>Tricholepis tibetica</i> H. & T.	H	N	Dec	-	D	L	W	Simple
147.	<i>Tussilago farfara</i> L.	G	Mac	Dec	-	Wet	S	W	Simple
148.	<i>Xanthium strumarium</i> L.	Th	Mes	Dec	+	D	L	W	Simple
22. Family Berberidaceae									
149.	<i>Berberis arthobotrys</i> Benth ex Aitch.	NP	N	Dec	+	D	L	W	Simple
150.	<i>Berberis lycium</i> Royle.	NP	N	Dec	+	D	L	W	Simple
151.	<i>Berberis pseudoumbellata</i> subsp. <i>gilgitica</i> Parker.	NP	N	Dec	+	D	L	W	Simple
23. Family Betulaceae									
152.	<i>Betula utilis</i> D. Don.	MesP	Mes	Dec	-	D	L	W	Simple
24. Family Boraginaceae									
153.	<i>Arnebia euchroma</i> (Royle ex Benth) Johnst.	H	N	Dec	-	D	L	W	Simple

154.	<i>Arnebia hispidissima</i> (Lehm.) DC.	H	Mes	Dec	-	D	L	W	Simple
155.	<i>Arnebia linearifolia</i> A.D.C.	H	N	Dec	-	D	L	W	Simple
156.	<i>Cynoglossum glochidiatum</i> Wall ex Benth.	H	N	Dec	-	D	L	W	Simple
157.	<i>Cynoglossum lanceolatum</i> Forssk.	H	Mes	Dec	-	D	L	W	Simple
158.	<i>Cynoglossum wallichii</i> G. Don.	H	Mes	Dec	-	D	L	W	Simple
159.	<i>Eritrichum canum</i> var. <i>canum</i> (Benth. Royle) Kit.	H	N	Dec	-	D	L	W	Simple
160.	<i>Myosotis alpestris</i> F.W. Schmidt.	H	Mic	Dec	-	D	L	W	Simple
161.	<i>Myosotis arvensis</i> (L.) Hill.	H	N	Dec	-	D	L	W	Simple
162.	<i>Nonnea edgeworthii</i> A.D.C.	H	N	Dec	-	D	L	W	Simple
163.	<i>Onosma hispida</i> Wall ex Don.	H	N	Dec	-	D	L	W	Simple
164.	<i>Rochelia stylaris</i> Boiss.	Th	N	Dec	-	D	L	W	Simple
25. Family Brassicaceae									
165.	<i>Arabis amplexicaulis</i> Edgew.	Th	N	Dec	-	D	L	W	Disec
166.	<i>Brassica campestris</i> L.	Th	Mac	Dec	-	D	L	C	Disec
167.	<i>Cephsella bursa-pastoris</i> (L.) Medic.	Th	Mes	Dec	-	Wet	L	W	Disec
168.	<i>Choriospora macropoda</i> Trautv.	Th	N	Dec	-	D	L	W	Simple
169.	<i>Coronopus didymus</i> (L.) Sm.	Th	L	Dec	-	Wet	L	W	Disec
170.	<i>Descurainia sophia</i> (L.) Webb. & Berth.	Th	N	Dec	-	D	L	W	Disec
171.	<i>Draba cachemirica</i> Gandoger.	Th	N	Dec	-	D	L	W	Simple
172.	<i>Lepidium sativum</i> L.	Th	N	Dec	-	D	L	W	Simple
173.	<i>Lepidium apetalum</i> H. & T.	Th	N	Dec	-	D	L	W	Simple
174.	<i>Malcolmia afaricana</i> (L.) R.Br.	Th	L	Dec	-	D	L	W	Simple
175.	<i>Malcolmia cabulica</i> (Boiss.) H. & T.	Th	N	Dec	-	D	L	W	Simple
176.	<i>Matthiola flavida</i> Boiss.	Th	Mes	Dec	-	D	L	W	Simple
177.	<i>Nasturtium officinale</i> R.Br.	G	N	E	-	Wet	L	W	Disec
178.	<i>Neslia apiculata</i> Fisch.	Th	L	Dec	-	D	L	W	Simple
179.	<i>Raphanus raphanistrum</i> L.	Th	N	Dec	-	D	L	C	Disec
180.	<i>Raphanus sativus</i> L.	Th	Mac	Dec	-	D	L	C	Disec
181.	<i>Rorippa islandica</i> (Oed.) Borbas.	Th	N	Dec	-	Wet	L	W	Simple
26. Family Campanulaceae									
182.	<i>Codonopsis clematidia</i> (Schrenk) Clarke.	Th	N	Dec	-	Wet	S	W	Simple
27. Family Canabinaceae									
183.	<i>Canabis sativa</i> L.	Th	N	Dec	-	D	L	W	Compound
28. Family Capparidaceae									
184.	<i>Capparis spinosa</i> L.	H	Mes	Dec	+	D	L	W	Simple
185.	<i>Cleome ariana</i> Hedge & Lamond.	Th	N	Dec	-	D	L	W	Simple
29. Family Caryophyllaceae									
186.	<i>Arenaria serpyllifolia</i> L.	Th	N	Dec	-	D	L	W	Simple
187.	<i>Ceratium cerastioides</i> (L.) Britton.	Th	Mes	Dec	-	D	S	W	Simple
188.	<i>Dianthus anatolicus</i> Boiss.	H	N	Dec	-	D	L	W	Simple
189.	<i>Lepyrodicilis holosteoides</i> C.A. Mey.	Th	N	Dec	-	D	L	W	Simple
190.	<i>Minuartia hybrida</i> (Vill.) Schischkin.	Th	N	Dec	-	D	L	W	Simple
191.	<i>Silene arenosa</i> C.Koch.	Th	N	Dec	-	D	L	W	Simple
192.	<i>Silene conoidea</i> L.	Th	N	Dec	-	D	L	W	Simple
193.	<i>Stellaria media</i> (L.) Vill.	Th	N	Dec	-	D	L	W	Simple
194.	<i>Vaccaria pyramidata</i> Medik.	Th	N	Dec	-	D	L	W	Simple

30. Family Chenopodiaceae								
195.	<i>Atriplex canescens</i> James.	H	N	E	-	D	L	W Simple
196.	<i>Atriplex crassifolia</i> C.A.Mey.	H	N	E	-	D	L	W Simple
197.	<i>Beta vulgaris</i> L.	Th	Mac	Dec	-	D	L	C Simple
198.	<i>Chenopodium album</i> L.	Th	N	Dec	-	D	L	C Simple
199.	<i>Chenopodium ambrosioides</i> L.	Th	L	Dec	-	Wet	L	W Simple
200.	<i>Chenopodium botrys</i> L.	Th	L	Dec	-	D	L	W Simple
201.	<i>Chenopodium foliosum</i> (Merrich.) Aschers.	Th	N	Dec	-	D	L	W Simple
202.	<i>Chenopodium murale</i> L.	Th	N	Dec	-	D	L	W Simple
203.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	Ch	L	E	-	D	L	W Simple
204.	<i>Kochia prostrata</i> (L.) Schard.	Th	L	Dec	-	D	L	W Disec
205.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	H	N	Dec	-	D	L	W Simple
206.	<i>Salsola kali</i> L.	H	L	E	+	D	L	W Simple
31. Family Convolvulaceae								
207.	<i>Convolvulus arvensis</i> L.	Th (Cl)	Mes	Dec	-	D	L	W Simple
32. Family Crassulaceae								
208.	<i>Sedum ewersii</i> Ledeb.	G	N	Dec	-	Wet	L	W Simple
33. Family Cucurbitaceae								
209.	<i>Citrulus vulgaris</i> L.	Th	Mes	Dec	-	D	L	C Compound
210.	<i>Cucurbita maxima</i> Duch ex Lam.	Th	Meg	Dec	-	D	L	C Compound
211.	<i>Cucumis sativa</i> L.	Th	Mes	Dec	-	D	L	C Compound
34. Family Cuscutaceae								
212.	<i>Cuscuta approximata</i> Bab.	Th (P)	Ap	E	-	D	L	W Ap
213.	<i>Cuscuta reflexa</i> Roxb.	Th (P)	Ap	E	-	D	L	W Ap
35. Family Elaeagnaceae								
214.	<i>Elaeagnus angustifolia</i> L.	MacP	Mes	Dec	+	D	L	C Simple
215.	<i>Hippophae rhamnoides</i> L.	MesP	N	Dec	+	D	L	W Simple
36. Family Euphorbiaceae								
216.	<i>Euphorbia falcata</i> L.	Th	N	Dec	-	D	L	W Simple
217.	<i>Euphorbia osyridea</i> Boiss.	Ch	N	E	-	D	L	W Simple
218.	<i>Euphorbia peplus</i> L.	Th	L	Dec	-	D	L	W Simple
219.	<i>Euphorbia wallichii</i> Hk.	Th	N	Dec	-	D	L	W Simple
37. Family Fumariaceae								
220.	<i>Corydalis govaniana</i> Wall ex Trend.	G	L	Dec	-	Wet	S	W Disec
221.	<i>Fumaria indica</i> (Hausskn.) L.	Th	L	Dec	-	D	L	W Disec
38. Family Gentianaceae								
222.	<i>Centaurium meyeri</i> (Bunge.) Druce.	Th	N	Dec	-	D	L	W Simple
223.	<i>Gentiana kurroo</i> Royle.	Th	L	Dec	-	Wet	S	W Simple
224.	<i>Jeshkea oligosperma</i> L.	Th	n	Dec	-	Wet	S	W Simple
225.	<i>Swertia speciosa</i> D.Don.	G	N	Dec	-	Wet	S	W Simple
39. Family Geraniaceae								
226.	<i>Geranium pratense</i> L.	Th	Mes	Dec	-	Wet	S	W Compound
227.	<i>Geranium rotundifolium</i> L.	Th	N	Dec	-	Wet	S	W Compound
228.	<i>Geranium wallichinum</i> D. Don ex Sweet.	Th	Mes	Dec	-	Wet	S	W Compound

40. Family Hippuridaceae									
229.	<i>Hippuris vulgaris</i> L.	G	N	Dec	-	Wet	L	W	Simple
41. Family Juglandaceae									
230.	<i>Juglans regia</i> L.	MegP	Mac	Dec	-	D	L	C	Compound
42. Family Lamiaceae									
231.	<i>Alujga rhomboidea</i> Benth. Ikonn. Gal.	G	N	Dec	-	D	L	W	Simple
232.	<i>Drachocephalum nutans</i> L.	G	N	Dec	-	D	L	W	Simple
233.	<i>Lamium amplexicaule</i> L.	Th	N	Dec	-	Wet	L	W	Simple
234.	<i>Marrubium vulgare</i> L.	Ch	Mes	Dec	-	D	L	W	Simple
235.	<i>Mentha longifolia</i> (L.) Huds.	G	Mes	Dec	-	Wet	L	W	Simple
236.	<i>Mentha royleana</i> Benth.	G	N	Dec	-	Wet	L	W	Simple
237.	<i>Nepeta cataria</i> L.	Ch	Mes	Dec	-	D	L	W	Simple
238.	<i>Nepeta glutinosa</i> Benth.	Th	Mic	Dec	-	Wet	L	W	Simple
239.	<i>Nepeta kokanica</i> Regel.	Th	N	Dec	-	Wet	L	W	Simple
240.	<i>Nepeta lavigata</i> (D. Don.) Hand. Mazz.	G	Mes	Dec	-	D	L	W	Simple
241.	<i>Nepeta paulsenii</i> Briq.	Th	N	Dec	-	D	L	W	Simple
242.	<i>Nepeta podostachys</i> Benth.	Th	N	Dec	-	D	L	W	Simple
243.	<i>Nepeta priostachya</i> Benth.	Th	Mic	Dec	-	D	L	W	Simple
244.	<i>Nepeta raphanorhiza</i> Benth.	Th	N	Dec	-	D	L	W	Simple
245.	<i>Ocimum basilicum</i> L.	Ch	N	Dec	-	D	L	C	Simple
246.	<i>Ocimum sanctum</i> L.	Th	Mes	Dec	-	D	L	C	Simple
247.	<i>Otostegia limbata</i> (Bth.) Boiss.	Ch	N	Dec	+	D	L	W	Simple
248.	<i>Salvia aegyptiaca</i> L.	Ch	N	Dec	-	D	L	W	Simple
249.	<i>Salvia nubicola</i> Wall ex Sweet.	Ch	Mes	Dec	-	D	L	W	Simple
250.	<i>Salvia rhytidea</i> Benth.	Ch	N	Dec	-	D	L	W	Simple
251.	<i>Thymus linearis</i> subsp. <i>hedgeri</i> Jales.	H	N	Dec	-	D	L	W	Simple
252.	<i>Thymus serpyllum</i> L.	H	N	Dec	-	D	L	W	Simple
253.	<i>Zizyphora clinopodioides</i> Lam.	Th	L	Dec	-	D	L	W	Simple
43. Family Lentibulariaceae									
254.	<i>Utricularia australis</i> R. Br.	G (insec)	L	Dec	-	Wet	S	W	Disec
44. Family Linaceae									
255.	<i>Linum usitatissimum</i> L.	Th	N	Dec	-	D	L	C	Simple
45. Family Malvaceae									
256.	<i>Abutilon bidentatum</i> Hochst ex A. Rich.	Th	Mes	Dec	-	D	L	W	Simple
257.	<i>Alcea rosea</i> (L.) Cav.	H	Mac	Dec	-	D	L	W	Compound
258.	<i>Malva neglecta</i> Wall.	Th	Mes	Dec	-	D	L	W	Compound
259.	<i>Malva parviflora</i> L.	Th	N	Dec	-	D	L	W	Simple
46. Family Meliaceae									
260.	<i>Melia azedarach</i> L.	MegP	Mic	Dec	-	D	L	C	Compound
47. Family Moraceae									
261.	<i>Morus alba</i> L.	MegP	Mac	Dec	-	D	L	C	Simple
262.	<i>Morus nigra</i> L.	MegP	Mac	Dec	-	D	L	C	Simple
48. Family Oleaceae									
263.	<i>Fraxinus xanthoxyloides</i> Wall ex G. Don.	NP	Mic	Dec	-	D	L	W	Compound
49. Family Onagraceae									
264.	<i>Epilobium angustifolium</i> L.	Th	Mes	Dec	-	D	L	W	Simple
265.	<i>Epilobium cylindricum</i> D. Don.	Th	N	Dec	-	D	L	W	Simple

266.	<i>Epilobium hirsutum</i> L.	Th	N	Dec	-	Wet	L	W	Simple
50. Family Paeoniaceae									
267.	<i>Paeonia emodi</i> Wall ex G. Don.	G	N	Dec	-	Wet	S	W	Compound
51. Family Papaveraceae									
268.	<i>Papaver somniferum</i> L.	Th	Mac	Dec	-	D	L	C	Simple
52. Family Papilionaceae									
269.	<i>Astragalus ambersianus</i> Royle ex Benth.	H	L	Dec	+	D	L	W	Simple
270.	<i>Astragalus chlorostachys</i> L.	Th	N	Dec	-	D	L	W	Simple
271.	<i>Astragalus corrugatus</i> Bertol.	Th	N	Dec	-	D	L	W	Simple
272.	<i>Astragalus gilgitensis</i> Ali.	H	Mic	Dec	+	D	L	W	Simple
273.	<i>Astragalus subumbellatus</i> Klotzsch.	H	N	Dec	+	D	L	W	Simple
274.	<i>Astragalus psilocentros</i> Fisch.	H	L	Dec	+	D	L	W	Simple
275.	<i>Astragalus cndolleanus</i> Royle ex Bth.	H	L	Dec	-	D	L	W	Simple
276.	<i>Chesneya depressa</i> (Oliver.) Popov.	H	L	Dec	-	D	L	W	Simple
277.	<i>Cicer macranthum</i> M. Popov.	Th	L	Dec	+	D	L	W	Simple
278.	<i>Colutea paulsenii</i> Feryh.	NP	N	Dec	-	D	L	W	Simple
279.	<i>Crotolaria prostrata</i> Roxb ex D. Don.	H	L	Dec	-	D	L	W	Simple
280.	<i>Glycyrrhiza glabra</i> L.	G	Mes	Dec	-	D	L	W	Simple
281.	<i>Lotus corniculatus</i> var. <i>tenifolius</i> L.	H	L	Dec	-	D	L	W	Simple
282.	<i>Lotus corniculatus</i> var. <i>corniculatus</i> L.	H	L	Dec	-	D	L	W	Simple
283.	<i>Lespedeza</i> Sp.	Th	N	Dec	-	D	L	W	Simple
284.	<i>Medicago lupulina</i> L.	Th	N	Dec	-	D	L	W	Simple
285.	<i>Medicago sativa</i> L.	H	N	Dec	-	D	L	C	Simple
286.	<i>Melilotus officinale</i> (L.) Desr.	Th	N	Dec	-	D	L	W	Simple
287.	<i>Melilotus indica</i> (L.) All.	Th	N	Dec	-	D	L	W	Simple
288.	<i>Pisum sativum</i> L.	Th	Mic	Dec	-	D	L	C	Simple
289.	<i>Sophora mollis</i> (Royle.) Baker.	NP	N	Dec	-	D	L	W	Simple
290.	<i>Trifolium pratense</i> L.	G	N	Dec	-	Wet	L	W	Simple
291.	<i>Trifolium repens</i> L.	G	N	Dec	-	Wet	L	W	Simple
292.	<i>Trifolium resupinatum</i> L.	Th	Mes	Dec	-	Wet	L	C	Simple
293.	<i>Vicia monantha</i> Retz.	Th (Cl)	N	Dec	-	Wet	L	W	Simple
294.	<i>Vicia sativa</i> L.	Th (Cl)	N	Dec	-	Wet	L	W	Simple
53. Family Parnassiaceae									
295.	<i>Parnassia nubicola</i> Planch ex Clarke.	Th	Mes	Dec	-	Wet	L	W	Simple
54. Family Plantaginaceae									
296.	<i>Plantago lanceolata</i> L.	Th	Mes	Dec	-	D	L	W	Simple
297.	<i>Plantago major</i> Aitch.	G	Mac	Dec	-	Wet	L	W	Simp
55. Family Platanaceae									
298.	<i>Platanus orientalis</i> L.	MegP	Mac	Dec	-	D	L	C	Compound
56. Family Plumbaginaceae									
299.	<i>Acantholimon longiscapum</i> Bokhari.	H	L	Dec	+	D	L	W	Simple
300.	<i>Psyllisotachys suworowii</i> (Regd.) Roshk.	Th	Mac	Dec	-	D	L	W	Simple
57. Family Polygonaceae									
301.	<i>Atraphaxis pyrifolia</i> Bunge.	NP	Mes	Dec	+	D	L	W	Simple
302.	<i>Atraphaxis spinosa</i> L.	Ch	L	Dec	+	D	L	W	Simple
303.	<i>Oxyria digyna</i> (L.) Hill.	Th	N	Dec	-	Wet	L	W	Simple
304.	<i>Polygonum afghanicum</i> Meiss.	Th	L	Dec	-	D	L	W	Simple

305.	<i>Polygonum aviculare</i> L.	Th	L	Dec	-	D	L	W	Simple
306.	<i>Polygonum barbatum</i> L.	Th	N	Dec	-	D	L	W	Simple
307.	<i>Polygonum chinensis</i> L.	Th	N	Dec	-	D	L	W	Simple
308.	<i>Polygonum convolvulus</i> L.	Th	N	Dec	-	D	L	W	Simple
309.	<i>Polygonum dumetorum</i> L.	Th	Mes	Dec	-	D	L	W	Simple
310.	<i>Polygonum glabrum</i> Willd.	H	N	Dec	-	D	L	W	Simple
311.	<i>Polygonum hydropiper</i> L.	G	Mes	Dec	-	Wet	L	W	Simple
312.	<i>Polygonum nepalense</i> Meiss.	G	N	Dec	-	D	L	W	Simple
313.	<i>Polygonum orientale</i> L.	G	N	Dec	-	D	L	W	Simple
314.	<i>Polygonum persicaria</i> L.	G	Mes	Dec	-	Wet	L	W	Simple
315.	<i>Rheum emodi</i> Wall. ex Meissn.	G	Meg	Dec	-	D	L	W	Compound
316.	<i>Rumex longifolius</i> DC.	Th	Mac	Dec	-	D	L	W	Simple
58. Family Portulacaceae									
317.	<i>Portulaca oleracea</i> L.	Th	N	Dec	-	D	L	C	Simple
59. Family Primulaceae									
318.	<i>Primula denticulata</i> Sm.	H	N	Dec	-	Wet	L	W	Simple
60. Family Punicaceae									
319.	<i>Punica granatum</i> L.	NP	Mic	Dec	-	D	L	C	Simple
61. Family Ranunculaceae									
320.	<i>Clematis graveolens</i> Lindl.	NP (Cl)	N	Dec	-	D	L	W	Compound
321.	<i>Clematis grata</i> Wall.	Ch (Cl)	N	Dec	-	D	L	W	Compound
322.	<i>Clematis orientalis</i> L.	Ch (Cl)	N	Dec	-	D	L	W	Compound
323.	<i>Delphinium nordhagenii</i> Wenddow.	Ch	Mic	Dec	-	Wet	L	W	Disec
324.	<i>Ranunculus arvensis</i> L.	Th	N	Dec	-	Wet	L	W	Disec
325.	<i>Ranunculus lobatus</i> Jacq. ex Cam.	G	L	Dec	-	Wet	L	W	Disec
326.	<i>Ranunculus natans</i> C.A. Mey.	Th	N	Dec	-	Wet	L	W	Disec
327.	<i>Thalictrum alpinum</i> L.	Th	N	Dec	-	Wet	L	W	Disec
62. Family Resedaceae									
328.	<i>Reseda odorata</i> L.	Th	L	Dec	-	D	L	W	Disec
63. Family Rosaceae									
329.	<i>Argemone eupatoria</i> L.	H	N	Dec	-	D	L	W	Compound
330.	<i>Cotoneaster affinis</i> var. <i>bacillaris</i> (Lindl.) Schneider.	MesP	Mes	Dec	-	D	L	W	Simple
331.	<i>Cotoneaster microphylla</i> Wall. ex Lind.	NP	L	Dec	-	D	L	W	Simple
332.	<i>Cotoneaster nummularia</i> Fisch. & Mey	NP	N	Dec	-	D	L	W	Simple
333.	<i>Crataegus songarica</i> C.Koch.	MegP	Mac	Dec	+	D	L	W	Compound
334.	<i>Potentilla ornithopoda</i> var. <i>ornithopoda</i> Tausch.	Th	N	Dec	-	D	L	W	Simple
335.	<i>Potentilla pamiica</i> Wolf.	Th	N	Dec	-	D	L	W	Simple
336.	<i>Potentilla supina</i> L.	H	L	Dec	-	D	L	W	Simple
337.	<i>Pyrus malus</i> L.	MegP	Mac	Dec	-	D	L	C	Simple
338.	<i>Pyrus communis</i> L.	MegP	Mac	Dec	-	D	L	C	Simple
339.	<i>Prunus amygdalus</i> L.	MesP	Mic	Dec	-	D	L	C	Simple
340.	<i>Prunus armeniaca</i> L.	MegP	Mes	Dec	+	D	L	C	Simple
341.	<i>Prunus persica</i> (L.) Batsch.	MesP	Mic	Dec	-	D	L	C	Simple
342.	<i>Rosa alba</i> L.	NP	Mic	Dec	+	D	L	C	Compound
343.	<i>Rosa webbiana</i> Wall. ex Royle.	NP	N	Dec	+	D	L	W	Compound
344.	<i>Rubus fruticosus</i> L.	NP	Mes	Dec	+	D	L	W	Compound

64. Family Rubiaceae									
345.	<i>Asperula oppositifolia</i> Ssp. <i>cabaulica</i> Ehrend.	Th	N	Dec	+	D	L	W	Simple
346.	<i>Asperula oppositifolia</i> Ssp. <i>pseudocynanchia</i> Ehrend.	Th	L	Dec	+	D	L	W	Simple
347.	<i>Galium aparine</i> L.	Th (Cl)	N	Dec	+	D	L	W	Simple
348.	<i>Galium asperifolium</i> Wall.	Th (Cl)	N	Dec	+	D	L	W	Simple
349.	<i>Galium tricornutum</i> Dandy.	Th (Cl)	N	Dec	+	D	L	W	Simple
65. Family Salicaceae									
350.	<i>Populus alba</i> L.	MacP	Mes	Dec	-	Wet	L	C	Simple
351.	<i>Populus nigra</i> L.	MegP	Mac	Dec	-	Wet	L	C	Simple
352.	<i>Salix acmophylla</i> Boiss.	MesP	Mes	Dec	-	Wet	L	W	Simple
353.	<i>Salix coerriola</i> (Sm.) Rech.	MesP	Mes	Dec	-	Wet	L	W	Simple
354.	<i>Salix tetrasperma</i> Roxb.	MegP	Mes	Dec	-	Wet	L	C	Simple
355.	<i>Salix wilhelmsiana</i> M.B.	MesP	Mes	Dec	-	Wet	L	W	Simple
66. Family Saxifragaceae									
356.	<i>Bergenia ciliata</i> (Haw.) Sternb.	G	Mic	E	-	Wet	S	W	Simple
357.	<i>Bergenia himalaica</i> Boiss.	G	Mic	E	-	Wet	S	W	Simple
358.	<i>Ribes orientale</i> Desf.	MacP	Mes	Dec	-	D	L	W	Compound
67. Family Scrophulariaceae									
359.	<i>Antirrhinum majus</i> L.	Th	L	Dec	-	D	L	W	Simple
360.	<i>Euphrasia aristulata</i> Perm.	Th	L	Dec	-	Wet	S	W	Simple
361.	<i>Linaria vulgaris</i> Mill.	Th	L	Dec	-	D	L	W	Simple
362.	<i>Scrophularia scoparia</i> Penn.	Th	N	Dec	-	D	L	W	Simple
363.	<i>Scrophularia stewartii</i> Penn.	H	Mic	Dec	-	D	L	W	Simple
364.	<i>Verbascum erianthum</i> Benth.	Th	Mic	Dec	-	D	L	W	Simple
365.	<i>Verbascum thapsus</i> L.	G	Mac	Dec	-	D	L	W	Simple
366.	<i>Veronica anagalis-aquatica</i> L.	G	Mes	Dec	-	Wet	L	W	Compound
367.	<i>Veronica serpyllifolia</i> L.	Th	Mic	Dec	-	Wet	L	W	Compound
68. Family Simarubaceae									
368.	<i>Ailanthus altissima</i> (Mill.) Swingle.	NP	Mic	Dec	-	D	L	W	Compound
69. Family Solanaceae									
369.	<i>Datura stramonium</i> L.	Th	Mac	Dec	+	D	L	W	Simple
370.	<i>Hyoscyamus niger</i> L.	Th	L	Dec	+	D	L	W	Simple
371.	<i>Hyoscyamus pusillus</i> L.	Th	N	Dec	+	D	L	W	Simple
372.	<i>Lycopersicum esculentum</i> L.	Th	Mic	Dec	-	D	L	C	Compound
373.	<i>Nicotiana tabacum</i> L.	Th	Mac	Dec	-	D	L	C	Simple
374.	<i>Nicotiana rustica</i> L.	Th	Mac	Dec	-	D	L	C	Simple
375.	<i>Solanum melongena</i> L.	Th	Mac	Dec	-	D	L	C	Simple
376.	<i>Solanum nigrum</i> L.	Th	Mes	Dec	-	Wet	S	W	Simple
377.	<i>Solanum tuberosum</i> L.	G	Mes	Dec	-	D	L	C	Compound
70. Family Tamaricaceae									
378.	<i>Myricaria elegans</i> Royle.	NP	L	Dec	-	Wet	L	W	Simple
379.	<i>Tamarix dioica</i> Rox. ex Roth.	NP	L	Dec	-	Wet	L	W	Simple
71. Family Thymeliaceae									
380.	<i>Daphne oleoides</i> Schrend.	NP	L	E	-	Wet	S	W	Simple
381.	<i>Thymelaea passerina</i> (L.) Cosson & Germain.	Th	N	Dec	-	D	L	W	Simple

72. Family Utricaceae									
382.	<i>Pilea umbrosa</i> Wedd.	Th	N	Dec	-	D	S	W	Simple
73. Family Violaceae									
383.	<i>Viola serpens</i> Wall ex Roxb.	G	Mic	E	-	Wet	S	W	Simple
74. Family Vitaceae									
384.	<i>Vitis vinifera</i> L.	NP	Mac	Dec	-	D	L	C	Compound
75. Family Zygophyllaceae									
385.	<i>Peganum harmala</i> L.	H	N	Dec	-	D	L	W	Simple
386.	<i>Tribulus terrestris</i> L.	Th	L	Dec	+	D	L	W	Simple

Keys :

- Life-form: Th. Therophyte, G. Geophyte, H. Hemicryptophytes, Ch. Chamaephytes, NP. Nanophanerophytes, MacP. Macrophanerophytes, MesP. Mesophanerophytes, MegP. Megaphanerophytes
- Leaf-size: Ap. Aphyllous, L. Leptophyll, N. Naonphyll, Mic. Microphyll, Mes. Mesophyll, Mac. Macrophyll, Meg. Megaphyll,
- Leaf persistence: E. Evergreen, Dec. Deciduous
- Spinyness: +. spiny
- Habitat: D. Dry
- Light: L. Light, S. Shade
- Cultivated/wild: W. Wild, C. Cultivated
- Leaf shape: Disec. Dissected

Table 5. Summary of ecological characters of plant species of Mastuj Valley, District Chitral, Pakistan.

S. No.	Parameters	No. of species	Percentage (%)
	Life-form classes		
1.	Therophytes	195	50
2.	Hemicryptophytes	66	17.09
3.	Geophytes	61	15.80
4.	Nanophanerophytes	22	5.69
5.	Chamaephytes	19	4.92
6.	Megaphanerophytes	12	3.10
7.	Mesophanerophytes	8	2.07
8.	Macrophanerophytes	3	0.77
	Total	386	99.44
	Leaf-size classes		
1.	Nanophylls	187	48.44
2.	Mesophylls	80	20.72
3.	Leptophylls	48	12.43
4.	Microphylls	31	8.03
5.	Macrophylls	28	7.25
6.	Megaphylls	7	1.81
7.	Aphyllous	5	1.30
	Total	386	99.98
	Leaf persistence		
1.	Deciduous	351	90.93
2.	Evergreen	35	8.03
	Total	386	98.96
	Spinyess		
1.	Non-spiny	349	90.41
2.	Spiny	37	9.58
	Habitat		
1.	Terrestrial	297	76.94
2.	Wet	89	23.05
	Total	386	99.99
	Light		
1.	Heliophytes	354	91.70
2.	Sciophytes	32	8.29
	Total	386	99.99
	Cultivated/wild		
1.	Wild	337	87.30
2.	Cultivated	49	12.69
	Total	386	99.99
	Leaf appearance		
1.	Simple	289	74.87
2.	Dissected	49	12.69
3.	Compound	45	11.13
	Total	386	98.69

62.	<i>Pistacia integerrhima</i> (L.) Steward ex Brand.	+	-	-	+	-	-	-	-	-
63.	<i>Pistacia khinjuk</i> Stock.	+	+	-	+	-	-	-	-	-
18. Family Apiaceae										
64.	<i>Ammi visnaga</i> (L.) Lam.	+	-	-	-	-	-	-	-	-
65.	<i>Anethum graveolens</i> L.	+	+	-	-	-	-	-	-	-
66.	<i>Bunium persicum</i> (Boiss.) Fedtsch.	+	+	-	-	-	-	+	-	-
67.	<i>Carum copticum</i> L.	+	+	-	-	-	-	+	-	-
68.	<i>Carum carvi</i> L.	+	+	-	-	-	-	-	-	-
69.	<i>Coriandrum sativum</i> L.	-	+	-	-	-	-	+	-	-
70.	<i>Cortia schmidii</i> Nasir.	+	-	-	-	-	-	-	-	-
71.	<i>Daucus carota</i> L.	+	+	-	-	-	+	-	-	-
72.	<i>Ferula jaeschkeana</i> Vatke.	+	+	-	-	-	-	-	-	-
73.	<i>Ferula</i> Sp.	+	-	-	-	-	-	-	-	-
74.	<i>Foeniculum vulgare</i> Miller.	-	+	-	-	-	-	+	-	-
75.	<i>Pleurospermum stylosum</i> Clarke.	+	-	-	-	-	-	-	-	-
76.	<i>Pimpinella stewartii</i> Dunn. Nasir.	+	-	-	-	-	-	-	-	-
77.	<i>Prongus publaria</i> (Lind.) Hiroe.	+	+	-	-	-	-	-	-	-
78.	<i>Seseli libanotis</i> (L.) Koch.	+	-	-	-	-	-	-	-	-
79.	<i>Torilis arvensis</i> (Huds.) Link.	+	-	-	-	-	-	-	-	-
80.	<i>Trachydium roylei</i> Lindl.	+	+	-	-	-	-	-	+	-
81.	<i>Trachyspermum ammi</i> (L.) Spargue.	+	-	-	-	-	-	+	-	-
19. Family Apocynaceae										
82.	<i>Trachomitum venetum</i> (L.) Woodson	+	+	-	-	-	-	-	+	-
20. Family Asclepiadaceae										
83.	<i>Cynanchum acutum</i> L.	+	-	-	+	-	-	-	-	-
84.	<i>Cynanchum arnottianum</i> Wight.	+	-	-	+	-	-	-	-	-
21. Family Asteraceae										
85.	<i>Anaphalia gracilis</i> Haud & Mazz.	+	-	-	-	-	-	-	-	-
86.	<i>Anthemis cotula</i> L.	+	-	-	-	-	-	-	-	-
87.	<i>Anthemis tinctoria</i> L.	+	-	-	-	-	-	-	-	-
88.	<i>Artemisia brevifolia</i> Wall ex DC.	+	-	-	+	-	-	-	-	-
89.	<i>Artemisia maritima</i> L.	+	-	-	+	-	-	-	-	-
90.	<i>Artemisia parviflora</i> Roxb.	+	+	-	-	-	-	-	-	-
91.	<i>Artemisia scoparia</i> Waldst. & Kit.	+	-	-	+	-	-	-	+	-
92.	<i>Artemisia rutifolia</i> Steph ex Spreng.	+	-	-	+	-	-	-	-	-
93.	<i>Artemisia laciniata</i> Willd.	+	-	-	+	-	-	-	-	-
94.	<i>Aster altiacus</i> Willd.	+	-	-	-	-	-	-	-	-
95.	<i>Aster amellus</i> auct.	+	-	-	-	-	-	-	-	-
96.	<i>Bidens tripartita</i> L.	+	-	-	-	-	-	-	-	-
97.	<i>Brachyactis roylei</i> Wendelbow.	+	-	-	-	-	-	-	-	-
98.	<i>Calendula officinalis</i> L.	-	+	-	-	-	-	-	-	-
99.	<i>Centaurea calcitrapa</i> L.	+	-	-	-	-	-	-	-	-
100.	<i>Chondrilla graminea</i> M. Bieb.	+	-	-	-	-	-	-	-	-

101.	<i>Chrysanthemum cinerariifolium</i> (Trev.) Vis.	+	-	-	-	-	-	-	-	-
102.	<i>Cirsium acaule</i> (L.) Scop.	+	-	-	-	-	-	-	-	-
103.	<i>Cirsium argyacanthum</i> D.C.	+	-	-	-	-	-	-	-	-
104.	<i>Cichorium intybus</i> L.	+	+	-	-	-	-	-	-	-
105.	<i>Cnicus benedictus</i> L.	+	-	-	-	-	-	-	-	-
106.	<i>Conyza bonariensis</i> (L.) Conquist.	+	-	-	-	-	-	-	-	-
107.	<i>Conyza canadensis</i> (L.) Conquist	+	-	-	-	-	-	-	-	-
108.	<i>Conyza japonica</i> Less.	+	-	-	-	-	-	-	-	-
109.	<i>Conyza stricta</i> Willd.	+	-	-	-	-	-	-	-	-
110.	<i>Cosmos bipinnatus</i> Cav.	+	-	-	-	-	-	-	-	-
111.	<i>Cousinia mattfeldii</i> Bornm.	+	-	-	-	-	-	-	-	-
112.	<i>Crepis sancta</i> (L.) Babc.	+	-	-	-	-	-	-	-	-
113.	<i>Crepis thomsonii</i> Babc.	+	-	-	-	-	-	-	-	-
114.	<i>Echinops echinatus</i> Roxb.	+	-	-	-	-	-	-	-	-
115.	<i>Erigeron acer</i> subsp. <i>acer</i> L.	+	-	-	-	-	-	-	-	-
116.	<i>Erigeron alpinus</i> L.	+	-	-	-	-	-	-	-	-
117.	<i>Erigeron canadensis</i> L. Cronq.	+	-	-	-	-	-	-	-	-
118.	<i>Erigeron acris</i> L.	+	-	-	-	-	-	-	-	-
119.	<i>Filago germanica</i> L.	+	-	-	-	-	-	-	-	-
120.	<i>Gnaphalium luteo-album</i> L.	+	-	-	-	-	-	-	-	-
121.	<i>Gnaphalium thomsonii</i> Hkf.	+	-	-	-	-	-	-	-	-
122.	<i>Inula obtusifolia</i> Kerner.	+	-	-	-	-	-	-	-	-
123.	<i>Lactuca clarkei</i> Hook.f.	+	-	-	-	-	-	-	-	-
124.	<i>Lactuca orientalis</i> (Boiss.) Boiss.	+	-	-	-	-	-	-	-	-
125.	<i>Lactuca sativa</i> L.	+	-	-	-	-	+	-	-	-
126.	<i>Lactuca serriola</i> L.	+	-	-	-	-	-	-	-	-
127.	<i>Lactuca tatarica</i> (L.) C. A. Mey.	+	-	-	-	-	-	-	-	-
128.	<i>Lactuca undulata</i> Ladb.	+	-	-	-	-	-	-	-	-
129.	<i>Lactuca viminea</i> (L.) F. W. Schmid.	+	-	-	-	-	-	-	-	-
130.	<i>Launaea polyclada</i> (Boiss.) Burkill.	+	-	-	-	-	-	-	-	-
131.	<i>Launaea procumbens</i> Roxb.	+	-	-	-	-	-	-	-	-
132.	<i>Matricaria chamomila</i> L.	+	+	-	-	-	-	-	-	-
133.	<i>Matricaria disciformis</i> (C.A.M.) DC.	+	-	-	-	-	-	-	-	-
134.	<i>Matricaria praecox</i> DC.	+	-	-	-	-	-	-	-	-
135.	<i>Myriactis wallichii</i> Less.	+	-	-	-	-	-	-	-	-
136.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	+	-	-	-	-	-	-	-	-
137.	<i>Senecio dubius</i> Ladeb.	+	-	-	-	-	-	-	-	-
138.	<i>Solidago virgaurea</i> L.	+	-	-	-	-	-	-	-	-
139.	<i>Sonchus arvensis</i> Boiss.	+	-	-	-	-	-	-	-	-
140.	<i>Sonchus asper</i> (L.) Hill.	+	-	-	-	-	-	-	-	-
141.	<i>Sonchus maritimus</i> L.	+	-	-	-	-	-	-	-	-
142.	<i>Sonchus oleraceus</i> L.	+	-	-	-	-	-	-	-	-
143.	<i>Tagetes erecta</i> L.	+	-	-	-	-	-	-	-	-
144.	<i>Taraxacum dealbatum</i> Haud & Mazz.	+	-	-	-	-	-	-	-	-

182..	<i>Codonopsis clematidia</i> (Schrenk) Clarke.	+	-	-	-	-	-	-	-	-
27. Family Canabinaceae										
183.	<i>Canabis sativa</i> L.	-	+	-	-	-	-	-	-	-
28. Family Capparidaceae										
184.	<i>Capparis spinosa</i> L.	+	+	-	-	-	+	-	-	-
185.	<i>Cleome ariana</i> Hedge & Lamond.	+	-	-	-	-	-	-	-	-
29. Family Caryophyllaceae										
186.	<i>Arenaria serpyllifolia</i> L.	+	-	-	-	-	-	-	-	-
187.	<i>Ceratium cerastioides</i> (L.) Britton.	+	-	-	-	-	-	-	-	-
188.	<i>Dianthus anatolicus</i> Boiss.	+	-	-	-	-	-	-	-	-
189.	<i>Lepyrodicilis holosteoides</i> C.A. Mey.	+	-	-	-	-	-	-	-	-
190.	<i>Minuartia hybrida</i> (Vill). Schischkin.	+	-	-	-	-	-	-	-	-
191.	<i>Silene areneosa</i> C.Koch.	+	-	-	-	-	-	-	-	-
192.	<i>Silene conoidea</i> L.	+	+	-	-	-	+	-	-	-
193.	<i>Stellaria media</i> (L.) Vill.	+	-	-	-	-	-	-	-	-
194.	<i>Vaccaria pyramidata</i> Medik.	+	-	-	-	-	-	-	-	-
30. Family Chenopodiaceae										
195.	<i>Atriplex canescens</i> James.	+	-	-	-	-	-	-	-	-
196.	<i>Atriplex crassifolia</i> C. A. Mey.	+	-	-	-	-	-	-	-	-
197.	<i>Beta vulgaris</i> L.	+	-	-	-	-	+	-	-	-
198.	<i>Chenopodium album</i> L.	+	-	-	-	-	+	-	-	-
199.	<i>Chenopodium ambrosioides</i> L.	+	-	-	-	-	-	-	-	-
200.	<i>Chenopodium botrys</i> L.	+	-	-	-	-	-	-	-	-
201.	<i>Chenopodium foliosum</i> (Merrich.) Aschers.	+	-	-	-	-	-	-	-	-
202.	<i>Chenopodium murale</i> L.	+	-	-	-	-	+	-	-	-
203.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	+	-	-	+	-	-	-	-	-
204.	<i>Kochia prostrata</i> (L.) Schard.	+	-	-	-	-	-	-	-	-
205.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	+	-	-	-	-	-	-	-	-
206.	<i>Salsola kali</i> L.	+	-	-	-	-	-	-	-	-
31. Family Convolvulaceae										
207.	<i>Convolvulus arvensis</i> L.	+	+	-	-	-	-	-	-	-
32. Family Crassulaceae										
208.	<i>Sedum ewersii</i> Ledeb.	+	-	-	-	-	-	-	-	-
33. Family Cucurbitaceae										
209.	<i>Citrulus vulgaris</i>	+	-	-	-	+	-	-	-	-
210.	<i>Cucurbita maxima</i> Duch ex Lam.	+	+	-	-	-	+	-	-	-
211.	<i>Cucumis sativa</i> L.	+	-	-	-	+	+	-	-	-
34. Family Cuscutaceae										
212.	<i>Cuscuta approximata</i> Bab.	+	-	-	-	-	-	-	-	-
213.	<i>Cuscuta reflexa</i> Roxb.	+	-	-	-	-	-	-	-	-
35. Family Elaeagnaceae										
214.	<i>Elaeagnus angustifolia</i> L.	+	+	+	+	+	-	-	+	-
215.	<i>Hippophae rhamnoides</i> L.	+	+	-	+	-	-	-	+	-
36. Family Euphorbiaceae										

216.	<i>Euphorbia falcata</i> L.	+	-	-	-	-	-	-	-	-
217.	<i>Euphorbia osyridea</i> Boiss.	+	-	-	+	-	-	-	-	-
218.	<i>Euphorbia peplus</i> L.	+	-	-	-	-	-	-	-	-
219.	<i>Euphorbia wallichii</i> Hk.	+	-	-	-	-	-	-	-	-
37. Family Fumariaceae										
220.	<i>Corydalis govaniana</i> Wall ex Trend.	+	-	-	-	-	-	-	-	-
221.	<i>Fumaria indica</i> (Hausskn.) L.	+	+	-	-	-	-	-	-	-
38. Family Gentianaceae										
222.	<i>Centaurium meyeri</i> (Bunge.) Druce.	+	-	-	-	-	-	-	-	-
223.	<i>Gentiana kurroo</i> Royle.	+	-	-	-	-	-	-	-	-
224.	<i>Jeshkea oligosperma</i> L.	+	-	-	-	-	-	-	-	-
225.	<i>Swertia speciosa</i> D. Don.	+	-	-	-	-	-	-	-	-
39. Family Geraniaceae										
226.	<i>Geranium pretense</i> L.	+	-	-	-	-	-	-	-	-
227.	<i>Geranium rotundifolium</i> L.	+	-	-	-	-	-	-	-	-
228.	<i>Geranium wallichinum</i> D. Don ex Sweet.	+	-	-	-	-	-	-	-	-
40. Family Hippuridaceae										
229.	<i>Hippuris vulgaris</i> L.	+	-	-	-	-	-	-	-	-
41. Family Juglandaceae										
230.	<i>Juglans regia</i> L.	+	+	+	+	+	-	-	-	-
42. Family Lamiaceae										
231.	<i>Alujga rhomboidea</i> Benth. Ikonn. Gal.	+	-	-	-	-	-	-	-	-
232.	<i>Drachcephalum nutans</i> L.	+	-	-	-	-	-	-	-	-
233.	<i>Lamium amplexicaule</i> L.	+	-	-	-	-	-	-	-	-
234.	<i>Marrubium vulgare</i> L.	+	-	-	-	-	-	-	-	-
235.	<i>Mentha longifolia</i> (L.) Huds.	+	+	-	-	-	-	+	-	-
236.	<i>Mentha royleana</i> Benth.	+	-	-	-	-	-	-	-	-
237.	<i>Nepeta cataria</i> L.	+	+	-	-	-	-	-	-	-
238.	<i>Nepeta glutinosa</i> Benth.	+	-	-	-	-	-	-	-	-
239.	<i>Nepeta kokanica</i> Regel.	+	-	-	-	-	-	-	-	-
240.	<i>Nepeta lavigata</i> (D. Don.) Hand. Mazz.	+	-	-	-	-	-	-	-	-
241.	<i>Nepeta paulsenii</i> Briq.	+	-	-	-	-	-	-	-	-
242.	<i>Nepeta podostachys</i> Benth.	+	-	-	-	-	-	-	-	-
243.	<i>Nepeta priostachya</i> Benth.	+	-	-	-	-	-	-	-	-
244.	<i>Nepeta raphanorhiza</i> Benth.	+	-	-	-	-	-	-	-	-
245.	<i>Ocimum basilicum</i> L.	-	+	-	-	-	-	+	-	-
246.	<i>Ocimum sanctum</i> L.	-	+	-	-	-	-	+	-	-
247.	<i>Otostegia limbata</i> (Bth.) Boiss.	+	-	-	+	-	-	-	-	-
248.	<i>Salvia aegyptiaca</i> L.	+	-	-	-	-	-	-	-	-
249.	<i>Salvia nubicola</i> Wall ex Sweet.	+	-	-	-	-	-	-	-	-
250.	<i>Salvia rhytidea</i> Benth.	-	+	-	-	-	-	+	-	-
251.	<i>Thymus linearis</i> subsp. <i>Hedgei</i> Jales.	+	-	-	-	-	-	-	-	-
252.	<i>Thymus serpyllum</i> L.	-	+	-	-	-	-	+	-	-
253.	<i>Zizyphora clinopodioides</i> Lam.	+	-	-	-	-	-	-	-	-

43. Family Lentibulariaceae										
254.	<i>Utricularia australis</i> R. Br.	+	-	-	-	-	-	-	-	-
44. Family Linaceae										
255.	<i>Linum usitatissimum</i> L.	+	+	-	-	-	-	-	-	-
45. Family Malvaceae										
256.	<i>Abutilon bidentatum</i> Hochst ex Rich.	+	-	-	-	-	-	-	-	-
257.	<i>Althaea rosea</i> (L.) Cav.	+	+	-	-	-	-	-	-	-
258.	<i>Malva neglecta</i> Wall.	+	+	-	-	-	-	-	-	-
259.	<i>Malva parviflora</i> L.	+	-	-	-	-	-	-	-	-
46. Family Meliaceae										
260.	<i>Melia azedarach</i> L.	+	-	+	+	-	-	-	-	-
47. Family Moraceae										
261.	<i>Morus alba</i> L.	+	+	+	+	+	-	-	-	-
262.	<i>Morus nigra</i> L.	+	+	+	+	+	-	-	-	-
48. Family Oleaceae										
263.	<i>Fraxinus xanthoxyloides</i> Wall ex G. Don.	+	+	+	+	-	-	-	-	-
49. Family Onagraceae										
264.	<i>Epilobium angustifolium</i> L.	+	-	-	-	-	-	-	-	-
265.	<i>Epilobium cylindricum</i> D. Don.	+	-	-	-	-	-	-	-	-
266.	<i>Epilobium hirsutum</i> L.	+	-	-	-	-	-	-	-	-
50. Family Paeoniaceae										
267.	<i>Paeonia emodi</i> Wall ex G. Don.	-	+	-	-	-	-	-	-	-
51. Family Papaveraceae										
268.	<i>Papaver somniferum</i> L.	+	+	-	-	-	-	-	-	-
52. Family Papilionaceae										
269.	<i>Astragalus amberstianus</i> Royle ex Benth.	+	-	-	-	-	-	-	-	-
270.	<i>Astragalus chlorostachys</i> L.	+	-	-	-	-	-	-	-	-
271.	<i>Astragalus corrugatus</i> Bertol.	+	-	-	-	-	-	-	-	-
272.	<i>Astragalus gilgitensis</i> Ali.	+	-	-	-	-	-	-	-	-
273.	<i>Astragalus subumbellatus</i> Klotzsch.	+	-	-	-	-	-	-	-	-
274.	<i>Astragalus psilocentros</i> Fisch.	+	+	-	+	-	-	-	-	-
275.	<i>Astragalus cndolleanus</i> Royle ex Bth.	+	-	-	-	-	-	-	-	-
276.	<i>Chesneya depressa</i> (Oliver.) Popov.	+	-	-	-	-	-	-	-	-
277.	<i>Cicer macranthum</i> M. Popov.	+	-	-	-	-	-	-	-	-
278.	<i>Colutea paulsenii</i> Feryh.	+	-	-	+	-	-	-	-	-
279.	<i>Crotolaria prostrata</i> Roxb ex D. Don.	+	-	-	-	-	-	-	-	-
280.	<i>Glycyrrhiza glabra</i> L.	+	+	-	-	-	-	-	-	-
281.	<i>Lotus corniculatus</i> var. <i>tennifolius</i> L.	+	-	-	-	-	-	-	-	-
282.	<i>Lotus corniculatus</i> var. <i>corniculatus</i> L.	+	-	-	-	-	-	-	-	-
283.	<i>Lespedeza</i> Sp.	+	-	-	-	-	-	-	-	-
284.	<i>Medicago lupulina</i> L.	+	-	-	-	-	-	-	-	-
285.	<i>Medicago sativa</i> L.	+	-	-	-	-	+	-	-	-
286.	<i>Melilotus officinale</i> (L.) Desr.	+	+	-	-	-	-	-	-	-
287.	<i>Melilotus indica</i> (L.) All.	+	-	-	-	-	-	-	-	-

288.	<i>Pisum sativum</i> L.	+	-	-	-	-	+	-	-	-
289.	<i>Sophora mollis</i> (Royle.) Baker.	+	+	-	+	-	-	-	+	-
290.	<i>Trifolium pratense</i> L.	+	-	-	-	-	-	-	-	-
291.	<i>Trifolium repens</i> L.	+	-	-	-	-	-	-	-	-
292.	<i>Trifolium resupinatum</i> L.	+	-	-	-	-	+	-	-	-
293.	<i>Vicia monantha</i> Retz.	+	-	-	-	-	-	-	-	-
294.	<i>Vicia sativa</i> L.	+	-	-	-	-	-	-	-	-
53. Family Parnassiaceae										
295.	<i>Parnassia nubicola</i> Planch ex Clarke.	+	-	-	-	-	-	-	-	-
54. Family Plantaginaceae										
296.	<i>Plantago lanceolata</i> L.	+	-	-	-	-	-	-	-	-
297.	<i>Plantago major</i> Aitch.	+	+	-	-	-	-	-	-	-
55. Family Platanaceae										
298.	<i>Platanus orientalis</i> L.	+	-	+	+	-	-	-	-	-
56. Family Plumbaginaceae										
299.	<i>Acantholimon longiscapum</i> Bokhari.	+	-	-	+	-	-	-	-	-
300.	<i>Psyllisotachys suworowii</i> (Regd.) Roshk.	+	+	-	-	-	+	-	-	-
57. Family Polygonaceae										
301.	<i>Atraphaxis pyrifolia</i> Bunge.	+	-	-	+	-	-	-	-	-
302.	<i>Atraphaxis spinosa</i> L.	+	-	-	+	-	-	-	-	-
303.	<i>Oxyria digyna</i> (L.) Hill.	+	-	-	-	-	-	-	-	-
304.	<i>Polygonum afghanicum</i> Meiss.	+	-	-	-	-	-	-	-	-
305.	<i>Polygonum aviculare</i> L.	+	-	-	-	-	-	-	-	-
306.	<i>Polygonum barbatum</i> L.	+	-	-	-	-	-	-	-	-
307.	<i>Polygonum chinensis</i> L.	+	-	-	-	-	-	-	-	-
308.	<i>Polygonum convolvulus</i> L.	+	-	-	-	-	-	-	-	-
309.	<i>Polygonum dumetorum</i> L.	+	+	-	-	-	+	-	-	-
310.	<i>Polygonum glabrum</i> Willd.	+	+	-	-	-	-	-	-	-
311.	<i>Polygonum hydropiper</i> L.	+	-	-	-	-	-	-	-	-
312.	<i>Polygonum nepalense</i> Meiss.	+	-	-	-	-	-	-	-	-
313.	<i>Polygonum orientale</i> L.	+	-	-	-	-	-	-	-	-
314.	<i>Polygonum persicaria</i> L.	+	-	-	-	-	-	-	-	-
315.	<i>Rheum emodi</i> Wall.ex Meissn.	+	+	-	-	-	-	-	-	-
316.	<i>Rumex longifolius</i> DC.	+	+	-	-	-	+	-	-	-
58. Family Portulacaceae										
317.	<i>Portulaca oleracea</i> L.	+	+	-	-	-	+	-	-	-
59. Family Primulaceae										
318.	<i>Primula denticulata</i> Sm.	+	-	-	-	-	-	-	-	-
60. Family Puniaceae										
319.	<i>Punica granatum</i> L.	+	+	+	+	+	-	-	-	-
61. Family Ranunculaceae										
320.	<i>Clematis graveolens</i> Lindl.	+	-	-	-	-	-	-	-	-
321.	<i>Clematis grata</i> Wall.	+	-	-	-	-	-	-	-	-
322.	<i>Clematis orientalis</i> L.	+	-	-	+	-	-	-	-	-

323.	<i>Delphinium nordhagenii</i> Wendd. & B. & S.	+	-	-	-	-	-	-	-	-
324.	<i>Ranunculus arvensis</i> L.	+	-	-	-	-	-	-	-	-
325.	<i>Ranunculus lobatus</i> Jacq. ex Cam.	+	-	-	-	-	-	-	-	-
326.	<i>Ranunculus natans</i> C.A. Mey.	+	-	-	-	-	-	-	-	-
327.	<i>Thalictrum alpinum</i> L.	+	-	-	-	-	-	-	-	-
62. Family Resedaceae										
328.	<i>Reseda odorata</i> L.	+	-	-	-	-	-	-	-	-
63. Family Rosaceae										
329.	<i>Argemone eupatoria</i> L.	+	-	-	-	-	-	-	-	-
330.	<i>Cotoneaster affinis</i> var. <i>bacillaris</i> (Lindl.) Schneider.	+	+	-	+	-	-	-	-	-
331.	<i>Cotoneaster microphylla</i> Wall. ex Lind.	+	-	+	+	+	-	-	-	-
332.	<i>Cotoneaster nummularia</i> Fisch. & Mey.	+	+	+	+	-	-	-	-	-
333.	<i>Crataegus songarica</i> C. Koch.	+	+	+	+	+	-	-	-	-
334.	<i>Potentilla ornithopoda</i> var. <i>ornithopoda</i> Tausch.	+	-	-	-	-	-	-	-	-
335.	<i>Potentilla pamirica</i> Wolf.	+	-	-	-	-	-	-	-	-
336.	<i>Potentilla supina</i> L.	+	-	-	-	-	-	-	-	-
337.	<i>Pyrus malus</i> L.	+	+	+	+	+	-	-	-	-
338.	<i>Pyrus communis</i> L.	+	-	+	+	+	-	-	-	-
339.	<i>Prunus armeniaca</i> L.	+	+	+	+	+	-	-	-	-
340.	<i>Prunus amygdalus</i> L.	+	+	+	+	+	-	-	-	-
341.	<i>Prunus persica</i> (L.) Batsch.	+	+	+	+	+	-	-	-	-
342.	<i>Rosa alba</i> L.	+	+	-	+	-	-	-	-	-
343.	<i>Rosa webbiana</i> Wall. ex Royle.	+	+	-	+	-	-	-	-	-
344.	<i>Rubus fruticosus</i> L.	+	+	-	-	-	-	-	-	-
64. Family Rubiaceae										
345.	<i>Asperula oppositifolia</i> Ssp. <i>cabaulica</i> Ehrend.	+	-	-	-	-	-	-	-	-
346.	<i>Asperula oppositifolia</i> Ssp. <i>pseudocynanchia</i> Ehrend.	+	-	-	-	-	-	-	-	-
347.	<i>Galium aparine</i> L.	+	-	-	-	-	-	-	-	-
348.	<i>Galium asperifolium</i> Wall.	+	-	-	-	-	-	-	-	-
349.	<i>Galium tricornutum</i> Dandy.	+	-	-	-	-	-	-	-	-
65. Family Salicaceae										
350.	<i>Populus alba</i> L.	+	-	+	+	-	-	-	-	-
351.	<i>Populus nigra</i> L.	+	-	+	+	-	-	-	-	-
352.	<i>Salix acmophylla</i> Boiss.	+	+	+	+	-	-	-	-	-
353.	<i>Salix coerriola</i> (Sm.) Rech.	+	-	+	+	-	-	-	+	-
354.	<i>Salix tetrasperma</i> Roxb.	+	-	+	+	-	-	-	-	-
355.	<i>Salix wilhelmsiana</i> M.B.	+	-	+	+	-	-	-	-	-
66. Family Saxifragaceae										
356.	<i>Bergenia ciliata</i> (Haw.) Sternb.	+	+	-	-	-	-	-	-	-
357.	<i>Bergenia himalaica</i> Boiss.	+	-	-	-	-	-	-	-	-
358.	<i>Ribes orientale</i> Desf.	+	-	+	+	-	-	-	-	-

67. Family Scrophulariaceae										
359.	<i>Antirrhinum majus</i> L.	+	-	-	-	-	-	-	-	-
360.	<i>Euphrasia aristulata</i> Perm.	+	-	-	-	-	-	-	-	-
361.	<i>Linaria vulgaris</i> Mill.	+	-	-	-	-	-	-	-	-
362.	<i>Scrophularia scoparia</i> Penn.	+	-	-	-	-	-	-	-	-
363.	<i>Scrophularia stewartii</i> Penn.	+	-	-	-	-	-	-	-	-
364.	<i>Verbascum erianthum</i> Benth.	+	-	-	-	-	-	-	-	-
365.	<i>Verbascum thapsus</i> L.	+	+	-	-	-	-	-	-	-
366.	<i>Veronica anagallis-aquatica</i> L.	+	-	-	-	-	-	-	-	-
367.	<i>Veronica serpyllifolia</i> L.	+	-	-	-	-	-	-	-	-
68. Family Simarubaceae										
368.	<i>Ailanthus altissima</i> (Mill.) Swingle.	+	-	+	+	-	-	-	-	-
69. Family Solanaceae										
369.	<i>Datura stramonium</i> L.	-	+	-	-	-	-	-	-	-
370.	<i>Hyoscyamus niger</i> L.	+	-	-	-	-	-	-	-	-
371.	<i>Hyoscyamus pusillus</i> L.	+	-	-	-	-	-	-	-	-
372.	<i>Lycopersicum esculentum</i> L.	+	-	-	-	-	+	+	-	-
373.	<i>Nicotiana tabacum</i> L.	-	+	-	-	-	-	-	-	+
374.	<i>Nicotiana rustica</i> L.	-	+	-	-	-	-	-	-	+
375..	<i>Solanum melongena</i> L.	-	-	-	-	-	+	-	-	-
376.	<i>Solanum nigrum</i> L.	+	+	-	-	-	+	-	-	-
377.	<i>Solanum tuberosum</i> L.	+	-	-	-	-	+	-	-	-
70. Family Tamaricaceae										
378.	<i>Myricaria elegans</i> Royle.	+	-	-	+	-	-	-	-	-
379.	<i>Tamarix dioica</i> Rox.ex Roth.	+	+	-	+	-	-	-	+	-
71. Family Thymeliaceae										
380.	<i>Daphne oleoides</i> Schrend.	+	-	-	-	-	-	-	-	-
381.	<i>Thymelaea passerina</i> (L.) Cosson & Germain.	+	-	-	-	-	-	-	-	-
72. Family Utricaceae										
382.	<i>Pilea umbrosa</i> Wedd.	+	-	-	-	-	-	-	-	-
73. Family Violaceae										
383.	<i>Viola serpens</i> Wall ex Roxb.	-	+	-	-	-	-	-	-	-
74. Family Vitaceae										
384.	<i>Vitis vinifera</i> L.	+	+	-	+	+	-	-	-	-
75. Family Zygophyllaceae										
385.	<i>Peganum harmala</i> L.	+	+	-	-	-	-	-	-	-
386.	<i>Tribulus terrestris</i> L.	+	+	-	-	-	-	-	-	-
Total species		366	88	26	58	15	25	17	13	5
% age		94.82	22.80	6.73	15.02	3.88	6.48	4.40	3.37	1.29

Key: 1. Fodder 2. Medicinal 3. Timber wood 4. Fuel wood 5. Fruit 6. Vegetable
7. Condiment 8. Thatching 9. Snuff.

Table 7. Traditional medicinal uses of some plants of Mastuj Valley, District Chitral, Pakistan.

S.No	Plant species	Local Names	Collector	Parts Used	Disease / health problem	Preparation
A. Pteridophyta						
1. Family Pteridaceae						
1.	<i>Adiantum venustum</i> D. Don.	Sumbul	Men	Leaves	Cardiac problems	2 gram dried powdered leaves are taken with a glass of water once before breakfast.
B. Gymnosperms						
2. Family Cupressaceae						
2.	<i>Juniperus excelsa</i> M.B.	Sawroz	Men	Shoots	Anthelmintic and abdominal pain	2-3 gram dried shoots and fruits are soaked in water for an hour. Extract from shoots is anthelmintic. While fruit extract is drunk in case of abdominal pain.
3. Family Ephedraceae						
3.	<i>Ephedra gerardiana</i> L.	Somany	Men	Shoots	Skin protection and diseases, Pneumonia and gastric problems.	Extract from boiled shoots is applied on face as sun screen. It is drunk in one spoon in case of pneumonia and gastric problems.
C. Angiosperms						
1. Monocotyledons						
4. Family Alliaceae						
4.	<i>Allium carolinianum</i> DC.	Latruk	Women	Shoots	Lumbago	Shoots are cooked as vegetable and eaten to treat lumbago.
5.	<i>Allium cepa</i> L.	Threshito	Women	Whole plant	Skin diseases	Oil obtained from warmed bulbs is applied on skin to treat skin diseases. The plant is used as condiment and as salad.
6.	<i>Allium sativa</i> L.	Wrezhnu	Women	Whole plant	Skin diseases and blood pressure	Gently warmed bulbs are used as poultice on boils to discharge puss. The fresh leaves are eaten to reduce high blood pressure.

5. Family Iridaceae

7.	<i>Iris germanica</i> L.	Sosun	Women	Roots	Rheumatism and fever.	The poultice from dried roots is placed over inflamed parts of the body as spasmodic. Root are boiled in water one glass extract is drunk as antipyretic to reduce temperature and fever.
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6. Family Poaceae

8.	<i>Zea mays</i> L.	Jawari	Women	Carpels	Kidney problems	5 grams carpels are boiled, filtered and one spoon is drunk twice a day to relieve kidney problems and promote urination.
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2. Dicotyledons

7. Family Anacardiaceae

9.	<i>Pistacia khinjuk</i> Stock.	Binju	Men	Shoots	Evil eye site	The wood is kept in houses to repel bad eye site.
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8. Family Apiaceae

10.	<i>Carum capticum</i> L.	Shounj mukh	Women	Fruits	Fever	Herbal tea made from fruits is drunk thrice a day to treat fever.
11.	<i>Carum carvi</i> L.	Hojoj	Women	Fruits	Throat infection	A glass of herbal tea made from fruits is drunk to cure throat infection.
12.	<i>Coriandrum sativum</i> L.	Danu	Women	Shoots	Appetizer, carminative and diuretic	Shoots are mixed with food, cooked and eaten as appetizer, carminative and diuretic agent.
13.	<i>Daucus carota</i> L.	Khashgum	Women	Seeds and roots	Abdominal pain and opthalmintic	A glass of herbal tea from seeds is drunk twice a day to cure abdominal pain. Roots are eaten to enhance eye sight.
14.	<i>Ferula jaeschkeana</i> Vatke.	Rav	Men	Latex	Toothache	Green herbaceous parts are incised and oozing latex is collected on flat stones. The color of the latex changes to brown which is called heeing. It is

						placed on infected teeth to relive toothache.
15.	<i>Foeniculum vulgare</i> Miller.	Bodyoung	Women	Fruits, leaves and flowers.	Toothache, cough, abdominal pain and lumbago	Leaves and fruits are chewed to relive toothache and cough. 5-10 grams flowers and fruits are mixed with wheat flour, cooked and eaten once a day to treat lumbago.
16.	<i>Prangos pabularia</i> (Lind.) Hiroe.	Shorum	Women	Shoots	Stomachic	10 grams fresh and dried shoots are mixed with wheat flour cooked and eaten twice a day as stomachic.
17.	<i>Trachydium roylei</i> Lindl.	Mushin	Men	Leaves	Antidote	Fresh leaves are crushed and applied on scorpion sting after every 30 minutes.
9. Family Apocynaceae						
18.	<i>Trachomitum venetum</i> (L.) Woodson.	Bakat	Women	Stems	Rheumatism	The dried stems are peeled off and placed over infected parts and burnt to cure rheumatic pain.
10. Family Asteraceae						
19.	<i>Artemisia parviflora</i> Roxb.	Kharkalich	Women	Seeds	Antidiabetic and wormicide	A glass of 2 grams seed extract is drunk once a day to cure diabetes and as wormicide.
20.	<i>Calendula officinalis</i> L.	Bodaki	Women	Flowers	Antispasmodic	Crushed flowers are mixed with vegetable oil and the paste is applied on affected joints.
21.	<i>Cichorium intybus</i> L.	Khasti	Men	Roots	Febrifuge	Root are boiled and the extract is drunk to treat intermittent fever.
22.	<i>Matricaria chamomilla</i> L.	Shrisht	Women	Flowers	Abdominal pain	Herbal tea made from the dried flowers is taken twice a day to cure abdominal pain.
11. Family Brassicaceae						
23.	<i>Lepidium sativum</i> L.	Troak khardachi	Women	Shoots	Stomachic	Fresh shoots are eaten as stomachic.
24.	<i>Nasturtium officinale</i> R.Br.	Shiakoshak	Men	Shoots	Stomachic	Fresh shoots are

32.	<i>Cucurbita maxima</i> Duch ex Lam.	Alok	Women	Seeds	Cough	Herbal tea made from seeds is drunk to cure cough.
18. Family Elaeagnaceae						
3.	<i>Elaeagnus angustifolia</i> L.	Shounjur	Men	Bark and Fruits	Dyspepsia and throat problems	Herbal tea made from fresh bark is drunk to improve digestion. The fruits are warmed and eaten to treat throat problems.
34.	<i>Hippophae rhamnoides</i> L.	Mirghenz	Men	Fruits	Skin diseases	The fruit juice is applied on face as sun screen.
19. Family Fumariaceae						
35.	<i>Fumaria indica</i> (Hausskn.) L.	Shatara	Men	Shoots	Abdominal pain	Shoots are shade dried, crushed and herbal tea is made, which is drunk to relieve abdominal pain.
20. Family Juglandaceae						
36.	<i>Juglans regia</i> L.	Birmough	Men	Leaves and bark	Insecticide	Leaves and root bark are used for cleaning teeth and as antimicrobial agent. These are locally called dandasa.
21. Family Lamiaceae						
37.	<i>Mentha longifolia</i> (L.) Huds.	Ben	Women	Whole plant	Febrifuge and stomachic	Green herbal tea from fresh roots is drunk to treat fever. Raw fresh leaves are eaten to improve digestion.
38.	<i>Nepeta cataria</i> L.	Sosambar	Women	Leaves	Toothache	Fresh leaves are chopped and applied on affected teeth to relieve toothache.
39.	<i>Ocimum basilicum</i> L.		Women	Shoots	Stomachic	Shoots are cooked as vegetable and eaten as stomachic.
40.	<i>Ocimum sanctum</i> L.	Suspru	Women	Leaves	Antipyretic and febrifuge	Green herbal tea made from fresh leaves is used to reduce fever. 5 to 10 grams leaves are meshed with wheat flour are cooked and eaten as febrifuge.
41.	<i>Salvia rhytidea</i> Benth.	Korach	Women	Shoots	Stomachic and abdominal pain	Shoots are cooked as vegetable and eaten as stomachic and to

32. Family Portulacaceae						
61.	<i>Portulaca oleracea</i> L.	Pecheli	Women	Shoots	Stomachic	The plant is cooked as vegetable and eaten as stomachic and to improve digestion.
33. Family Punicaceae						
62.	<i>Punica granatum</i> L.	Dalum	Men	Fruit rind	Vulnerary	Paste of dried rind is applied over affected parts of the body as vulnerary.
34. Family Rosaceae						
63.	<i>Cotoneaster nummularia</i> Fisch. & Mey.	Mekin	Men	Fruits	Anemia	The fruits are eaten to combat anemia.
64.	<i>Cotoneaster affinis</i> var. <i>bacillaris</i> (Lindl.) Schneider.	Badur	Men	Fruits	Indigestion and abdominal pain	Fresh fruits are crushed to get extract which is sweetened and is drunk to improve digestion and to cure abdominal pain.
65.	<i>Crataegus songarica</i> C. Koch.	Ghoni	Women	Bark	Labour pain	5 grams bark is soaked in a jug of water for an hour and a spoonful of this extract is given to pregnant women twice a day to reduce labour pain.
66.	<i>Prunus amygdalus</i> L.	Badam	Men	Seeds	Brain tonic	Seed are mixed with milk and eaten as brain tonic.
67.	<i>Prunus armeniaca</i> L.	Zuli	Women	Fruits and gum	Weakness and lumbago	The dried fruits are soaked in water and eaten as tonic. The gum is eaten to cure lumbago.
68.	<i>Prunus persica</i> (L.) Batsch.	Gerwalough.	Women	Fruits and Seeds	kidney problems and wound healing	The dried fruits are eaten to treat kidney problems. Powered seeds are mixed with water and usually applied on hands as vulnerary during winter.
69.	<i>Pyrus malus</i> L.	Palough	Men	Seeds and Fruits	Loss of Appetite	Seeds are eaten as appetizer. Fruits are nutritious and tonic.
70.	<i>Rosa webbiana</i> Wall ex Royle.	Throny	Men	Petals	Stomachic	Dried powdered petals are used as herbal tea, which is considered as stomachic. Rose tea

79.	<i>Viola serpens</i> Wall ex Roxb.	Milkhon	Women	Flowers	Cough	5 grams dried flowers are soaked in water and a glass is drunk twice a day to relieve cough.
41. Family Vitaceae						
80.	<i>Vitis vinifera</i> L.	Droach	Men	Fruits	Typhoid and dyspepsia	The juice extracted from fresh fruits is drunk to cure typhoid fever and to heal dyspepsia.
42. Family Zygophyllaceae						
81.	<i>Peganum harmala</i> L.	Ispandur	Men	Seeds	Evil eye repellent	Dried seeds are burnt to smoke to repel evil eyes.
82.	<i>Tribulus terrestris</i> L.	Koluzoakh	Men	Fruits	Spermatosis	Fruit extract is drunk to cure spermatosis.

Vegetation structure / Phytosociology

A. Aquatic vegetation

There were following 5 communities in various aquatic habitats of the area (Appendices 1-5).

1. *Mentha-Hippophae-Trifolium* community

This community with 41 species occurred between altitude of 2250m-2350m (Table 8; Appendix 1). The dominant plant species included *Mentha longifolia* (IV. 24.19), *Hippophae rhamnoides* (IV. 21.08) and *Trifolium repens* (IV. 17.69). *Plantago major*, *Cnicus benedictus*, *Salvia nubicola* and *Taraxacum officinale* were co-dominants. The water depth was 2 cm with amphibias habitat. The soil was sandy loam with 2.07 % organic matter, 15.25 % calcium carbonate, 0.103 ppm nitrogen, 15.73 ppm phosphorus, 114 ppm potassium, 8.1 pH, 0.40 % electrical conductivity, 0.128 % total soluble salts, 2.4 % clay, 38.0 % silt and 59.6 % sand (Table 11).

2. *Mentha-Epilobium-Trifolium* community

This community consisted of 43 species between 2300m-2400m altitude (Table 8; Appendix 2). The dominants includes *Mentha longifolia* (IV. 33.73), *Epilobium hirsutum* (IV. 20.9) and *Trifolium repens* (IV. 18.34). *Primula denticulata*, *Cnicus* sp. *Equisetum ramossimum*, *Triglochin palustris*, *Salix coerriola* and *Taraxacum officinale* were co-dominants. Water depth was 2 cm representing amphibias situation. Soil contained 2.31 % organic matter, 13.25 % calcium carbonate, 0.115 ppm nitrogen, 5.72 ppm phosphorus, 95 ppm potassium, 8.1 pH, 0.20 % electrical conductivity, 0.064 % total soluble salts. The soil was composed of 4.4 % clay, 52.0 % silt and 43.6 % sand with silty loam texture (Table 11).

3. *Mentha-Salix-Plantago* community

There were 40 species situated between 2410m-2510m altitude (Table 8; Appendix 3). The dominants were *Mentha longifolia* (IV. 31.21), *Salix acmophylla* (IV. 25.01) and *Plantago major* (IV. 21.57). The co-dominants were *Hippophae rhamnoides*, *Trifolium repens* and *Primula denticulata*. The water depth was 4 cm. There were 2.27 % organic matter, 16.25 % calcium carbonate, 0.113 ppm nitrogen, 6.57 ppm phosphorus, 95 ppm potassium, 7.8 pH, 0.09 % electrical conductivity, 0.029 % total soluble salts. The sandy loam soil had 4.4 % clay, 32.0 % silt and 63.6 % sand (Table 11).

Table 8. IV values of plant species of Aquatic habitats in Mastuj Valley, District Chitral.

S.No.	Plant species	MHT	MET	MSP	JPN	EJP
1.	<i>Alcea rosea</i> (L.) Cav.	-	-	2.46	-	-
2.	<i>Amaranthus retiflexus</i> L.	-	2.56	-	-	-
3.	<i>Arnebia hispidissima</i> (Lehm.) DC.	2.45	-	-	-	-
4.	<i>Artemisia parviflora</i> Roxb.	-	-	4.92	-	-
5.	<i>Berberis lycium</i> Royle.	-	-	4.92	-	-
6.	<i>Bromus gracillimus</i> Bunge.	-	-	2.46	2.62	-
7.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	7.36	5.13	7.39	-	-
8.	<i>Capparis spinosa</i> L.	2.45	-	-	-	-
9.	<i>Carex diluta</i> M.Bieb.	-	-	-	-	9.58
10.	<i>Centaurium meyeri</i> (Bunge.) Druce.	5.6	2.56	-	2.62	2.61
11.	<i>Cepella bursa-pastoris</i> (L.) Medic.	-	2.56	-	-	-
12.	<i>Chara</i> Sp.	-	5.48	-	10.67	21.92
13.	<i>Chenopodium album</i> L.	-	2.56	2.46	-	-
14.	<i>Chenopodium botrys</i> L.	-	2.56	2.46	-	-
15.	<i>Cichorium intybus</i> L.	-	-	8.57	-	2.61
16.	<i>Cirsium</i> sp.	-	-	14.8	-	-
17.	<i>Clematis orientalis</i> L.	2.45	-	-	-	-
18.	<i>Cnicus benedictus</i> L.	12.76	4.05	2.46	-	6.84
19.	<i>Cnicus</i> Sp.	-	13.48	-	-	-
20.	<i>Conyza bonariensis</i> (L.) Conquist.	-	2.56	-	-	-
21.	<i>Conyza canadensis</i> (L.) Conquist.	-	-	2.46	-	-
22.	<i>Cotoneaster affinis</i> var. <i>bacillaris</i> (Lindl.) Schneider.	-	-	2.46	-	-
23.	<i>Crotalaria prostrata</i> Roxb ex D. Don.	2.45	-	-	-	-
24.	<i>Cuscuta reflexa</i> Roxb.	2.45	-	2.46	-	-
25.	<i>Cynodon dactylon</i> (L.) Pers.	6.94	5.48	-	5.41	-
26.	<i>Cynoglossum lanceolatum</i> Forssk.	2.45	5.13	-	2.62	-
27.	<i>Cyperus</i> Sp.	-	-	-	6.64	7.85
28.	<i>Daucus carota</i> L.	-	-	2.46	-	-
29.	<i>Dicanthium annulatum</i> Forssk. Stapf.	-	2.56	5.14	-	-
30.	<i>Elaeagnus angustifolia</i> L.	4.26	-	-	-	-
31.	<i>Epilobium angustifolium</i> L.	-	-	-	5.24	2.61
32.	<i>Epilobium hirsutum</i> L.	5.8	20.9	4.92	13.14	17.45
33.	<i>Equisetum ramosissimum</i> Desf.	14.3	13.19	-	14.23	29.54
34.	<i>Eragrostis minor</i> Host.	-	2.56	-	-	2.61
35.	<i>Eragrostis poaeoides</i> P. Beauv.	-	-	-	10.51	-
36.	<i>Ferula</i> sp.	-	-	6.32	-	-
37.	<i>Geranium wallichinum</i> D.Don ex Sweet.	-	5.48	-	-	-
38.	<i>Hippophae rhamnoides</i> L.	21.08	5.13	20.92	-	-
39.	<i>Hippuris vulgaris</i> L.	-	-	-	6.51	-

40.	<i>Inula obtusifolia</i> Kerner.	7.36	-	-	10.51	7.85
41.	<i>Iris ensata</i> Thunb.	-	-	7.39	-	-
42.	<i>Juncus articulata</i> L.	7.14	7.7	5.14	32.05	29.54
43.	<i>Juncus himalensis</i> K.L & Gracke.	-	2.56	-	7.88	-
44.	<i>Lactuca serriola</i> L.	-	-	2.46	-	5.23
45.	<i>Lactuca tatarica</i> (L.) C.A. Mey.	-	-	-	2.62	-
46.	<i>Lotus corniculatus</i> L.	2.45	7.7	8.89	-	2.61
47.	<i>Matricaria chamomila</i> L.	-	2.56	2.46	-	2.61
48.	<i>Medicago sativa</i> L.	-	-	7.6	-	-
49.	<i>Melilotus indica</i> (L.) All.	-	-	-	3.88	-
50.	<i>Melilotus officinale</i> (L.) Desr.	2.45	-	4.92	-	-
51.	<i>Mentha longifolia</i> (L.) Huds.	24.19	33.73	31.21	13.04	22.57
52.	<i>Myricaria elegans</i> Royle.	13.44	6.56	6.1	-	-
53.	<i>Nasturtium officinale</i> R. Br.	2.45	8.05	-	18.79	12.09
54.	<i>Nepeta cataria</i> L.	5.6	-	2.46	-	-
55.	<i>Parnassia nubicola</i> Planch ex Clarke.	-	7.7	-	5.24	-
56.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	8.95	2.56	-	28.2	26.44
57.	<i>Plantago lanceolata</i> L.	11.2	6.98	2.46	2.62	5.23
58.	<i>Plantago major</i> Aitch.	13.66	2.56	21.57	6.51	11.84
59.	<i>Polygonum persicaria</i> L.	-	5.13	-	9.8	-
60.	<i>Potamogeton</i> Sp.	6.94	-	-	2.62	8.34
61.	<i>Primula denticulata</i> Sm.	2.45	17.61	15.45	5.41	-
62.	<i>Pteris</i> sp.	-	-	2.46	-	-
63.	<i>Ranunculus lobatus</i> Jacq ex Cam.	2.45	2.56	-	5.24	6.97
64.	<i>Rosa webbiana</i> Wall ex Royle	7.61	5.13	9.97	-	-
65.	<i>Salix acmophylla</i> Boiss.	6.5	-	25.01	-	-
66.	<i>Salix coerriola</i> (Sm.) Rich.	5.6	10.56	-	-	-
67.	<i>Salix wilhelmsiana</i> M.B.	-	6.85	-	-	-
68.	<i>Salvia nubicola</i> Wall ex Sweet.	12.54	6.56	-	-	-
69.	<i>Schoenoplectus litoralis</i> (Schard.) Palla.	-	-	-	6.51	-
70.	<i>Scirpus planifolius</i> Grimm.	-	2.56	5.14	-	-
71.	<i>Setaria glauca</i> (Retz.) Trin ex Steud	2.45	5.48	-	2.62	-
72.	<i>Sonchus asper</i> (L.) Hill.	3.35	2.56	2.46	2.62	-
73.	<i>Swertia speciosa</i> D.Don.	-	-	-	-	5.23
74.	<i>Tamarix dioica</i> Roxb ex Roth.	11.2	-	-	-	-
75.	<i>Taraxacum officinale</i> Weber.	12.53	10.27	9.85	-	7.85
76.	<i>Torilis arvensis</i> (Huds.) Link.	-	-	2.46	-	2.61
77.	<i>Trifolium repens</i> L.	17.69	18.34	17.69	-	13.82
78.	<i>Trifolium</i> Sp.	-	-	-	-	2.61
79.	<i>Triglochin palustris</i> L.	-	10.69	-	12.35	10.47
80.	<i>Tussilago farfara</i> L.	-	-	6.32	9.3	5.47
81.	<i>Typha angustata</i> Borry & Chaub.	-	-	-	9.47	-
82.	<i>Utricularia australis</i> R.Br	-	-	-	9.47	3.98
83.	<i>Verbascum thapsus</i> L.	5.8	-	-	-	-

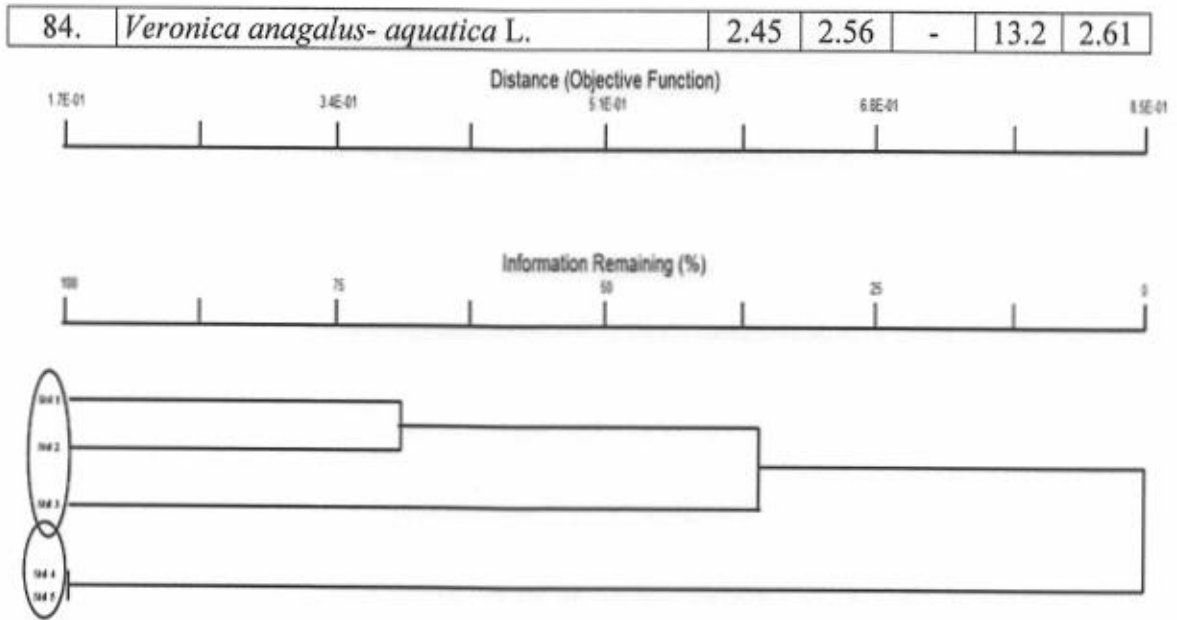


Fig. 2. Cluster Dendrogram Analysis showing two 2 association of 5 aquatic communities based on IV (Importance values) in Mastuj Valley, District Chitral.

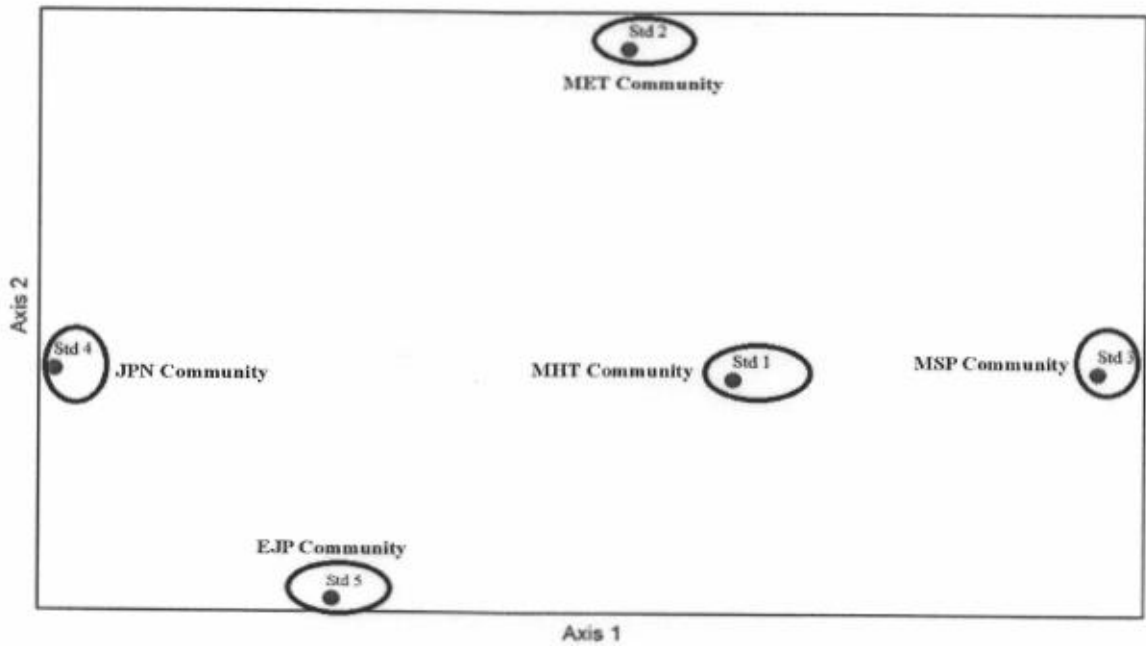


Fig. 3. Detrended Correspondence Analysis of 5 aquatic communities in Mastuj Valley, District Chitral.

4. *Juncus-Phragmites-Nasturtium* community

Along 2250m-2350m altitude this community had 34 species (Table 8; Appendix 4). *Juncus articulatus* (IV. 32.05), *Phragmites karka* (IV. 28.2) and *Nasturtium officinale* (IV. 18.79) dominated. *Equisetum ramossimum*, *Epilobium hirsutum*, *Veronica anagalis-aquatica*, *Mentha longifolia* and *Triglochin palustris* were co-dominants. The water depth measured was 10 cm. Table 11 shows that the muddy soil was sandy loam with 2.4 % clay, 40.0 % silt and 57.6 % sand. It also had 1.79 % organic matter, 7.00 % calcium carbonate, 0.089 ppm nitrogen, 10.58 ppm phosphorus, 133 ppm potassium, 8.0 pH, 0.08 % electrical conductivity and 0.026 % total soluble salts.

5. *Equisetum-Juncus-Phragmites* community

Of the 31 species at 2220m-2360m altitude, *Equisetum ramossimum* (IV. 29.54), *Juncus articulatus* (IV.29.54) and *Phragmites karka* (IV. 26.44) dominated the habitat (Table 8; Appendix 5). *Mentha longifolia*, *Chara* sp. *Epilobium hirsutum*, *Trifolium repens*, *Nasturtium officinale* and *Plantago major* were co-dominants. The water depth remained 5 cm. There were 2.38 % organic matter, 10.50 % calcium carbonate, 0.119 ppm nitrogen, 13.15 ppm phosphorus, 190 ppm potassium, 8.1 pH, 0.27 % electrical conductivity and 0.086 % total soluble salts. The loamy soil had 20.4 % clay, 40.0 % silt and 39.6 % sand (Table 11).

Ordination

When the data was subjected to cluster analysis (Fig. 2) and DCA (Fig. 3), it was seen that all the communities separated from each other as they were placed far away from each other. They neither clustered nor grouped in any way. This might be due to small sample size within this habitat. In Mastuj Valley the water bodies are few and rare.

B. Vegetation of foothills

The vegetational components of the plains and foothills is tabulated in Table 9 Appendices 6-10). There are following 5 communities in the foothills.

1. *Rheum-Artemisia-Ephedra* community

This community consisting of 35 species were present 2250m-2500m altitude (Table 9; Appendix 6). The dominants were *Rheum emodi* (IV. 27.2), *Artemisia maritima* (IV. 26.86) and *Ephedra gerardiana* (IV. 21.97). *Verbascum thapsus*, *Tamarix dioica*, *Artemisia brevifolia*, *Astragalus psilocentros* and *Rosa webbiana* were co-dominants. There were 2.13 % organic matter, 6.00 % calcium carbonate, 0.106 ppm nitrogen, 20.59 ppm phosphorus, 114 ppm potassium, 6.9 pH, 0.14 % electrical conductivity and 0.045 % total soluble salts. The sandy loam soil was composed of 5.6 % clay, 42.0 % silt and 52.4 % sand (Table 11).

2. *Sophora-Salvia-Hippophae* community

This community had 58 species occurred between altitude of 2290m-2410m (Table 9; Appendix 7). The dominants were *Sophora mollis* (IV. 25.93), *Salvia nubicola* (IV. 16.32) and *Hippophae rhamnoides* (IV. 13.42). *Artemisia scoparia*, *Kochia prostrata* and *Cnicus benedictus* were co-dominants. The soil texture was sandy loam with 3.6 % clay, 36.0 % silt and 60.4 % sand. It had 2.13 % organic matter, 5.50 % calcium carbonate, 0.106 ppm nitrogen, 52.05 ppm phosphorus, 171 ppm potassium, 7.9 pH, 0.20 % electrical conductivity and 0.064 % total soluble salts (Table 11).

3. *Sophora-Capparis-Saccharum* community

Along 2320m-2420m altitude this community had 43 species (Table 9; Appendix 8). *Sophora mollis* (IV. 36.23), *Capparis spinosa* (IV. 16.84) and *Saccharum spontaneum* (IV. 15.95) were dominant. The co-dominants included *Artemisia scoparia*, *Verbascum thapsus*, *Artemisia brevifolia* and *Haloxylon griffithii*. The soil sandy loamy had 3.6 % clay, 18.0 % silt and 78.4 % sand. It had 1.79 % organic matter, 6.50 % calcium carbonate, 0.089 ppm nitrogen, 55.77 ppm phosphorus, 237 ppm potassium, 6.5 pH, 0.20 % electrical conductivity and 0.064 % total soluble salts (Table 11).

4. *Hippophae-Cnicus-Myricaria* community

This community consisted of 49 species which occurred along 2200m-2400m (Table 9; Appendix 9). *Hippophae rhamnoides* (IV. 17.58), *Cnicus benedictus* (IV. 14.78) and *Myricaria elegans* (IV. 14.78) were dominants of this community. *Rosa webbiana*, *Chondrilla graminea*, *Equisetum ramossimum* and *Elaeagnus angustifolia* were co-dominants. The sandy loam soil consisted of 3.6 % clay, 42.0 % silt and 54.4 % sand. There were 2.27 % organic matter, 7.00 % calcium carbonate, 0.113 ppm nitrogen, 56.91 ppm phosphorus, 142 ppm potassium, 7.5 pH, 0.21 % electrical conductivity and 0.067 % total soluble salts (Table 11).

5. *Elaeagnus-Salix-Hippophae* community

This community consisting of 54 species which occurred along 2260m-2350m altitude (Table 9; Appendix 10). The dominant species were *Elaeagnus angustifolia* (IV. 18.33), *Salix acmophylla* (IV. 17.78) and *Hippophae rhamnoides* (IV. 17.21). *Myricaria elegans*, *Clematis orientalis*, *Plantago lanceolata* and *Calamogrostris pseudophragmites* were co-dominants. The soil had 1.65 % organic matter, 12.50 % calcium carbonate, 0.082 ppm nitrogen, 13.44 ppm phosphorus, 133 ppm potassium, 8.3 pH, 0.20 % electrical conductivity and 0.064 % total soluble salts. The soil texture consisted 11.6 % clay, 14.0 % silt and 74.4 % sand giving loamy sand texture (Table 11).

Ordination

The cluster and DCA analyses (Figs. 4 & 5) showed that all the five communities differed from each other without having any association. This might be due to variation of habitat in terms of edaphic and biotic factors.

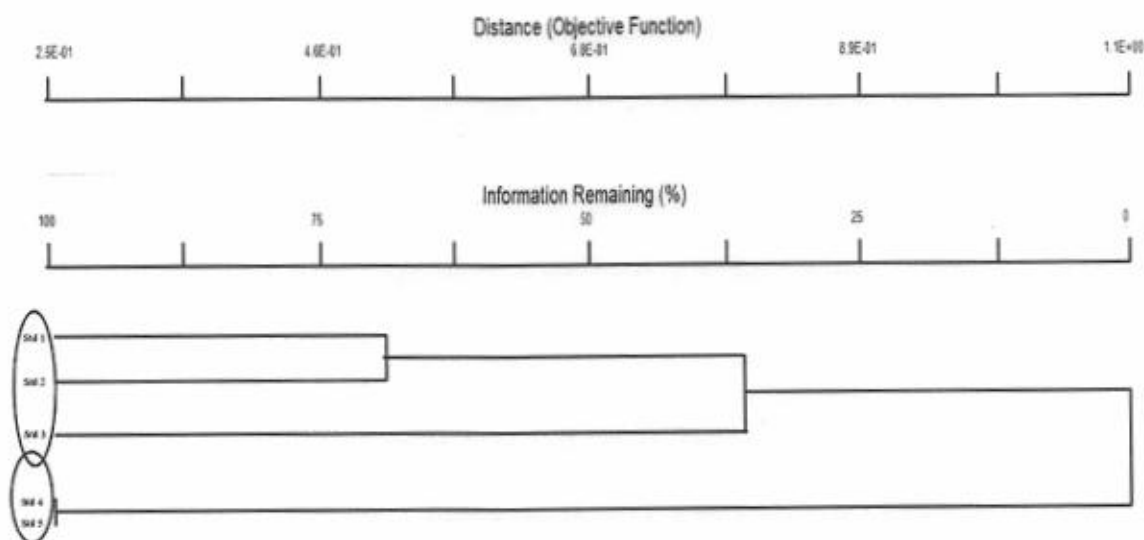


Fig. 4. Cluster Dendrogram Analysis of 5 communities of foothills based on IV (Importance values) in Mastuj Valley, District Chitral.

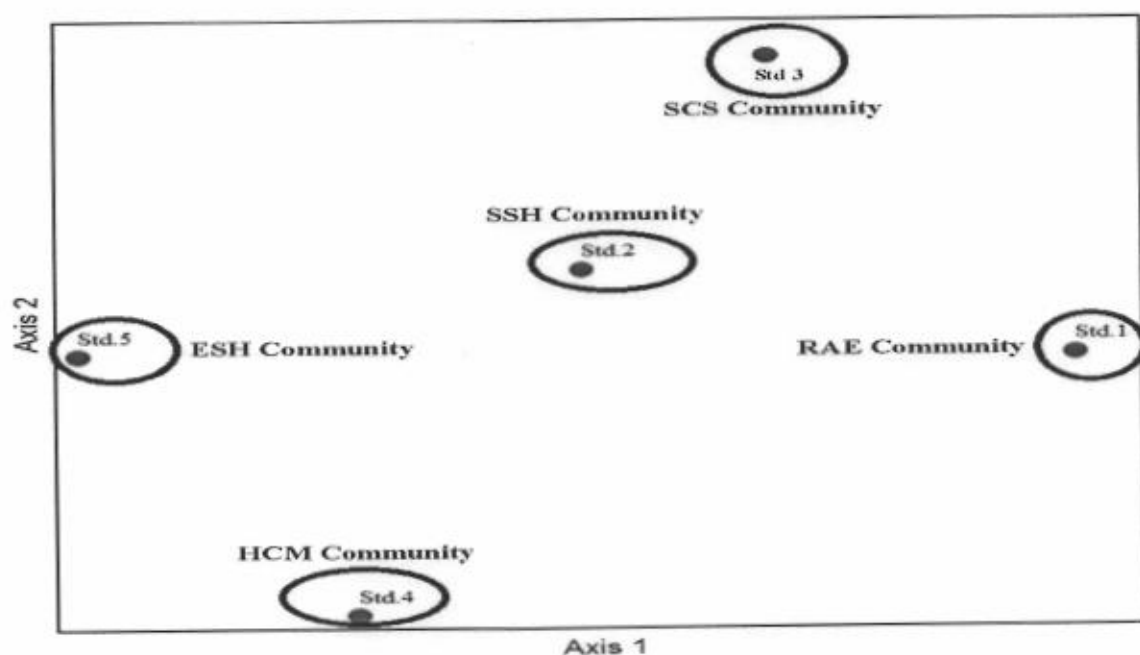


Fig. 5. Detrended Correspondence Analysis of 5 plant communities of foothills in Mastuj Valley, District Chitral.

Table 9. IV Values of plant species of Dry Plain and foothills in Mastuj Valley, District Chitral.

S.No.	Plant species	RAE	SSH	SCS	HCM	ESH
1.	<i>Abutilon bidentatum</i> Hochst ex A.Rich.	-	-	-	-	2.3
2.	<i>Acantholimon longiscapum</i> Bokhari.	-	-	2.86	-	-
3.	<i>Ailanthus altissima</i> (Mill.) Swingle.	-	-	2.86	-	-
4.	<i>Amaranthus retroflexus</i> L.	-	-	2.86	-	-
5.	<i>Anaphalia gracilis</i> Haud & Mazz.	-	-	8.6	2.98	-
6.	<i>Arisaema jacquemontii</i> Blume.	-	5.15	-	-	-
7.	<i>Arnebia hispidissima</i> (Lehm.) DC.	-	-	-	5.98	-
8.	<i>Artemisia brevifolia</i> Wall ex DC.	12.48	2.57	14.34	10.38	2.3
9.	<i>Artemisia maritima</i> L.	26.86	2.57	2.86	-	9.8
10.	<i>Artemisia parviflora</i> Roxb.	-	2.57	2.86	2.98	4.61
11.	<i>Artemisia scoparia</i> Waldst & Kit.	7.43	13.32	14.61	5.98	9.8
12.	<i>Artemisia</i> Sp.	3.15	-	-	-	4.89
13.	<i>Astragalus ambersianus</i> Royle ex Benth.	-	-	2.86	-	2.3
14.	<i>Astragalus psilocentrus</i> Fisch.	12.32	-	-	2.98	-
15.	<i>Atraphaxis spinosa</i> L.	-	-	2.86	-	-
16.	<i>Berberis lycium</i> Royle.	5.37	3.91	2.86	-	-
17.	<i>Bromus gracillimus</i> Bunge.	-	-	-	-	2.3
18.	<i>Calamagrostis pseudophragmites</i> Hall. F. Koeker.	-	-	-	-	9.22
19.	<i>Capparis spinosa</i> L.	5.37	3.91	16.84	2.98	5.73
20.	<i>Chenopodium album</i> L.	-	5.15	6	-	-
21.	<i>Chenopodium botrys</i> L.	9.32	6.49	8.87	-	4.61
22.	<i>Chesneya depressa</i> (Oliver.) Popov.	-	-	-	2.98	-
23.	<i>Chondrilla graminea</i> M.Bieb.	-	-	6	14.02	2.3
24.	<i>Cicer macranthum</i> M. Popov.	4.26	2.57	-	-	-
25.	<i>Cichorium intybus</i> L.	-	-	-	5.98	6.91
26.	<i>Cirsium acaule</i> (L.) Scop.	-	5.15	-	-	-
27.	<i>Clematis orientalis</i> L.	3.15	-	2.86	5.98	13.77
28.	<i>Cnicus benedictus</i> L.	3.15	12.51	-	14.78	4.61
29.	<i>Cnicus</i> Sp.	3.15	-	-	5.98	-
30.	<i>Colutea paulsenii</i> Feryh.	6.15	-	-	4.38	-
31.	<i>Compositae</i> Sp.	-	-	-	2.98	-
32.	<i>Conyza bonariensis</i> (L.) Conquist.	3.15	-	-	-	-
33.	<i>Conyza canadensis</i> (L.) Conquist.	-	-	2.86	-	-
34.	<i>Conyza</i> Sp.	-	-	9.14	-	-
35.	<i>Cotoneaster microphylla</i> Wall ex Lind.	-	2.57	5.54	-	-
36.	<i>Cousinia maffeldii</i> Bornm.	-	2.57	-	-	-
37.	<i>Crataegus songarica</i> C. Koch.	-	2.57	-	-	-
38.	<i>Crotolaria prostrata</i> Roxb ex D.Don.	-	2.57	-	2.98	2.3
39.	<i>Cuscuta reflexa</i> Roxb.	-	-	-	2.98	2.3
40.	<i>Cynanchum acutum</i> L.	9.49	-	2.86	2.98	2.3
41.	<i>Cynodon dactylon</i> (L) Pers.	-	10.31	-	2.98	-

42.	<i>Cynoglossum lanceolatum</i> Royle.	-	-	-	-	4.61
43.	<i>Datura stramonium</i> L.	-	-	-	-	2.3
44.	<i>Dichanthium annulatum</i> Forssk. Stapf.	4.26	5.15	2.86	2.98	-
45.	<i>Echinops echinatus</i> Roxb.	4.26	7.73	11.47	2.98	-
46.	<i>Elaeagnus angustifolia</i> L.	-	6.66	2.86	13.18	18.33
47.	<i>Ephedra gerardiana</i> L.	21.97	2.57	8.87	2.98	2.3
48.	<i>Epilobium hirsutum</i> L.	-	5.15	-	2.98	-
49.	<i>Equisetum ramossimum</i> Desf.	-	-	-	13.38	2.3
50.	<i>Eragrostis minor</i> Host.	-	-	-	-	6.08
51.	<i>Euphorbia peplus</i> L.	-	2.57	-	-	-
52.	<i>Ferula jaeschkeana</i> Vatke.	-	3.91	-	-	-
53.	<i>Geranium wallichianum</i> D.Don ex Sweet.	--	-	-	-	2.3
54.	<i>Glycyrrhiza glabra</i> L.	10.25	-	-	10.38	-
55.	<i>Gnaphalium luteo-album</i> L.	3.15	2.57	2.86	-	-
56.	Grass sp 1.	-	-	2.86	2.98	-
57.	Grass sp 2.	-	-	-	-	6.91
58.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	10.25	2.57	14.7	-	-
59.	<i>Hippophae rhamnoides</i> L.	-	13.42	-	17.58	17.21
60.	<i>Inula obtusifolia</i> Kerner.	-	-	-	5.98	-
61.	<i>Iris ensata</i> Thunb.	-	-	-	2.98	4.61
62.	<i>Juncus articulata</i> L.	-	-	-	2.98	-
63.	<i>Juniperus excelsa</i> M.Bieb.	9.65	2.57	5.14	-	-
64.	<i>Kochia prostrata</i> (L.) Schard.	3.15	13.32	-	-	-
65.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	10.43	2.57	2.86	-	-
66.	<i>Lactuca serriola</i> L.	3.15	2.57	8.6	-	-
67.	<i>Lactuca tatarica</i> (L.) C.A. Mey.	-	-	-	4.38	-
68.	<i>Lactuca viminea</i> (L.) Schmid.	-	2.57	6	-	-
69.	<i>Lotus corniculatus</i> L.	-	-	6	2.98	4.61
70.	<i>Malva neglecta</i> Wall.	-	2.57	-	-	-
71.	<i>Marrubium vulgare</i> L.	8.54	2.57	6	-	-
72.	<i>Matricaria disciformis</i> (Cam.) DC.	-	2.57	-	-	-
73.	<i>Matthiola flavida</i> Boiss.	4.26	2.57	-	-	2.3
74.	<i>Medicago sativa</i> L.	-	-	-	-	8.33
75.	<i>Melilotus officinale</i> (L.) Desr	-	-	-	-	3.42
76.	<i>Mentha longifolia</i> (L.) Huds.	-	9.07	2.86	8.98	2.3
77.	<i>Myricaria elegans</i> Royle.	-	5.15	-	14.78	15.76
78.	<i>Nepeta cataria</i> L.	-	-	2.86	-	2.3
79.	<i>Nepeta lavigata</i> (D.Don.) Hand. Mazz.	-	5.58	-	-	-
80.	<i>Nepeta pulsenii</i> Briq.	10.43	2.57	-	-	-
81.	<i>Nepeta raphanorhiza</i> Benth.	-	2.57	-	-	-
82.	<i>Nepeta</i> Sp.	-	2.57	-	-	-
83.	<i>Otostegia limbata</i> (Bth.) Boiss.	-	2.57	-	-	-
84.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	-	-	-	8.98	-
85.	<i>Pistacia integerrhima</i> (L.) Stewart ex Brand.	4.26	-	-	-	-
86.	<i>Plantago lanceolata</i> L.	-	-	-	10.38	11.27
87.	<i>Plantago major</i> Aitch.	-	6.25	-	2.98	4.61
88.	<i>Polygonum persicaria</i> L.	-	-	-	2.98	-
89.	<i>Populus alba</i> L.	-	-	-	9.43	-

90.	<i>Populus nigra</i> L.	-	-	-	-	2.3
91.	<i>Pteris</i> Sp.	-	-	-	-	2.3
92.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	3.15	2.57	-	-	2.3
93.	<i>Rheum emodi</i> Wall ex Meissn.	27.2	2.57	-	-	-
94.	<i>Rosa webbiana</i> Wall ex Royle.	11.54	6.49	-	14.58	5.73
95.	<i>Rubus fruticosus</i> L.	-	-	2.86	-	-
96.	<i>Saccharum spontaneum</i> L.	-	-	15.95	2.98	4.72
97.	<i>Salix acmophylla</i> Boiss.	-	2.57	-	-	17.78
98.	<i>Salix coerriola</i> (Sm.) Rech.	-	-	-	5.78	3.42
99.	<i>Salvia nubicola</i> Wall ex Sweet.	-	16.32	4.2	-	-
100.	<i>Scrophularia stewartii</i> Penn.	-	-	2.86	-	-
101.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	-	-	-	-	8.38
102.	<i>Solanum nigrum</i> L.	-	2.57	-	-	-
103.	<i>Sonchus asper</i> (L.) Hill.	-	-	-	2.98	6.91
104.	<i>Sophora mollis</i> (Royle.) Baker.	5.37	25.93	36.23	-	6.86
105.	<i>Tagetes erecta</i> L.	-	5.15	-	-	-
106.	<i>Tamarix dioica</i> Roxb ex Roth.	13.43	6.49	4.2	4.38	9.45
107.	<i>Taraxacum officinale</i> Weber.	-	5.15	-	5.98	2.3
108.	<i>Torilis arvensis</i> (Huds.) Link.	-	-	-	-	2.3
109.	<i>Trachomitum venetum</i> (L.) Woodson	-	-	-	5.98	-
110.	<i>Tribulus terrestris</i> L.	-	3.91	-	2.98	-
111.	<i>Trifolium repens</i> L.	-	2.57	-	-	3.77
112.	<i>Trifolium</i> Sp.	-	-	-	-	2.3
113.	<i>Triglochin palustris</i> L.	-	-	-	2.98	-
114.	<i>Tussilago farfara</i> L.	-	2.57	-	-	2.3
115.	<i>Verbascum thapsus</i> L.	15.98	5.58	14.61	-	-
116.	<i>Mentha</i> Sp.	-	-	-	-	2.3

C. Mountain and alpine communities

The vegetation of uphill mountains including alpine regions is characterized by data given in Table 10 (Appendices 11-43).

1. *Sophora-Rheum-Haloxylon* community

This community had 25 species which occurred at Mastuj along foothill between altitude of 2325m-2425m (Table 10; Appendix 11). The dominants were *Sophora mollis* (IV. 46.25), *Rheum emodi* (IV. 31.69) and *Haloxylon griffithii* (IV. 29.65). *Lactuca viminea*, *Chenopodium botrys*, *Polygonum plebjum* and *Artemisia brevifolia* were co-dominants. The soil had 0.69 % organic matter, 10.50 % calcium carbonate, 0.034 ppm nitrogen, 18.00 ppm phosphorus, 140 ppm potassium, 7.6 pH, 0.16 % electrical conductivity and 0.051 % total soluble salts. There were 6.8 % clay, 28.0 % silt and 71.2 % sand making loamy-sandy soil (Table 12).

2. *Artemisia-Sophora-Ephedra* community

This community had 15 species which occurred along mid hill at Mastuj between 2440m-2620m altitude (Table 10; Appendix 12). *Artemisia scoparia* (IV. 52.42), *Sophora mollis* (IV. 46.74) and *Ephedra gerardiana* (IV. 41.13) were dominants. *Haloxylon griffithii*, *Bromus gracillimus*, *Echinops echinatus* and *Rheum emodi* were co-dominants. The soil had 1.38 % organic matter, 10.75 % calcium carbonate, 0.069 ppm nitrogen, 15.00 ppm phosphorus, 100 ppm potassium, 6.8 pH, 0.07 % electrical conductivity and 0.022 % total soluble salts. The sandy loam soil had 8.8 % clay, 30.0 % silt and 61.2 % sand (Table 12).

3. *Artemisia-Matricaria-Juniperus* community

This community consisted of 32 species which occurred at Mastuj along top hill between altitude of 2725m-3000m (Table 10; Appendix 13). The community was dominated by *Artemisia maritima* (IV. 31.02), *Matricaria disciformis* (IV. 29.97) and *Juniperus excelsa* (IV. 25.96). *Rosa webbiana*, *Trachyspermum ammi*, *Cicer macranthum*, *Aristida cynantha* and *Nepeta paulsenii* were co-dominants. The soil

contained 1.00 % organic matter, 10.00 calcium Carbonate, 0.050 ppm nitrogen, 20.00 ppm phosphorus, 150 ppm potassium, 7.6 pH, 0.18 % electrical conductivity and 0.058 % total soluble salts. The texture composed of 2.8 % clay, 24.0 % silt and 73.2 % sand was loamy sand (Table 12). This community was under high biotic pressure due to fuel wood collection.

4. *Betula-Ribes-Rosa* community

This community had 22 species that occurred along timber line at Mastuj between altitude of 3010m-3300m (Table 10; Appendix 14). *Betula utilis* (IV. 52.1), *Ribes orientale* (IV. 33.77) and *Rosa webbiana* (IV. 23.56) were dominants. *Cicer macranthum*, *Rheum emodi*, *Aristida cynantha* and *Swertia speciosa* were co-dominants. The soil was sandy loam with 0.86 % organic matter, 10.25 % calcium carbonate, 0.043 ppm nitrogen, 21.00 ppm phosphorus, 160 ppm potassium, 7.5 pH, 0.22 % electrical conductivity, 0.070 % total soluble salts, 2.8 % clay, 46.0 % silt and 51.4 % sand (Table 12). This community faces overgrazing and severe fuel wood collection.

5. *Salvia-Berberis-Rosa* community

This community with 25 species was recognized at Miragram-1 between altitude of 2230m-2525m (Table 10; Appendix 15). *Salvia nubicola* (IV. 42.31), *Berberis lyceum* (IV. 40.14) and *Rosa webbiana* (IV. 30.49) were dominants; while *Echinops echinatus*, *Gnaphalium luteo-album* and *Calamogrostris pseudophragmites* were co-dominants. The soil had 0.69 % organic matter, 10.00 % calcium carbonate, 0.034 ppm nitrogen, 14.00 ppm phosphorus, 170 ppm potassium, 6.6 pH, 0.05 % electrical conductivity and 0.016 % total soluble salts. The soil had 2.8 % clay, 50.0 % silt and 47.2 % sand with sandy loam texture (Table 12).

6. *Sophora-Astragalus-Berberis* community

This community consisted of 14 species at Miragram-1 along mid hills between altitude of 2320m-2550m (Table 10; Appendix 16). The dominants were *Sophora mollis* (IV. 58.29), *Astragalus psilocentros* (IV. 43.39) and *Berberis lycium* (IV. 25.36). The co-dominants were *Echinops echinatus*, *Astragalus amberstianus*, *Marrubium vulgare* and

Rosa webbiana. There was 1.03 % organic matter, 6.25 % calcium carbonate, 0.051 ppm nitrogen, 15.00 ppm phosphorus, 120 ppm potassium, 6.5 pH, 0.06 % electrical conductivity and 0.019 % total soluble salts. The soil was loamy sand with 2.8 % clay, 20.0 % silt and 77.2 % sand (Table 12).

7. *Gnaphalum-Nepeta-Matricaria* community

At Miragram-1 along top hills between altitude of 2640m-2935m this community had 22 species (Table 10; Appendix 17). *Gnaphalum luteo-album* (IV. 48.04), *Nepeta paulsenii* (IV. 35.57) and *Matricaria disciformis* (IV. 32.63) were dominants. The co-dominants included *Primula* sp. *Juniperus excelsa*, *Rheum emodi* and *Ribes orirntale*. The soil features included 0.48 % organic matter, 9.25 % calcium carbonate, 0.024 ppm nitrogen, 20.00 ppm phosphorus, 110 ppm potassium, 6.5 pH, 0.09 % electrical conductivity and 0.029 % total soluble salts. The texture was sandy loam with 2.8 % clay, 40.0 % silt and 57.2 % sand (Table 12).

8. *Epilobium-Rheum-Matricaria* community

This community possessed 23 species at Miragram-1 near timber line between altitude of 2935m-3100m (Table 10; Appendix 18). The dominants were *Epilobium angustifolium* (IV. 61.71), *Rheum emodi* (IV. 39.32) and *Matricaria disciformis* (IV. 26.9). *Asteraceae* sp. *Aristida cynantha* and *Oxyria digyna* were co-dominants. There were 1.65 % organic matter, 10.75 % calcium carbonate, 0.082 ppm nitrogen, 25.00 ppm phosphorus, 210 ppm potassium, 6.3 pH, 0.09 % electrical conductivity and 0.029 % total soluble salts. The soil was silt-loam with 0.8 % clay, 54.0 % silt and 45.2 % sand (Table 12).

9. *Rosa-Artemisia-Berberis* community

This community had 14 species at Miragram-2 along foot hill between altitude of 2400m-2710m (Table 10; Appendix 19). The dominants were *Rosa webbiana* (IV. 46.81), *Artemisia brevifolia* (IV. 44.59) and *Berberis lyceum* (IV. 30.83). *Ephedra*

gerardiana, *Juniperus excelsa*, *Colutea paulsenii*, *Echinops echinatus* and *Gnaphalium luteo-album* were co-dominants. The soil had 0.82 % organic matter, 13.00 % calcium carbonate, 0.041 ppm nitrogen, 15.00 ppm phosphorus, 100 ppm potassium, 7.3 pH, 0.19 % electrical conductivity and 0.061 % total soluble salts. The soil was loamy-sand with 0.8 % clay, 20.0 % silt and 79.2 % sand (Table 12).

Table 10. IV values of plant species in different plant communities in mountain and alpine habitats in Mastuj Valley, District Chitral.

S. No.	Plant Species	SRH	ASE	AMJ	BRR	SBR	SAB	GNM	ERM	RAB	EMA	EJR	BSR	CHE	REA	PER	CAT	CAF	ACC	CAJ	BJA	ASH	AES	SCF	JSA	AER	ARS	AHA	ARB	AHE	JAC	EAJ	CBA	EJA	
1.	<i>Acantholimon longiscapum</i> Bokhari.	-	-	7.65	-	-	-	13.93	-	-	44.04	-	-	-	9.87	9.08	25.66	-	-	23.24	33S	-	3.54	-	-	49.53	-	-	-	-	3.75	16.23	-	-	
2.	<i>Acantholimon</i> Sp.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
3.	<i>Acantholimon</i> Sp.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
4.	<i>Adiantum venustum</i> D.Don.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.13	-	-	-	-	-	-	-	-	-	-	-	-	
5.	<i>Allium carolinianum</i> DC.	-	-	4.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
6.	<i>Arenaria serphyllifolia</i> L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18.63	-	-	-	-	-	-	-	-	
7.	<i>Argimonia</i> Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
8.	<i>Aristida cynantha</i> Nees & Steud.	-	-	14.35	18.84	3.38	-	-	-	-	7.86	13.01	14.69	3.47	2.79	12.95	42.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	<i>Arnebia hispidissima</i> (Lehm.) DC.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	<i>Artemisia brevifolia</i> Wall & DC.	15.17	-	-	-	-	-	-	-	44.59	27.53	-	-	12.2	24.1	10.36	-	22.55	15.51	41.48	26.11	43.17	22	15.78	40.03	26.04	38.35	59.39	49.11	55.92	37.74	35.22	39.87	36.2	
11.	<i>Artemisia maritima</i> L.	-	-	31.02	-	13.54	8.45	-	-	-	-	26.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12.	<i>Artemisia scoparia</i> Waldst & Kit.	2.95	52.42	-	-	-	-	-	-	9.9	-	-	-	12.2	-	-	-	-	-	-	-	12.58	38.25	6.1	8.64	-	11.5	4.32	-	-	-	3.5	-	4.51	
13.	<i>Artemisia</i> Sp.	2.95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
14.	<i>Asperula oppositifolia</i> Ehrend.	-	-	7.17	-	-	-	-	-	-	-	-	-	-	2.79	-	6.59	-	-	-	10.6	-	-	-	-	-	-	-	-	-	-	-	3.98	-	
15.	<i>Asperula</i> Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
16.	Asteraceae 1.	-	-	4.78	14.13	-	-	-	-	-	-	-	-	-	2.79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
17.	Asteraceae 2.	-	-	-	-	-	-	11.54	-	-	-	-	-	-	8.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
18.	<i>Astragalus amberstianus</i> Royle ex Benth.	8.88	4.46	11.95	4.71	3.38	21.13	-	-	-	-	-	-	-	5.59	-	6.35	-	-	-	-	-	-	-	-	9.3	3.82	-	-	-	-	7.03	-	-	

80.	<i>Juniperus excelsa</i> M.Bieb.	5.91	-	25.96	-	5.42	15.3	16.19	-	25.7	-	45.38	17.43	-	16.08	9.12	-	21.63	17.89	40.68	34.82	-	-	6.61	49.19	-	12.47	6.88	6.82	20.71	44.69	33.84	26.3	46.28
81.	<i>Kochia prostrata</i> (L.) Schard.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.99	-	-	-	-	-	-	-	-	3.82	-	-	-	-	-	-	
82.	<i>Kracheninnikovia</i> <i>ceratoides</i> (L.) Guelden.	-	-	-	-	-	-	-	14.85	-	13.01	-	-	6.87	-	-	-	5.99	3.87	8.29	-	-	3.54	-	-	-	7.65	30.35	14.17	24.86	15.96	3.5	11.95	-
83.	<i>Lactuca serriola</i> L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.13	7.76	-	-	-	-	-	-	-	-	-	-	
84.	<i>Lactuca</i> Sp.	-	-	-	-	-	-	-	-	-	-	-	4.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
85.	<i>Lactuca viminea</i> (L.) F.W. Schmid	22.62	17.93	-	-	3.38	-	-	-	-	-	-	10.46	2.79	5.17	-	-	-	-	-	-	15.9	10.66	6.61	3.92	-	3.82	8.66	4.35	14.91	7.53	3.5	-	-
86.	<i>Lamiaceae</i> l.	-	-	-	-	-	-	3.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
87.	<i>Lepidium</i> Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.13	-	-	-	-	-	-	-	-	-	-	-	
88.	<i>Marrubium</i> <i>vulgare</i> L.	2.95	-	-	-	3.38	21.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.13	7.1	6.1	-	-	-	-	-	-	-	-	-	
89.	<i>Matricaria</i> <i>disciformis</i> (C.A.M.) DC.	-	-	29.97	4.71	6.77	-	32.63	26.9	-	51.46	16.27	-	-	-	2.57	12.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
90.	<i>Matricaria</i> Sp.	-	-	4.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
91.	<i>Medicago</i> <i>lupulina</i> L.	-	-	-	-	-	-	4.46	-	-	-	-	-	2.79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
92.	<i>Mentha longifolia</i> (L.) Huds.	-	-	-	4.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
93.	<i>Myricaria</i> <i>elegans</i> Royle.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.51	-	-	-	-	-	-	-	-	-	-	-	-	
94.	<i>Nepeta lavigata</i> (D.Don) Hand.Mazz.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.99	-	-	-	-	-	9.17	-	-	-	8.66	-	-	-	-	-	-	
95.	<i>Nepeta paulsenii</i> Briq.	12.2	-	14.35	14.13	10.98	13.78	35.57	4.46	-	7.86	-	-	-	21.1	7.77	19.07	-	-	-	-	-	-	12.71	-	-	-	-	-	-	-	-	-	
96.	<i>Nepeta</i> <i>raphanorrhiza</i> Benth.	-	-	-	-	3.38	-	-	-	-	-	-	-	2.79	5.47	-	-	-	-	-	-	3.54	-	-	-	-	4.32	-	-	-	-	-	-	
97.	<i>Nepeta</i> Sp.	2.95	-	-	4.71	-	-	8.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
98.	<i>Orostegia limbata</i> (Bth.) Boiss.	5.91	-	-	-	-	-	-	-	-	-	-	-	4.07	5.47	6.35	-	-	-	-	-	-	-	-	-	3.82	-	-	-	-	3.5	-	-	
99.	<i>Oxyria digyna</i> (L.) Hill.	-	-	5.25	-	-	-	-	17.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
100.	<i>Papilionaceae</i> l.	-	-	-	-	-	-	-	-	-	-	-	-	14.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 11. Physico-chemical features of soils of aquatic and foothills plant communities found in Mastuj Valley, District Chitral, Pakistan.

Habitat	Plant communities	Textural class	CaCO ₃ (%)	Organic matter (%)	N %	P %	K %	pH	Ec $\times 10^3$	TSS %	Clay %	Silt %	Sand %
Water courses	MHT	Sandy loam	15.25	2.07	0.103	15.73	114	8.1	0.40	0.128	2.4	38.0	59.6
	MET	Silt loam	13.25	2.31	0.115	5.72	95	8.1	0.20	0.064	4.4	52.0	43.6
	MSP	Sandy loam	16.25	2.27	0.113	6.57	95	7.8	0.09	0.029	4.4	32.0	63.6
	JPN	Sandy loam	7.00	1.79	0.089	10.58	133	8.0	0.08	0.026	2.4	40.0	57.6
	EJP	Loam	10.50	2.38	0.119	13.15	190	8.1	0.27	0.086	20.4	40.0	39.6
Plains & foothills	RAE	Sandy loam	6.00	2.13	0.106	20.59	114	6.9	0.14	0.045	5.6	42.0	52.4
	SSH	Sandy loam	5.50	2.13	0.106	52.05	171	7.9	0.20	0.064	3.6	36.0	60.4
	SCS	Loamy sand	6.50	1.79	0.089	55.77	237	6.5	0.20	0.064	3.6	18.0	78.4
	HCM	Sandy loam	7.00	2.27	0.113	56.91	142	7.5	0.21	0.067	3.6	42.0	54.4
	ESH	Loamy sand	12.50	1.65	0.082	13.44	133	8.3	0.20	0.064	11.6	14.0	74.4

Table 12. Physico-chemical features of soils of mountain and alpine plant communities of Mastuj Valley, District Chitral, Pakistan.

S No	Plant communities	Textural class	CaCO ₃ (%)	Organic matter (%)	N %	P %	K %	pH	Ec _x 10 ³	TSS %	Clay %	Silt %	Sand %
1.	SRH	Loamy sand	10.50	0.69	0.034	18.00	140	7.6	0.16	0.051	6.8	28.0	71.2
2.	ASE	Sandy loam	10.75	1.38	0.069	15.00	100	6.8	0.07	0.022	8.8	30.0	61.2
3.	AMJ	Loamy sand	10.00	1.00	0.050	20.00	150	7.6	0.18	0.058	2.8	24.0	73.2
4.	BRR	Sandy loam	10.25	0.86	0.043	21.00	160	7.5	0.22	0.070	2.8	46.0	51.4
5.	SBR	Sandy loam	10.00	0.69	0.034	14.00	170	6.6	0.05	0.016	2.8	50.0	47.2
6.	SAB	Loamy sand	6.25	1.03	0.051	15.00	120	6.5	0.06	0.019	2.8	20.0	77.2
7.	GNM	Sandy loam	9.25	0.48	0.024	20.00	110	6.5	0.09	0.029	2.8	40.0	57.2
8.	ERM	Silt loam	10.75	1.65	0.082	25.00	210	6.3	0.09	0.029	0.8	54.0	45.2
9.	RAB	Loamy sand	13.00	0.82	0.041	15.00	100	7.3	0.19	0.061	0.8	20.0	79.2
10.	EMA	Sandy loam	11.25	1.03	0.051	21.00	150	7.1	0.06	0.019	2.8	50.0	47.2
11.	EJR	Sandy loam	10.50	0.55	0.027	16.00	180	7.4	0.10	0.032	2.8	34.0	63.2
12.	BSR	Sandy loam	10.75	1.17	0.058	18.00	200	7.0	0.12	0.038	2.8	38.0	59.2
13.	CHE	Sandy loam	14.00	1.03	0.051	16.00	150	7.1	0.28	0.090	6.8	44.0	49.2
14.	REA	Loamy sand	6.25	0.89	0.044	19.00	200	7.0	0.09	0.029	4.8	18.0	77.2
15.	PER	Sandy loam	10.00	1.50	0.075	22.00	180	7.1	0.11	0.035	10.8	34.0	55.2
16.	CAT	Sandy loam	11.00	0.72	0.036	20.00	160	6.6	0.06	0.019	0.8	32.0	67.2
17.	CAF	Loamy sand	6.54	1.70	0.090	54.80	130	7.4	0.12	0.049	6.8	29.0	71.4
18.	ACC	Sandy loam	10.70	1.33	0.085	52.00	120	7.4	0.12	0.044	8.9	30.0	61.6
19.	CAJ	Loamy sand	10.00	1.25	0.052	22.00	145	7.6	0.17	0.056	2.8	26.0	74.2
20.	BJA	Sandy loam	10.25	1.10	0.045	21.00	165	7.5	0.20	0.065	2.7	48.0	52.4
21.	ASH	Sandy loam	10.75	1.24	0.062	26.21	110	8.1	0.13	0.041	9.2	18.0	72.8
22.	AES	Sandy loam	10.00	1.31	0.065	64.38	130	8.1	0.10	0.032	9.2	28.0	62.8
23.	SCF	Loam	11.25	0.96	0.048	15.02	110	8.0	0.11	0.035	11.2	44.0	44.8
24.	JSA	Sandy loam	10.00	0.62	0.031	13.87	135	8.5	3.24	1.03	9.2	32.0	58.8
25.	AER	Sandy loam	5.00	1.44	0.072	24.00	100	6.6	0.16	0.051	9.2	24.0	66.8

26.	ARS	Sandy loam	9.00	0.75	0.037	16.51	160	8.3	0.09	0.029	11.2	32.0	56.8
27.	AHA	Sandy loam	12.50	0.62	0.031	21.67	140	8.9	3.57	1.14	9.2	36.0	54.8
28.	ARB	Sandy loam	7.50	0.41	0.020	25.29	115	8.6	0.13	0.041	9.2	38.0	52.8
29.	AHE	Loam	8.75	1.10	0.055	44.79	130	8.4	0.09	0.029	11.2	46.0	42.8
30.	JAC	Sandy loam	10.00	1.20	0.050	16.00	110	8.1	0.10	0.020	9.2	40.0	60.5
31.	EAJ	Sandy loam	11.20	1.40	0.040	25.30	140	7.1	0.09	0.040	9.5	44.0	62.5
32.	CBA	Sandy loam	14.25	1.30	0.020	30.00	160	7.6	0.10	0.035	10.5	40.0	65.5
33.	EJA	Sandy loam	10.00	1.10	0.035	20.00	130	7.1	0.15	0.060	9.5	45.0	58.5

10. *Ephedra-Matricaria-Acantholimon* community

This community also had 14 species at Miragram-2 along mid hills between altitude of 2720m-2860m (Table 10; Appendix 20). The dominants were *Ephedra gerardiana* (IV. 58.87), *Matricaria disciformis* (IV. 51.46) and *Acantholimon longiscapum* (IV. 44.04). *Artemisia brevifolia*, *Codonopsis clematidia*, *Astragalus psilocentros* and *Gnaphalum luteo-album* were co-dominants. The soil contained 1.03 % organic matter, 11.25 % calcium carbonate, 0.051 ppm nitrogen, 21.00 ppm phosphorus, 150 ppm potassium, 7.1 pH, 0.06 % electrical conductivity and 0.019 % total soluble salts. The soil textural was sandy-loam with 2.8 % clay, 50.0 % silt and 47.2 % sand (Table 12).

11. *Ephedra-Juniperus-Rosa* community

This community had 16 species at Miragram-2 along top hills between altitudes of 2870m-2950m (Table 10; Appendix 21). *Ephedra gerardiana* (IV. 45.46), *Juniperus excelsa* (IV. 45.38) and *Rosa webbiana* (IV. 33.34) were dominants; while *Artemisia maritima*, *Gnaphalum luteo-album*, *Codonopsis clematidia*, *Matricaria disciformis* and *Ribes orientale* were co-dominants. The soil possessed 0.55 % organic matter, 10.50 % calcium carbonate, 0.027 ppm nitrogen, 16.00 ppm phosphorus, 180 ppm potassium, 7.4 pH, 0.10 % electrical conductivity and 0.032 % total soluble salts. The soil with 2.8 % clay, 34.0 % silt and 63.2 % sand represented sandy loam texture (Table 12).

12. *Betula-Salix-Rosa* community

This community consisted of 15 species at Miragram-2 near timber line between altitudes of 298m-3100m (Table 10; Appendix 22). The dominants included *Betula utilis* (IV. 64.02), *Salix acmophylla* (IV. 44.93) and *Rosa webbiana* (IV. 40.03). *Rumex longifolius*, *Epilobium hirsutum*, *Polygonum* sp. and *Juniperus excelsa* were co-dominants. The soil had 1.17 % organic matter, 10.75 % calcium carbonate, 0.058 ppm nitrogen, 18.00 ppm phosphorus, 200 ppm potassium, 7.0 pH, 0.12 % electrical conductivity and 0.038 % total soluble salts. The soil was sandy-loam with 2.8 % clay, 38.0 % silt and 59.2 % sand (Table 12).

13. *Chenopodium-Haloxylon-Echinops* community

This community was composed of 29 species at Ghuru along foot hills between altitudes of 2200m-2300m (Table 10; Appendix 23). The dominants included *Chenopodium botrys* (IV. 47.2), *Haloxylon griffithii* (IV. 41.35) and *Echinops echinatus* (IV. 22.69). The co-dominants were *Capparis spinosa*, *Sophora mollis*, *Artemisia brevifolia* and *Artemisia scoparia*. The soil had 1.03 % organic matter, 14.00 % calcium carbonate, 0.051 ppm nitrogen, 16.00 ppm phosphorus, 150 ppm potassium, 7.1 pH, 0.28 % electrical conductivity and 0.090 % total soluble salts. The soil was sandy-loam with 6.8 % clay, 44.0 % silt and 49.2 % sand (Table 12).

14. *Rosa-Ephedra-Artemisia* community

This community with 41 species was present in mid hills at Ghuru between altitudes of 2480m-3000m (Table 10; Appendix 24). *Rosa webbiana* (IV. 32.67), *Ephedra gerardiana* (IV. 31.59) and *Artemisia brevifolia* (IV. 24.1) were dominants. *Nepeta paulsenii*, *Juniperus excelsa*, *Ferula jaeschkeana* and Papilionaceae sp. and were co-dominants. The soil consisted 0.89 % organic matter, 6.25 % calcium carbonate, 0.044 ppm nitrogen, 19.00 ppm phosphorus, 200 ppm potassium, 7.0 pH, 0.09 % electrical conductivity and 0.029 % total soluble salts. The soil was loamy sand with 4.8 % clay, 18.0 % silt and 77.2 % sand (Table 12).

15. *Polygonum-Ephedra-Rheum* community

This community consisted of 38 species along top hills at Ghuru between altitudes of 3010m-3500m (Table 10; Appendix 25). *Polygonum angustifolium* (IV. 30.41), *Ephedra gerardiana* (IV. 28.13) and *Rheum emodi* (IV. 20.35) were dominants. *Aristida cynantha*, *Ribes orientale*, *Artemisia brevifolia* and *Scrophularia stewartii* were co-dominants. There were 1.50 % organic matter, 10.00 % calcium carbonate, 0.075 ppm nitrogen, 22.00 ppm phosphorus, 180 ppm potassium, 7.1 pH, 0.11 % electrical conductivity and 0.035 % total soluble salts. The sandy loam texture consisted of 10.8 % clay, 34.0 % silt and 55.2 % sand (Table 12).

16. *Cicer-Aristida-Tricholepsis* community

At Ghuru near timber line between altitudes of 3520m-3900m this community had 21 species (Table 10; Appendix 26). The dominants included *Cicer macranthum* (IV. 45.7), *Aristida cynantha* (IV. 42.76) and *Tricholepsis tibetica* (IV. 32.74). *Acantholimon longiscapum*, *Trachyspermum ammi*, *Nepeta paulsenii* and *Acantholimon* sp. were co-dominants. The soil had 0.72 % organic matter, 11.00 % calcium carbonate, 0.036 ppm nitrogen, 20.00 ppm phosphorus, 160 ppm potassium, 6.6 pH, 0.06 % electrical conductivity and 0.019 % total soluble salts. The soil was sandy loam with 0.8 % clay, 32.0 % silt and 67.2 % sand (Table 12). This community was under heavy grazing pressure.

17. *Capparis-Atraphaxis-Fraxinus* community

This community consisted of 22 species at Chumarkhan Pass along foot hills between altitudes of 2380m-2480m (Table 10; Appendix 27). The dominants included *Capparis spinosa* (IV. 33.77), *Atraphaxis spinosa* (IV. 30) and *Fraxinus xanthoxyloides* (IV. 28.4). *Artemisia brevifolia*, *Juniperus excelsa*, *Chondrilla graminea* and *Astragalus psilocentros* were co-dominants. The soil had 1.70 % organic matter, 6.54 % calcium carbonate, 0.090 ppm nitrogen, 54.80 ppm phosphorus, 130 ppm potassium, 7.4 pH, 0.12 % electrical conductivity and 0.049 % total soluble salts. The soil with 6.8 % clay, 29.0 % silt and 71.4 % sand showed loamy-sand texture (Table 12).

18. *Atraphaxis-Cotoneaster-Capparis* community

Nineteen at Chumarkhan Pass between altitudes of 2540m-2660m (Table 10; Appendix 28) made this community. *Atraphaxis spinosa* (IV. 53.25), *Cotoneaster nummularia* (IV. 35.85) and *Capparis spinosa* (IV. 31.03) were dominants. The co-dominants included *Ephedra gerardiana*, *Haloxylon griffithii*, *Juniperus excelsa* and *Colutea paulsenii*. The soil had 1.33 % organic matter, 10.70 % calcium carbonate, 0.085 ppm nitrogen, 52.00 ppm phosphorus, 120 ppm potassium, 7.4 pH, 0.12 % electrical conductivity and 0.044 % total soluble salts. The soil was sandy loam with 8.9 % clay, 30.0 % silt and 61.6 % sand (Table 12).

19. *Cotoneaster-Artemisia-Juniperus* community

This community had 13 species along top hills at Chumarkhan Pass between altitudes of 2720m-3000m (Table 10; Appendix 29) was dominated by *Cotoneaster nummularia* (IV. 43.98), *Artemisia brevifolia* (IV. 41.48) and *Juniperus excelsa* (IV. 40.68). *Ephedra gerardiana*, *Ribes orientale*, *Rosa webbiana* and *Berberis lycium* were co-dominants. The soil had 1.25 % organic matter, 10.00 % calcium carbonate, 0.052 ppm nitrogen, 22.00 ppm phosphorus, 145 ppm potassium, 7.6 pH, 0.17 % electrical conductivity and 0.056 % total soluble salts. The soil was loamy sand with 2.8 % clay, 26.0 % silt and 74.2 % sand (Table 12). This community was under heavy biotic pressure due to fuel wood collection and overgrazing.

20. *Betula-Juniperus-Acantholimon* community

At Chumarkhan Pass near timber line between altitudes of 3100m-3500m this community was composed of 18 species (Table 10; Appendix 30). *Betula utilis* (IV. 40.74), *Juniperus excelsa* (IV. 34.82) and *Acantholimon longiscapum* (IV. 33) were dominants, while *Artemisia brevifolia*, *Rosa webbiana*, *Ribes orientale*, *Cotoneaster nummularia* and *Ephedra gerardiana* were co-dominants.. The soil was composed of 1.10 % organic matter, 10.25 % calcium carbonate, 0.045 ppm nitrogen, 21.00 ppm phosphorus, 165 ppm potassium, 7.5 pH, 0.20 % electrical conductivity and 0.065 % total soluble salts. The soil was sandy loam with 2.7 % clay, 48.0 % silt and 52.4 % sand (Table 12). This community was under heavy grazing pressure and extensive fuel wood collection.

21. *Artemisia-Sophora-Haloxylon* community

Some 27 species at Reshun along foot hills between altitudes of 1800m-1910m composed this community (Table 10; Appendix 31). The dominants included *Artemisia brevifolia* (IV. 43.17), *Sophora mollis* (IV. 40.02) and *Haloxylon griffithii* (IV. 38.77). The co-dominants were *Capparis spinosa*, *Saccharum spontaneum*, *Echinops echinatus* and *Lactuca viminea*. The soil consisted of 1.24 % organic matter, 10.75 % calcium carbonate, 0.062 ppm nitrogen, 26.21 ppm phosphorus, 110 ppm potassium, 8.1 pH, 0.13

% electrical conductivity and 0.041 % total soluble salts. The soil with 9.2 % clay, 18.0 % silt and 72.8 % sand was sandy-loam (Table 12).

22. *Artemisia-Echinops-Saccharum* community

This community was composed of 22 species along foot hills at Koragh between altitudes of 1880m-2100m (Table 10; Appendix 32). *Artemisia scoparia* (IV. 38.25), *Echinops echinatus* (IV. 36.23) and *Saccharum spontaneum* (IV. 32.45) were dominants. The co-dominants included *Sophora mollis*, *Verbascum thapsus*, *Cotoneaster nummularia* and *Haloxylon griffithii*. The soil possessed 1.31 % organic matter, 10.00 % calcium carbonate, 0.065 ppm nitrogen, 64.38 ppm phosphorus, 130 ppm potassium, 8.1 pH, 0.10 % electrical conductivity and 0.032 % total soluble salts. The soil was sandy loam with 9.2 % clay, 28.0 % silt and 62.8 % sand (Table 12).

23. *Sophora-Cotoneaster-Fraxinus* community

Along foot hills at Booni between altitudes of 2140m-2220m this community consisted of 25 species (Table 10; Appendix 33). The dominants included *Sophora mollis* (IV. 35.8), *Cotoneaster nummularia* (IV. 29.68) and *Fraxinus xanthoxyloides* (IV. 22.17). The co-dominants were *Hippophae rhamnoides*, *Artemisia brevifolia*, *Saccharum spontaneum*, *Atraphaxis pyrifolia*, *Nepeta paulsenii* and *Rosa webbiana*. The soil had 0.96 % organic matter, 11.25 % calcium carbonate, 0.048 ppm nitrogen, 15.02 ppm phosphorus, 110 ppm potassium, 8.0 pH, 0.11 % electrical conductivity and 0.035 % total soluble salts. The soil was loam with 11.2 % clay, 44.0 % silt and 44.8 % sand (Table 12).

24. *Juniperus-Sophora-Artemisia* community

This community had 18 species at Parwak along foothills between altitudes of 2240m-2335m (Table 10; Appendix 34). The dominant members were *Juniperus excelsa* (IV. 49.19), *Sophora mollis* (IV. 46.97) and *Artemisia brevifolia* (IV. 40.03). *Haloxylon griffithii*, *Echinops echinatus*, *Cotoneaster nummularia* and *Saccharum spontaneum* were co-dominants. The soil contained 0.62 % organic matter, 10.00 % calcium carbonate, 0.031 ppm nitrogen, 13.87 ppm phosphorus, 135 ppm potassium, 8.5 pH, 3.24 %

electrical conductivity and 1.03 % total soluble salts. The soil was sandy loam with 9.2 % clay, 32.0 % silt and 58.8 % sand (Table 12).

25. *Acantholimon-Ephedra-Ribes* community

This community also consisting of 18 species at Shandur Pass between altitudes of 3640m-3910m (Table 10; Appendix 35) was dominated by *Acantholimon longiscapum* (IV. 49.53), *Ephedra gerardiana* (IV. 36.51) and *Ribes orientale* (IV. 33.77). *Artemisia brevifolia*, *Swertia speciosa*, *Arenaria* sp. *Cicer macranthum*, *Potentilla supina* and *Rosa webbiana* were next in dominance. There was 1.44 % organic matter, 5.00 % calcium carbonate, 0.072 ppm nitrogen, 24.00 ppm phosphorus, 100 ppm potassium, 6.6 pH, 0.16 % electrical conductivity and 0.051 % total soluble salts. The soil with 9.2 % clay, 24.0 % silt and 66.8 % sand represented sandy loam texture (Table 12). This community faced heavy overgrazing pressure and fuel wood collection.

26. *Artemisia-Rosa-Sophora* community

This community with 24 species at Chuving along foot hills between altitudes 2300m-2400m (Table 10; Appendix 36) was dominated by *Artemisia brevifolia* (IV. 38.35), *Rosa webbiana* (IV. 34.52) and *Sophora mollis* (IV. 31.85). The co-dominants included *Haloxylon griffithii*, *Capparis spinosa*, *Cotoneaster nummularia* and *Ephedra gerardiana* were co-dominants. The soil had 0.75 % organic matter, 9.00 % calcium carbonate, 0.037 ppm nitrogen, 16.51 ppm phosphorus, 160 ppm potassium, 8.3 pH, 0.09 % electrical conductivity and 0.029 % total soluble salts. The soil was sandy loam with 11.2 % clay, 32.0 % silt and 56.8 % sand (Table 12).

27. *Artemisia-Haloxylon-Atraphaxis* community

This community consisted of 18 species at foot hills of Chapali between altitudes 2160m-2300m (Table 10; Appendix 37). The dominants included *Artemisia brevifolia* (IV. 59.39), *Haloxylon griffithii* (IV. 35.69) and *Atraphaxis spinosa* (IV. 31.36). The co-dominants were *Kracheninnikovia ceratoides*, *Ephedra gerardiana*, *Rosa webbiana*, *Colutea paulsenii* and *Fraxinus xanthoxyloides*. The soil possessed 0.62 % organic matter, 12.50 % calcium carbonate, 0.031 ppm nitrogen, 21.67 ppm phosphorus, 140 ppm

potassium, 8.9 pH, 3.57 % electrical conductivity and 1.14 % total soluble salts. The soil with 9.2 % clay, 36.0 % silt and 54.8 % sand was sandy loam (Table 12).

28. *Artemisia-Rosa-Berberis* community

At foothills of Brep between altitudes 2280m-2420m 22 species made community (Table 10; Appendix 38), which was dominated by *Artemisia brevifolia* (IV. 49.11), *Rosa webbiana* (IV. 46.12) and *Berberis lycium* (IV. 24.29). The co-dominants included *Echinops echinatus*, *Kracheninnikovia ceratoides*, *Capparis spinosa*, *Chenopodium botrys*, *Cotoneaster nummularia* and *Gnaphalum luteo-album*. The soil consisted of 0.41 % organic matter, 7.50 % calcium carbonate, 0.020 ppm nitrogen, 25.29 ppm phosphorus, 115 ppm potassium, 8.6 pH, 0.13 % electrical conductivity and 0.041 % total soluble salts. The sandy-loamy soil had 9.2 % clay, 38.0 % silt and 52.8 % sand (Table 12).

29. *Artemisia-Haloxylon-Ephedra* community

This community possessed 18 species at Bang along mid hills between altitudes of 2340m-2615m (Table 10; Appendix 39). The dominants included *Artemisia brevifolia* (IV. 55.92), *Haloxylon griffithii* (IV. 39.79) and *Ephedra gerardiana* (IV. 31.04). The co-dominants consisted *Cotoneaster nummularia*, *Kracheninnikovia ceratoides*, *Rosa webbiana* and *Juniperus excelsa*. The soil had 1.10 % organic matter, 8.75 % calcium carbonate, 0.055 ppm nitrogen, 44.79 ppm phosphorus, 130 ppm potassium, 8.4 pH, 0.09 % electrical conductivity and 0.029 % total soluble salts. The soil texture was loam with 11.2 % clay, 46.0 % silt and 42.8 % sand (Table 12).

30. *Juniperus-Artemisia-Cotoneaster* community

At Power along foot hills between altitudes of 2460m-2660m the community was composed of 16 species (Table 10; Appendix 40), which was dominated by *Juniperus excelsa* (IV. 44.69), *Artemisia brevifolia* (IV. 37.74) and *Cotoneaster nummularia* (IV. 34.84). The co-dominants were *Rosa webbiana*, *Ephedra gerardiana*, *Astragalus psilocentros*, *Colutea paulsenii* and *Berberis lycium*. The soil had 1.20 % organic matter, 10.00 % calcium carbonate, 0.050 ppm nitrogen, 16.00 ppm phosphorus, 110 ppm

potassium, 8.1 pH, 0.10 % electrical conductivity and 0.020 % total soluble salts. The soil with 9.2 % clay, 40.0 % silt and 60.5 % sand was sandy loam (Table 12).

31. *Ephedra-Artemisia-Juniperus* community

Eighteen species composed a community at Wasum along foot hills between altitudes 2520m-2600m (Table 10; Appendix 41). The dominant members included *Ephedra gerardiana* (IV. 39.67), *Artemisia brevifolia* (IV. 35.22) and *Juniperus excelsa* (IV. 33.84), while the co-dominants were *Colutea paulsenii*, *Atraphaxis pyrifolia*, *Cotoneaster nummularia* and *Rosa webbiana*. The soil had 1.40 % organic matter, 11.20 % calcium carbonate, 0.040 ppm nitrogen, 25.30 ppm phosphorus, 140 ppm potassium, 7.1 pH, 0.09 % electrical conductivity and 0.040 % total soluble salts. The soil was sandy loam with 9.5 % clay, 44.0 % silt and 62.5 % sand (Table 12).

32. *Cotoneaster-Berberis-Artemisia* community

Cotoneaster nummularia (IV. 45.76), *Berberis lycium* (IV. 43.69) and *Artemisia brevifolia* (IV. 39.87) dominated a community of 16 species at Ghazin along foot hills between altitudes 2580m-2800m (Table 10; Appendix 42). *Rosa webbiana*, *Juniperus excelsa* and *Ribes orientale* were co-dominants. The chemical features of soil included 1.30 % organic matter, 14.25 % calcium carbonate, 0.020 ppm nitrogen, 30.00 ppm phosphorus, 160 ppm potassium, 7.6 pH, 0.10 % electrical conductivity and 0.035 % total soluble salts. The soil was sandy loam with 10.5 % clay, 40.0 % silt and 65.5 % sand (Table 12).

33. *Ephedra-Juniperus-Artemisia* community

At Baroghill Pass between 3060m-3100m altitudes 14 species made a community (Table 10; Appendix 43) that was dominated by *Ephedra gerardiana* (IV. 46.44), *Juniperus excelsa* (IV. 46.28) and *Artemisia brevifolia* (IV. 36.2). *Ribes orientale*, *Rosa webbiana*, *Atraphaxis pyrifolia* and *Hippophae rhamnoides* act as co-dominants. The soil had 1.10 % organic matter, 10.00 calcium carbonate, 0.035 ppm nitrogen, 20.00 ppm phosphorus, 130 ppm potassium, 7.1 pH, 0.15 % electrical conductivity and 0.060 % total

soluble salts. The soil represented sandy loam texture with 9.5 % clay, 45.0 % silt and 58.5 % sand (Table 12).

Vegetation is the reflection of ecological conditions of plant and other resources of an area. Vegetation structure depends upon the prevailing environmental condition. Habitat condition depends on a number of factors including biotic interaction in the form of overgrazing, deforestation and clearing of land for developing new settlements. Natural habitats have been changed into town and industrial states. This has imbalanced the nature of associated plants and wild life. Therefore, vegetation studies reflect the existing state of interference caused by man. Keeping this aspect, many vegetation studies have been conducted worldwide (Shah & Hussain, 2009). A lot of quantitative phytosociological work has been published from various parts of Pakistan. Shah & Hussain (2008) recognized 6 plant communities in different seral stages while studying the ecology of wetlands of Akbarpura, District Nowshera. Ahmad *et al.* (2009) established 10 communities in *Olea ferruginea* forests of lower Dir. Shah & Hussain (2009) recognized 5 plant communities from Hayatabad, District Peshawar. Farooq *et al.* (2010) established 5 plant communities in Push Ziarat, South Waziristan. Rahim *et al.* (2011) established 14 associations while conducting phytosociological analysis of saline area of Tehsil Ferozewala, Punjab. The study revealed that the vegetation cover is disappearing due to anthropogenic activities. The communities so established reflected the characters of dry temperate condition of the investigated area.

Associations of mountain and alpine vegetation

The mountain vegetation had 143 species in 33 plant communities which were grouped into the following 4 associations following cluster analysis.

i. Herbaceous association

This association had 4 communities and 53 species (Fig. 5, Table 10). Annual and perennial herbaceous species dominated the association. *Rhenum emodi* (IV. 31.69), *Matricaria disciformis* (IV. 29.97) and *Artemisia brevifolia* (IV. 29.88) were dominants (Table 10).

ii. Woody herbaceous association

Betula utilis (IV. 40.74), *Artemisia brevifolia* (IV. 36.15) and *Atraphaxis spinosa* (IV. 31.13) dominated the association. This association had 17 communities and 74 species (Fig. 5, Table 10).

iii. Herbaceous and woody association

This association was dominated by *Salvia nubicola* (IV. 42.31), *Acantholimon longiscapum* (IV. 34.48) and *Ephedra gerardiana* (IV. 34.31). It had 6 communities and 82 species (Fig. 5, Table 10). This association was present along midhills.

iv. Herbaceous and woody association

This association occurred along timberline the dominant species were *Epilobium angustifolium* (IV. 61.71), *Betula utilis* (IV. 52.1) and *Gnaphalium luteo-album* (IV. 48.04). There were 74 species 6 communities (Fig. 5, Table 10).

The DCA classified the 33 mountain site plant communities into 2 groups and 2 outliers making 4 associations. The largest group was composed of 26 communities along high altitude. It consisted of 3, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32 and stand 33 designated as group 1 association (Fig. 6). In the association most of the herbaceous and woody grouped due to their high importance values and similar habitat nature, The main vegetation consisted of *Artemisia brevifolia*, *Berberis Lycium*, *Ephedra gerardiana*, *Juniperus excelsa*, *Matricaria disciformis*, *Rosa webbiana*, *Ribes orientale*, *Salvia nubicola* and *Sophora mollis*. The second group association had 5 communities including stand 1, stand 2, stand 13, stand 21 and stand 22 (Fig. 6). The dominant vegetation of this association consisted of *Artemisia brevifolia*, *Artemisia maritima*, *Chenopodium botrys*, *Echinops echinatus*, *Haloxylon griffithii* and *Rheum emodi*. Two communities including stand 4 and stand 8 were outliers that occurred along timber line and did not participate in these associations. The differences in the vegetation types occurred due to altitudinal variation and soil types. The soil texture was mostly sandy loam with less nitrogen contents. The pH ranged from 6.5 to 8.9. The result agreed with that of Jiang *et al.* (2007) who showed similar change in vegetation along the altitudinal gradient in China. According to Solon *et al.* (2007) the most important components controlling vegetation diversity and cover is the soil and topography amongst other things, which were observed in these findings.

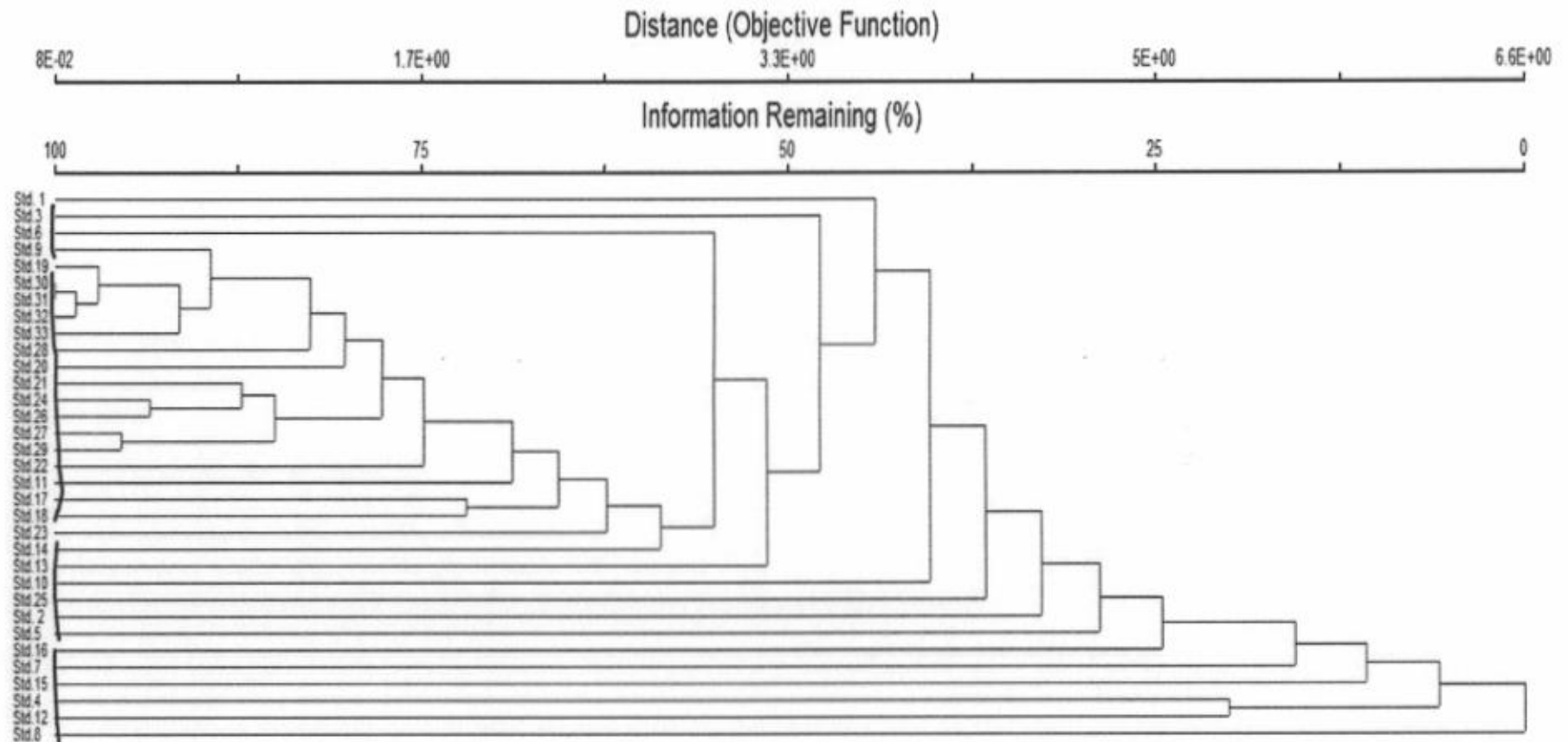


Fig 6. Cluster Dendrogram Analysis showing two 4 associations of 33 communities of mountains and alpine vegetation based on IV (Importance values) in Mastuj Valley, District Chitral.

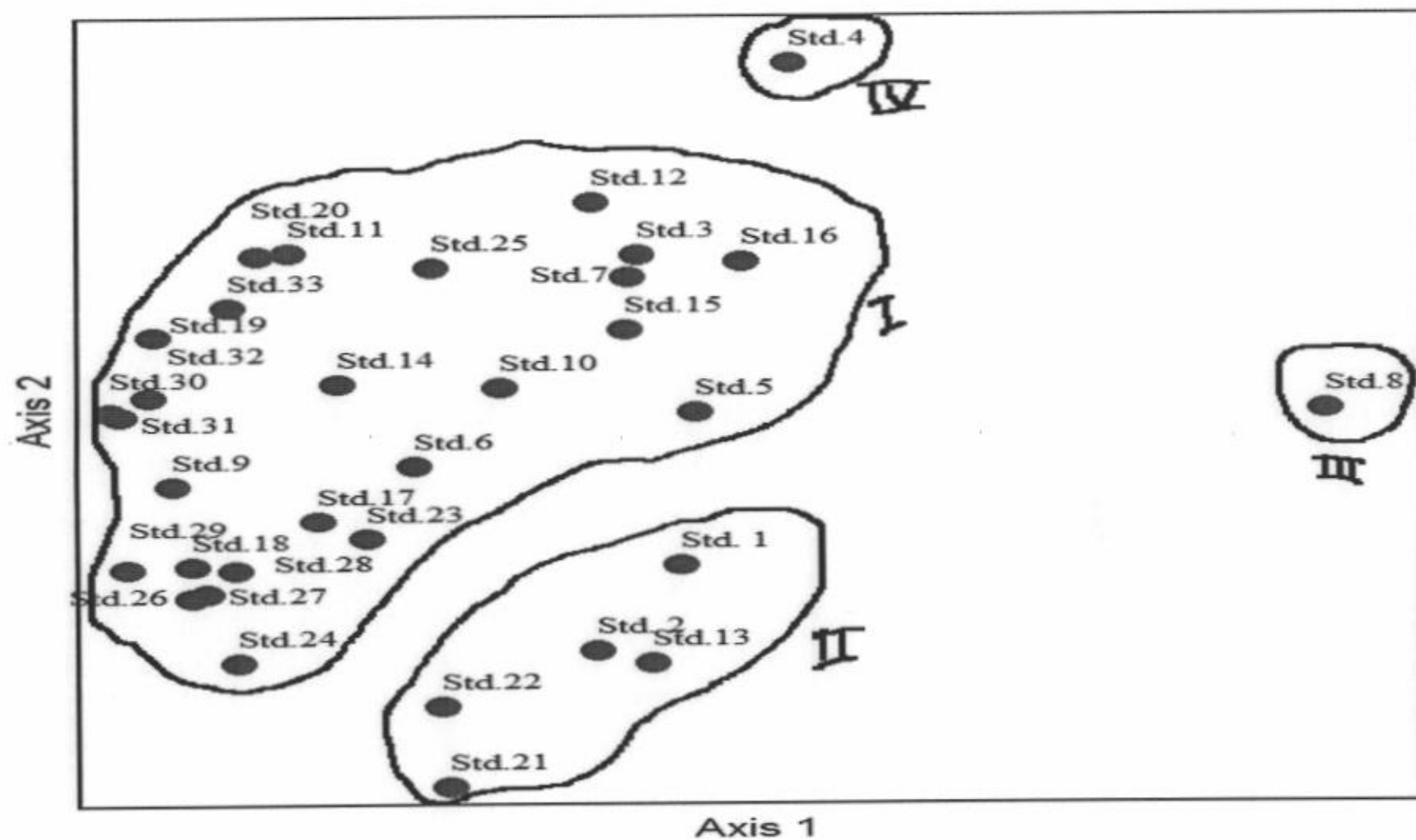


Fig 7. Groups demarcated by Detrended Correspondence Analysis of 33 plant communities of mountains and alpine vegetation in Mastuj Valley, District Chitral.

Degree of Palatability

Cattle grazing behaviour was observed from early May to late of December. Cow grazed upon 41 plant species (Table 13). Of them, 21 species were highly palatable, 16 mostly palatable, 3 less palatable and 1 species was rarely palatable. Parts used indicated that in 29 species whole plants and in 12 species leaves were utilized. Fortyone plant species were palatable to goats (Table 14). Of them, 15 species were highly palatable, 19 mostly palatable, 4 less palatable and 3 species were rarely palatable. 14 whole plants, 10 species leaves, 10 species shoots, 6 species flowers and 1 species fruits were utilized. Sheep grazed 23 plant species (Table 15). Of them, 13 species were highly palatable, 7 mostly palatable, 2 less palatable and 1 rarely palatable. In 13 species whole plants, in 6 species leaves and in 4 species shoots were palatable. Livestock improvement demands the efficient use of available feed resources. Factors like climate, agronomic practices, feed processing technologies and genetic variations ultimately affect the nutritive value of feed for live stock. Feeding resources and feeding systems of farm animals vary from one place to another. Feeding practices are governed by the farmer's land holdings, socio-economic status and marketing of livestock and their products (Younas & Yaqoob, 2005). Grazing is the most economical way of utilizing rangeland vegetation. Palatability is a plant characteristic that refers to the relish with which plants or its parts or feed is consumed as stimulated by the sensory impulses of grazing animal (Hussain & Durrani, 2009). Glindemann *et al.* (2009) studied the effects of grazing of sheep on herbage mass and live weight gain. Sher *et al.* (2010) studied the effect of nomadic grazing on medicinal plants in Miandam, Swat. Badshah & Hussain (2011) reported 38 fodder species from District Tank. *Acacia nilotica*, *Zizyphus mauritiana* and *Convolvulus arvensis* were the most preferred species. Rahim *et al.* (2011) proposed indigenous fodder trees for landless and mobile pastoralists in Northern Pakistan. Livestock herding is the means of earning livelihood of the inhabitants of Mastuj Valley. Grazing starts from early May to late October during summer while during winter livestock feed on stored food materials.

Table 13. Palatability of forage species by parts used by cow, in Mastuj Valley, District Chitral, Pakistan.

S.No.	Plant species	Palatability	Part used	Availability
1.	<i>Amaranthus retroflexus</i> L.	MP	WP	September
2.	<i>Bromus gracillimus</i> Bunge.	HP	WP	June
3.	<i>Cephsella bursa-pactoris</i> (L.) Medic.	MP	WP	June
4.	<i>Chenopodium album</i> L.	HP	WP	June
5.	<i>Chenopodium botrys</i> L.	HP	WP	June
6.	<i>Cichorium intybus</i> L.	MP	WP	June
7.	<i>Convolvulus arvensis</i> L.	HP	WP	June
8.	<i>Cynodon dactylon</i> (L.) Pers.	HP	WP	June
9.	<i>Elaeagnus angustifolia</i> L.	MP	Lvs	June
10.	<i>Equisetum ramossimum</i> Desf.	HP	WP	August
11.	<i>Gallium aparine</i> L.	HP	WP	June
12.	<i>Hippophae rhamnoides</i> L.	LP	Lvs	June
13.	<i>Inula obtusifolia</i> Kerner.	HP	WP	August
14.	<i>Iris ensata</i> Thunb.	RP	Lvs	August
15.	<i>Juglans regia</i> L.	MP	Lvs	October
16.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	MP	WP	August
17.	<i>Lotus corniculatus</i> L.	HP	WP	June
18.	<i>Malva neglecta</i> Wall.	MP	WP	June
19.	<i>Medicago sativa</i> L.	MP	WP	June
20.	<i>Morus alba</i> L.	HP	Lvs	September
21.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	MP	WP	June
22.	<i>Plantago lanceolata</i> L.	HP	WP	June
23.	<i>Plantago major</i> Aitch.	MP	WP	June
24.	<i>Polygonum aviculare</i> L.	MP	WP	June
25.	<i>Polygonum dumetorum</i> L.	HP	WP	June

26.	<i>Polygonum persicaria</i> L.	MP	WP	June
27.	<i>Populus nigra</i> L.	HP	Lvs	October
28.	<i>Potentilla supine</i> L.	HP	WP	May
29.	<i>Prunus armeniaca</i> L.	HP	Lvs	July
30.	<i>Prunus persica</i> (L.) Batsch.	MP	Lvs	September
31.	<i>Pyrus malus</i> L.	HP	Lvs	July
32.	<i>Rosa webbiana</i> Wall ex Royle.	LP	Lvs	July
33.	<i>Salix tetrasperma</i> Roxb.	MP	Lvs	July
34.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	HP	WP	August
35.	<i>Silene conoidea</i> L.	HP	WP	June
36.	<i>Taraxacum officinale</i> Weber.	MP	WP	June
37.	<i>Trachomitum venetum</i> (L.) Woodson.	LP	WP	August
38.	<i>Trifolium repens</i> L.	HP	WP	June
39.	<i>Trifolium resupinatum</i> L.	HP	WP	May
40.	<i>Vicia sativa</i> L.	HP	WP	June
41.	<i>Vitis venifera</i> L.	MP	Lvs	September

Table 14. Palatability of forage species by parts used by goats, in Mastuj Valley, District Chitral, Pakistan.

S.No	Plant species	Palatability	Part used	Availability
1.	<i>Artemisia brevifolia</i> Wall ex DC.	MP	Shoots	October
2.	<i>Artemisia maritima</i> L.	LP	Shoots	October
3.	<i>Artemisia scoparia</i> Waldst & Kit.	RP	Shoots	October
4.	<i>Astragalus psilocentros</i> Fisch.	MP	Shoots	December
5.	<i>Berberis lycium</i> Royle.	MP	Lvs	September
6.	<i>Chenopodium album</i> L.	MP	WP	July
7.	<i>Chenopodium botrys</i> L.	HP	WP	June
8.	<i>Clematis orientalis</i> L.	HP	Shoots	December
9.	<i>Convolvulus arvensis</i> L.	MP	WP	June
10.	<i>Cynodon dactylon</i> (L.) Pers.	HP	WP	June
11.	<i>Datura stramonium</i> L.	MP	WP	October
12.	<i>Echinops echinatus</i> Roxb.	MP	WP	November
13.	<i>Elaeagnus angustifolia</i> L.	HP	Lvs	October
14.	<i>Ephedra gerardiana</i> L.	RP	Shoots	October
15.	<i>Euphorbia peplus</i> L.	LP	WP	July
16.	<i>Glycyrrhiza glabra</i> L.	MP	Fls	June
17.	<i>Gnaphalium luteo-album</i> L.	HP	WP	December
18.	<i>Grass</i> Sp.	MP	WP	June
19.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	MP	Shoots	June
20.	<i>Hippophae rhamnoides</i> L.	MP	Lvs	May
21.	<i>Iris ensata</i> Thunb.	MP	Fls	May
22.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	MP	Shoots	June
23.	<i>Matricaria chamomile</i> L.	HP	WP	November
24.	<i>Morus alba</i> L.	HP	Lvs	July
25.	<i>Myricaria elegans</i> Royle.	HP	Shoots	November

26.	<i>Nepeta cataria</i> L.	LP	WP	June
27.	<i>Parnassia nubicola</i> Planch ex Clarke.	HP	WP	August
28.	<i>Plantago lanceolata</i> L.	MP	Fls	May
29.	<i>Plantago major</i> Aitch.	MP	Fls	May
30.	<i>Populus alba</i> L.	HP	Lvs	November
31.	<i>Populus nigra</i> L.	HP	Lvs	November
32.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	HP	WP	December
33.	<i>Rosa webbiana</i> Wall ex Royle.	MP	Lvs	August
34.	<i>Rumex longifolius</i> DC.	MP	Fls	May
35.	<i>Salix acmophylla</i> Boiss.	HP	Lvs	October
36.	<i>Salix tetrasperma</i> Roxb.	HP	Lvs	November
37.	<i>Silene conoidea</i> L.	MP	Fls	May
38.	<i>Sophora mollis</i> (Royle.) Baker.	MP	Fr	October
39.	<i>Tamarix dioica</i> Roxb ex Roth.	RP	Shoots	November
40.	<i>Trachomitum venetum</i> (L.) Woodson.	LP	Lvs	May
41.	<i>Trifolium repens</i> L.	HP	WP	May

Table 15. Palatability of forage species by parts used by sheep, in Mastuj Valley, District Chitral, Pakistan.

S.No.	Plant species	Palatability	Part used	Availability
1.	<i>Artemisia brevifolia</i> Wall ex DC.	MP	Shoots	May
2.	<i>Bromus gracillimus</i> Bunge.	HP	WP	May
3.	<i>Chenopodium album</i> L.	HP	WP	August
4.	<i>Chenopodium botrys</i> L.	HP	WP	October
5.	<i>Clematis orientalis</i> L.	HP	Shoots	July
6.	<i>Cnicus benedictus</i> L.	MP	WP	November
7.	<i>Cynodon dactylon</i> (L.) Pers.	HP	WP	August
8.	<i>Echinops echinatus</i> Roxb.	LP	WP	August
9.	<i>Elaeagnus angustifolia</i> L.	MP	Lvs	September
10.	<i>Glycyrrhiza glabra</i> L.	MP	Lvs	July
11.	<i>Iris ensata</i> Thunb.	HP	Lvs	November
12.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	HP	Shoots	May
13.	<i>Hippophae rhamnoides</i> L.	MP	Lvs	August
14.	<i>Hippuris vulgaris</i> L.	HP	WP	July
15.	<i>Lotus corniculatus</i> L.	HP	WP	July
16.	<i>Medicago sativa</i> L.	HP	WP	August
17.	<i>Mentha longifolia</i> (L.) Huds.	LP	WP	August
18.	<i>Saccharum spontaneum</i> L.	MP	Shoots	August
19.	<i>Salix tetrasperma</i> Roxb.	MP	Lvs	July
20.	<i>Sophora mollis</i> (Royle.) Baker.	RP	Lvs	July
21.	<i>Taraxacum officinale</i> Weber.	HP	WP	July
22.	<i>Trifolium repens</i> L.	HP	WP	June
23.	<i>Trifolium resupinatum</i> L.	HP	WP	June

Rangeland Productivity

Mastuj Valley rangeland is an arid sub-alpine range. Productivity of herbs, shrubs/trees and grasses were measured for three consecutive years i.e. 2006-2008. Herbaceous plants contributed 60811 Kg/ha, shrubs and trees had 127235 Kg/ha and grasses contributed 1899 Kg/ha (Table 16). Highest productivity 11510 Kg/ha was measured in Sarghuz, followed by 11370 Kg/ha in Sarghuz, 10890 Kg/ha in Tooque and 9758 Kg/ha in Mastuj. The total productivity was 186581 Kg/ha. "Many studies made for the assessment of forage productivity suggest that the sustainability of the range depends upon a number of factors such as rainfall, edaphic features, grazing system and seasonal availability of forage" (Durrani *et al.*, 2005). Omer *et al.* (2006) reported high forage production during spring in dry temperate rangelands of Pakistan. Optimum use of rangeland resources depends on the understanding of the amount and dynamics of seasonal phytomass production as influenced by climatic fluctuations (Hussain & Durrani, 2007). Like the present study, Hussain & Durrani (2007) also reported rangeland productivity in Balochistan. Forage biomass is generally the most important resource for animal production in high altitude ecosystems that is rapidly being depleted due to heavy grazing over the vast areas of rangelands. It is evident that successful range management and improvement requires knowledge of forage calendar, nutritional value of forage plant species (both qualitative and quantitative) and forage palatability and preferences of the flock in the region (Hussain, 2009). Mirza *et al.* (2009) studied the effect of drought on rangeland productivity and animal performance in dryland region of Balochistan. They concluded that annual range productivity has declined from an average 150-180 kg/ha to 30-45 kg/ha as a result of continuous drought. The present investigated area is dry temperate region with poor rain fall and high snow fall during winter. This has led to the poor biomass production. Chaudhry *et al.* (2010) determined the carrying capacity of untreated and treated areas of Mari Reserve Forest, Pothwar Tract. Dishi & Daniel (2010) determined forage yield in the Sudan savannah zone of Nigeria. The total forage yield for the three months was 2130 kg DM/ha. Haq *et al.* (2011) carried out vegetation analysis and winter season carried out capacity of sub-tropical, sub-humid rangelands of Dhrabi Watershed, Pakistan. The range was found in good condition with overall carrying capacity of 2.41 ha/AU/4 months. It was observed that Mastuj Valley is suffering with

overgrazing by livestock, over exploitation for fuel wood, rapid urbanization due to population explosion and soil erosion. Range management practices with the help of local inhabitants must be tried for its sustainable use and improvement.

Table 16. Biomass production (Kg/ha) in different plant communities found in Mastuj Valley, Hindukush Range, Pakistan.

Habitat	Plant Communities/ Stands	Localities, altitude	Herbs	Shrubs/ Trees	Grasses	Total
A. Water course	MHT	Sarghuz, 2250-2350 m	2890	8230	250	11370
	RAE	Sarghuz, 2250-2500 m	3360	8100	50	11510
	MET	Malakandi, 2300-2400 m	1150	2400	15	3565
	SSH	Malakandi, 2290-2410 m	900	4240	75	5215
	MSP	Mastuj, 2410-2510 m	980	1725	70	2775
B. Plains & Foothills	SCS	Mastuj, 2320-2420 m	1140	3305	70	4515
	JPN	Tooque, 2250-2350 m	3290	-	115	3405
	HCM	Tooque, 2200-2400 m	3630	7180	80	10890
	EJP	Chinar, 2220-2360 m	2875	-	390	3265
	ESH	Chinar, 2260-2350 m	1580	6660	70	831
C. Mountains	ASH	Reshun, 1800-1910 m	580	655	-	1235
	AES	Koragh, 1880-2100 m	700	490	-	1190
	SCF	Booni, 2140-2220 m	1175	2295	-	3470
	JSA	Parwak, 2240-2335 m	320	1050	-	1500
	AER	Shandur Pass, 3640-3910 m	415	500	-	915
	ARS	Chuing, 2300-2400 m	1166	1795	-	2961
	AHA	Chapali, 2160-2300 m	630	1470	-	2100
	ARB	Brep, 2280-2420 m	875	1630	15	2520
	AHE	Bang, 2340-2615 m	325	2200	-	2525
	JAC	Power, 2460-2660 m	535	3400	-	3935
	EAJ	Wasum, 2520-2660 m	940	2100	-	3040
	CBA	Ghazin, 2580-2800 m	260	1700	25	1985
	EJA	Baroghil Pass, 3060-3100 m	235	1030	15	1280
	CAF	Chumarkhan Pass, 2380-2480 m	410	1200	5	1615
	ACC	Chumarkhan Pass, 2540-2660 m	690	1950	-	2640
	CAJ	Chumarkhan Pass, 2720-3000 m	270	2040	25	2335
	BJA	Chumarkhan Pass, 3100-3500 m	610	3150	-	3760
	SRH	Mastuj, 2325-2425 m	1265	6420	5	7690
	ASE	Mastuj, 2440-2620 m	1450	2100	-	3550
	AMJ	Mastuj, 2725-3000 m	2660	7080	18	9758
	BRR	Mastuj, 3010-3300 m	1250	5000	18	6268
	SBR	Miragram - I, 2230 -2525 m	2000	5000	100	7100
	SAB	Miragram - I, 2320- 2550 m	1500	3000	-	4500
	GNM	Miragram - I, 2640 - 2935 m	1200	3500	25	4725
	ERM	Miragram - I, 2935 - 3100 m	800	1500	60	2366
	RAB	Miragram - II, 2400 -2710 m	1500	4000	-	5500
	EMA	Miragram - II, 2720 - 2860 m	3800	4000	35	7835
	EJR	Miragram - II, 2870 - 2950 m	3400	4900	110	8410
	BSR	Miragram - II, 2980 - 3100 m	630	4000	25	4655
	CHE	Ghuru, 2200-2300 m	785	750	10	1545
	REA	Ghuru 2480-3000 m	865	4175	25	5065
	PER	GhuruM 3010-3500 m	1520	1165	28	2713
	CAT	Ghuru, 3520-3900 m	755	150	170	1075
Total			60811	127235	1899	186581

Chemical Evaluation of some Forage Plants

A. Secondary metabolites

Table 17 showed the qualitative presence/absence of some secondary metabolites.

1. Alkaloids

It was found that alkaloid contents were absent at pre-reproductive stage in *Elaeagnus angustifolia* and *Juniperus excelsa*, but were present in *Hippophae* at post-reproductive stage and at reproductive stage in *Tamarix*. Among shrubs, alkaloid contents were absent in *Capparis spinosa*. *Myricaria elegans* and *Rosa webbiana* had it only at pre-reproductive stages. Alkaloid contents among herbs were absent at reproductive stage in *Artemisia parviflora* but *Verbascum thapsus* had at post-reproductive stage. Among grasses alkaloid contents were absent in *Calamogrostris pseudophragmites* and *Saccharum spontaneum* (Table 17).

2. Saponins

Saponin was absent in *Hippophae rhamnoides* at post-reproductive stage among trees. Among shrubs, saponin was absent at all the three phenological stages in *Berberis*, *Myricaria elegans* at post-reproductive stage. Among herbs, saponin was present at pre-reproductive stages in *Artemisia parviflora* and *Nepeta cataria*. It was absent at post-reproductive stage in *Salvia*. Among grasses, saponin was absent in *Calamogrostris* and *Phragmites* (Table 17).

3. Tannins

Among trees, tannin was absent in *Tamarix dioica* at reproductive and post-reproductive stages. In shrubs, tannin was absent at pre-reproductive and reproductive stages in *Acantholimon longiscapum* and at post-reproductive stage in *Capparis spinosa*. Among herbs, tannin was present at pre-reproductive stage in *Artemisia*, *Rheum* and *Verbascum thapsus*. Tannin was absent among grasses (Table 17).

4. Cutin

Among trees, cutin was present at post-reproductive stage in *Elaeagnus angustifolia* and at pre-reproductive stage in *Tamarix dioica*. It was present at reproductive and post-reproductive stages in *Juniperus excelsa*. Among shrubs, *Acantholimon*, *Ephedra*, *Myricaria* and *Rosa webbiana* had cutin at pre-reproductive stages. In *Berberis lycium* cutin was absent at post-reproductive stage and it was absent at

pre-reproductive stage in *Sophora mollis*. Among herbs, cutin was absent in *Artemisia parviflora*. In *Glycyrrhiza glabra* and *Rheum emodi* cutin was present only at pre-reproductive stages. Cutin was absent among grasses (Table 17).

5. Oil

Among trees, oil was absent at pre-reproductive stage in *Elaeagnus angustifolia* and at reproductive stage in *Tamarix dioica*. In shrubs, oil was present at post-reproductive stage in *Acantholimon* and *Rosa webbiana*. Among herbs, oil was absent in *Artemisia*, *Glycyrrhiza* and *Rheum emodi*. In *Verbascum thapsus* oil was present only at pre-reproductive stage. All the grasses had oil at three phenological stages (Table 17).

Knowledge of the phytochemical constituents of plants is desirable, not only for the discovery of therapeutic agents, but also because such informations may be of value in disclosing new sources of such economic materials such as tannins, oils, gums, flavonoids, saponins, essential oils precursors for the synthesis of complex chemical substances, etc. In addition, the knowledge of mineral contents of plants is useful to evaluate their nutritive potentialities as fodder for livestock and human (Ahmed, 2010).

Table 17. Secondary metabolites in some forage plants of Mastuj Valley, Hindukush Range, Pakistan,

S.No.	Plant species	Phenological stages	Alkaloid	Saponin	Tannin	Cutin	Oil
1.	A. Trees <i>Elaeagnus angustifolia</i> L.	1.	-	+	+	-	-
		2.	+	+	+	-	+
		3.	+	+	+	+	+
2.	<i>Hippophae rhamnoides</i> L.	1.	-	+	+	+	+
		2.	-	+	+	+	+
		3.	+	-	+	-	+
3.	<i>Juniperus excelsa</i> M. Bieb.	1.	-	+	+	-	+
		2.	+	+	+	+	+
		3.	+	+	+	+	+
4.	<i>Tamarix dioica</i> Roxb ex Roth.	1.	-	+	+	+	+
		2.	+	+	-	-	-
		3.	-	+	-	-	+
5.	B. Shrubs <i>Acantholimon longiscapum</i> Bokhari.	1.	+	+	-	+	-
		2.	+	+	-	-	-
		3.	+	+	+	-	+
6.	<i>Berberis lycium</i> Royle.	1.	+	-	+	+	+
		2.	+	-	+	+	+
		3.	+	-	+	-	+
7.	<i>Capparis spinosa</i> L.	1.	-	+	+	-	-
		2.	-	+	+	+	-
		3.	-	+	+	+	-
8.	<i>Ephedra gerardiana</i> L.	1.	+	+	-	+	+
		2.	+	+	+	-	+
		3.	+	+	+	-	+
9.	<i>Myricaria elegans</i> Royle.	1.	-	+	+	+	+
		2.	+	+	+	-	-
		3.	+	-	+	-	+
10.	<i>Rosa webbiana</i> Wall ex Royle.	1.	-	+	+	+	-
		2.	+	+	+	-	-
		3.	+	+	+	-	+
11.	<i>Sophora mollis</i> (Royle.) Baker.	1.	+	+	+	-	+
		2.	+	+	+	+	+
		3.	+	+	+	+	+
12.	C. Herbs/Forbs	1.	-	+	+	-	-
		2.	+	-	-	-	-

	<i>Artemisia parviflora</i> Roxb.	3.	+	-	-	-	-
13.	<i>Datura stramonium</i> L.	1.	-	+	+	+	+
		2.	-	+	+	+	+
		3.	-	+	+	-	+
14.	<i>Glycyrrhiza glabra</i> L.	1.	-	+	+	+	-
		2.	-	+	+	-	-
		3.	-	+	+	-	-
15.	<i>Mentha longifolia</i> (L.) Huds.	1.	+	+	+	+	-
		2.	+	+	+	+	+
		3.	+	+	+	+	+
16.	<i>Nepeta cataria</i> L.	1.	-	+	+	-	+
		2.	-	-	+	+	+
		3.	+	-	+	+	+
17.	<i>Rheum emodi</i> Wall ex Meissn.	1.	+	+	+	+	-
		2.	+	+	-	-	-
		3.	+	+	-	-	-
18.	<i>Salvia nubicola</i> Wall ex Sweet.	1.	+	+	+	-	-
		2.	+	+	+	+	+
		3.	+	-	+	+	+
19.	<i>Verbascum thapsus</i> L.	1.	-	+	+	+	+
		2.	-	+	-	+	-
		3.	+	+	-	+	-
20.	D. Grasses <i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	1.	-	-	-	-	+
		2.	-	-	-	-	+
		3.	-	-	-	-	+
21.	<i>Cynodon dactylon</i> (L.) Pers.	1.	+	+	-	-	+
		2.	+	+	-	-	+
		3.	+	+	-	-	+
22.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	1.	+	-	-	-	+
		2.	+	-	-	-	+
		3.	+	-	-	-	+
23.	<i>Saccharum spontaneum</i> L.	1.	-	+	-	-	+
		2.	-	+	-	-	+
		3.	-	+	-	-	+

Keys: 1. Pre-reproductive stage, 2. Reproductive stage, 3. Post-reproductive stage

B. Mineral composition

Thirteen mineral contents were analyzed in three phenological stages of 28 species (Table 18). Of them, 4 were trees, 9 shrubs, 11 herbs/forbs and 4 grasses. The results for each mineral is presented below.

a. Macrominerals

1. Calcium (Ca)

The results for Ca contents are presented in Table 19. Among trees, maximum level of Ca contents were 219.1 mg/l recorded for *Juniperus* at reproductive stage, which was followed by 206.5 mg/l at post-reproductive stage of *Tamarix dioica*. On the average *Juniperus excelsa* had the highest level of Ca (160.23 mg/l), which was followed by *Tamarix dioica* (140.36 mg/l) and *Betula utilis* (98.65 mg/l). Considering the various phenological stages as a whole for trees it was seen that post-reproductive stages had the highest (129.67 mg/l) Ca contents, followed by reproductive stage (97.29 mg/l) and pre-reproductive stage (83.38 mg/l). The trend in individual species showed that the Ca contents progressively increased towards maturity in *Betula utilis*, *Elaeagnus angustifolia*, *Hippophae rhamnoides* and *Tamarix dioica*. In *Juniperus excels* Ca was highest at reproductive stage (219.1 mg/l), lowest at post-reproductive stage (127.8 mg/l) and medium at pre-reproductive stage (133.8 mg/l) (Table 19). Among shrubs, maximum Ca contents was observed in *Myricaria elegans* (229.7 mg/l) at post-reproductive stage, which was followed by *Rosa webbiana* (224.7 mg/l) at reproductive stage and *Sophora mollis* (224.4 mg/l) at post-reproductive stage. On the average *Myricaria* had the highest level of Ca (193.37 mg/l), followed by *Sophora mollis* (157.87 mg/l) and *Capparis spinosa* (139.23 mg/l). Considering the phenological stages as a whole for shrubs (Table 19) it was observed that post-reproductive stage had the highest Ca (147.27 mg/l), followed by reproductive stage (130.31 mg/l) and pre-reproductive stage (101.27 mg/l). Taking the trend for accumulation of Ca in individual species it was observed that there was progressive increase with the maturity of plants in *Acantholimon longiscapum*, *Berberis lycium*, *Capparis spinosa*, *Ephedra gerardiana*, *Haloxylon griffithii*, *Myricaria elegans* and *Sophora mollis*. In *Rosa webbiana* Ca was maximum (224.7 mg/l) at reproductive stage, followed by pre-reproductive stage (104.1 mg/l) and post-

reproductive stage. In herbs, maximum Ca contents was found in *Rheum emodi* (231.2 mg/l) at pre-reproductive stage. It was followed by *Datura stramonium* (230.4 mg/l) at post-reproductive stage and *Mentha longifolia* (227.4 mg/l) at post-reproductive stage. On the average *Datura stramonium* had the highest level of Ca contents (207.37 mg/l), followed by *Mentha longifolia* (164.2 mg/l) and *Rheum emodi* (159.83 mg/l). Considering the phenological stages as a whole for herbs, it was seen that post-reproductive stages had the highest Ca contents (155.72 mg/l), followed by pre-reproductive stage (116.38 mg/l) and reproductive stage (101.20 mg/l). The trend in individual species showed that Ca contents increased with maturity of plants in *Cichorium intybus*, *Datura stramonium*, *Glycyrrhiza glabra*, *Mentha longifolia*, *Nepeta cataria*, *Rheum emodi*, *Salvia nubicola*, *Trifolium repens* and *Verbascum thapsus*. In *Artemisia parviflora* Ca was highest (75.92 mg/l) at pre-reproductive stage, followed by (64.02 mg/l) at post-reproductive stage and (43.23 mg/l) at reproductive stage (Table 19). *Ferula jaeschkeana* had maximum at reproductive stage (216.3 mg/l), followed by (111.7 mg/l) at post-reproductive stage and (90.73 mg/l) at pre-reproductive stage. Among grasses, maximum Ca content was found in *Calamogrostris pseudophragmites* (94.85 mg/l) at pre-reproductive stage, which was followed by *Phragmites karka* (64.41 mg/l) at pre-reproductive stage. On the average *Calamogrostris* had the highest Ca content (52.543 mg/l), followed by *Phragmites karka* (47.637 mg/l) and *Cynodon dactylon* (47.100 mg/l). Across the phenological stages as a whole for grasses (Table 19), it was seen that pre-reproductive, reproductive and post-reproductive stages had 55.095 mg/l, 40.995 mg/l and 31.622 mg/l Ca contents respectively. Considering the trend in individual species, it was seen that Ca contents increased with maturity in *Cynodon dactylon* with 38.24 mg/l, 49.17 mg/l and 56.58 mg/l respectively from pre-reproductive to post-reproductive stage. In *Phragmites karka* and *Saccharum spontaneum* Ca contents decreased towards maturity. While in *Calamogrostris pseudophragmites* it was highest at pre-reproductive stage (94.85 mg/l), followed by post-reproductive stage (34.31 mg/l) and reproductive stage (28.47 mg/l) (Fig. 8, Table 19). Anova showed that Ca contents showed highly significant variation among the three phenological stages and among the plant species at α 0.01 (Table 32).

Table 18. Plant species with different palatability at different phenological stages used for mineral and proximat composition.

S.No.	Plant species	Phenological stage		
		Pre-reproductive stage	Reproductive stage	Post-reproductive stage
		Palatability		
A. Trees				
1.	<i>Betula utilis</i> D. Don.	MP	HP	HP
2.	<i>Elaeagnus angustifolia</i> L.	RP	MP	HP
3.	<i>Hippophae rhamnoides</i> L.	RP	LP	MP
4.	<i>Juniperus excelsa</i> M. Bieb.	NP	NP	RP
5.	<i>Tamarix dioica</i> Rox. ex Roth.	RP	RP	LP
B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari	RP	LP	MP
7.	<i>Berberis lycium</i> Royle.	RP	LP	MP
8.	<i>Capparis spinosa</i> L.	NP	LP	MP
9.	<i>Ephedra gerardiana</i> L.	NP	NP	RP
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	LP	MP	HP
11.	<i>Myricaria elegans</i> Royle.	LP	MP	HP
12.	<i>Rosa webbiana</i> Wall ex Royle.	LP	HP	MP
13.	<i>Sophora mollis</i> (Royle) Baker.	NP	MP	HP
C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i> Roxb.	RP	NP	LP
15.	<i>Cichorium intybus</i> L.	MP	HP	HP
16.	<i>Datura stramonium</i> L.	NP	NP	RP
17.	<i>Ferula narthex</i> Boiss.	RP	LP	MP
18.	<i>Glycyrrhiza glabra</i> L.	LP	MP	HP
19.	<i>Mentha longifolia</i> (L.) Huds.	RP	LP	MP
20.	<i>Nepeta cataria</i> L.	RP	LP	MP
21.	<i>Rheum emodi</i> Wall ex Meissn.	LP	MP	HP
22.	<i>Salvia nubicola</i> Wall ex Sweet.	NP	RP	MP
23.	<i>Trifolium resupinatum</i> L.	MP	HP	HP
24.	<i>Verbascum thapsus</i> L.	NP	NP	RP
D. Grasses				
25.	<i>Cymbopogon</i> Sp.	MP	HP	HP
26.	<i>Cynodon dactylon</i> (L.) Pers.	MP	HP	HP
27.	<i>Phragmites karka</i> Trin ex Steud	LP	MP	HP
28.	<i>Saccharum spontaneum</i> L.	MP	MP	HP

Table 19. Ca (mg/l) contents at three phenological stages in some plants of Mastuj Valley, Hindukush Range, Pakistan.

S.NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post-reproductive stage	
A. Trees					
1.	<i>Betula utilis</i> D. Don.	86.32	90.94	118.7	98.65
2.	<i>Elaeagnus angustifolia</i> L.	64.00	46.29	92.75	67.68
3.	<i>Hippophae rhamnoides</i> L.	32.38	15.94	102.6	50.30
4.	<i>Juniperus excelsa</i> M. Bieb.	133.8	219.1	127.8	160.23
5.	<i>Tamarix dioica</i> Rox ex Roth.	100.4	114.2	206.5	140.36
Average		83.38	97.29	129.67	103.44
B. Shrubs					
6.	<i>Acantholimon longiscapum</i> Bokhari.	28.50	36.02	36.49	33.67
7.	<i>Berberis lycium</i> Royle.	48.10	107.3	135.7	97.03
8.	<i>Capparis spinosa</i> L.	120.1	127.5	170.1	139.23
9.	<i>Ephedra gerardiana</i> L.	105.2	131.0	136.9	124.37
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	102.0	118.6	189.8	136.8
11.	<i>Myricaria elegans</i> Royle.	216.6	133.8	229.7	193.37
12.	<i>Rosa webbiana</i> Wall ex Royle.	104.1	224.7	55.13	127.98
13.	<i>Sophora mollis</i> (Royle.) Baker.	85.60	163.6	224.4	157.87
Average		101.27	130.31	147.27	126.29
C. Herbs /Forbs					
14.	<i>Artemisia parviflora</i> Roxb.	75.92	43.23	64.02	61.05
15.	<i>Cichorium intybus</i> L.	133.8	106.6	152.3	130.9
16.	<i>Datura stramonium</i> L.	188.7	203.0	230.4	207.37

17.	<i>Ferula jaeschkeana</i> Vatke.	90.73	216.3	111.7	139.77
18.	<i>Glycyrrhiza glabra</i> L.	63.41	51.89	168.2	94.5
19.	<i>Mentha longifolia</i> (L.) Huds.	127.4	137.8	227.4	164.2
20.	<i>Nepeta cataria</i> L.	138.7	99.67	170.5	136.29
21.	<i>Rheum emodi</i> Wall ex Meissn.	231.2	23.69	224.6	159.83
22.	<i>Salvia nubicola</i> Wall ex Sweet.	55.62	61.81	130.9	82.77
23.	<i>Trifolium repens</i> L.	104.6	97.51	118.2	106.77
24.	<i>Verbascum thapsus</i> L.	69.90	71.78	114.7	85.46
Average		116.38	101.20	155.72	124.44
D. Grasses					
25.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler	94.85	28.47	34.31	52.543
26.	<i>Cynodon dactylon</i> (L.) Pers. <i>Phragmites karka</i> (Retz.)	38.24	49.17	56.58	47.100
27.	Trin ex Steud.	64.41	62.14	16.36	47.637
28.	<i>Saccharum spontaneum</i> L.	22.88	24.20	19.24	22.107
Average		55.095	40.995	31.622	42.347

2. Potassium (K)

Among trees, the maximum K (27.03 mg/l) contents were recorded for *Hippophae rhamnoides* at post-reproductive stage (Table 20). It was followed by 27.02 mg/l at post-reproductive stage of *Juniperus excelsa* and by *Tamarix dioica* with 27.02 mg/l at reproductive stage. On the average, *Hippophae* had the highest K (27 mg/l) contents, followed by *Juniperus* (26.99 mg/l) and *Betula* (26.96 mg/l). Among the phenological stages as a whole for trees, the reproductive stage had the highest K contents (26.98 mg/l), followed by pre-reproductive stage (26.96 mg/l) and post-reproductive stage (21.92 mg/l). Among the individual species, it was observed that K contents increased with the maturity in *Hippophae* and *Juniperus*. Potassium was highest at reproductive stage than the other stages in *Elaeagnus* and *Tamarix*. In *Betula* it was (26.95 mg/l) at pre-reproductive stage and remained the same (26.97 mg/l) at both the reproductive and post-reproductive stages. In shrubs, maximum K contents were recorded in *Sophora mollis* (27.08 mg/l) at post-reproductive stage, followed by *Myricaria elegans* (27.07 mg/l) at post-reproductive stage and *Acantholimon longiscapum* (27.05 mg/l) at pre-reproductive stage. Thinking of the overall averages for shrubs, it was clear that *Sophora*, *Myricaria* and *Rosa webbiana* respectively had 27.07 mg/l, 27.04 mg/l and 27.01 mg/l K contents. The various stages had 26.96 mg/l, 26.96 mg/l and 26.01 mg/l K contents respectively at pre-reproductive, reproductive and post-reproductive stages. It was observed that K contents progressively increased with the maturity in *Capparis*, *Ephedra*, *Haloxylon*, *Myricaria* and *Sophora mollis*. *Acantholimon* and *Berberis* had the highest concentration at pre-reproductive stage than the other stages. *Rosa webbiana* had the highest (27.04 mg/l) contents at reproductive stage, less (26.98 mg/l) at post-reproductive stage and medium (27.01 mg/l) at pre-reproductive stage (Table 20). In herbs, highest K contents were noticed in *Artemisia parviflora* (27.07 mg/l) at post-reproductive stage. It was followed by *Datura stramonium* (27.03 mg/l) at pre-reproductive stage and *Glycyrrhiza glabra* (27.01 mg/l) at pre-reproductive stage. On the average, *Artemisia*, *Glycyrrhiza* and *Datura* respectively had 26.99 mg/l, 26.96 mg/l and 26.91 mg/l K contents. As a whole various phenological stages had 26.86 mg/l, 26.82 mg/l and 23.14 mg/l K contents respectively at pre-reproductive, reproductive and post-reproductive stages. Potassium contents generally showed increasing trend with the

maturity in *Artemisia*, *Cichorium*, *Mentha*, *Nepeta* and *Trifolium repens*. While in *Datura*, *Glycyrrhiza*, *Salvia* and *Verbascum thapsus* it was highest at pre-reproductive stage than the other stages. In case of *Ferula jaeschkeana* maximum K contents (26.71 mg/l) were noticed at reproductive stage and in *Rheum emodi* K was lowest (6.481 mg/l) at post-reproductive stage. Maximum K contents among grasses, were recorded for *Calamogrostris pseudophragmites* (26.95 mg/l) at reproductive stage, which was followed by *Saccharum spontaneum* (26.94 mg/l) at post-reproductive stage and *Phragmites karka* (26.92 mg/l) at reproductive stage. Based on the average values *Saccharum*, *Cynodon* and *Calamogrostris* respectively had 26.93 mg/l, 26.82 mg/l and 22.99 mg/l K contents. Tracing the trend on individual species basis, it was seen that K contents increased with the maturity in *Cynodon* and *Saccharum* but *Calamogrostris* and *Phragmites* had maximum at reproductive stage than the other stages (Fig. 9, Table 20). Anova showed that K contents exhibited highly significant variation among phenological stages at α 0.01 and non-significant variation among plant species at α 0.05 (Table 32).

3. Magnesium (Mg)

Table 21 shows the Mg concentration of various plants. It was seen that the highest level of Mg among trees was recorded for *Tamarix dioica* (20.92 mg/l) at post-reproductive stage, followed by *Elaeagnus angustifolia* (15.31 mg/l) at post-reproductive stage and *Juniperus excelsa* (14.13 mg/l) at post-reproductive stage (Table 21). On the average, *Tamarix* had the highest Mg (18.07 mg/l) contents, followed by *Elaeagnus* (13.71 mg/l) and *Juniperus* (12.11 mg/l). Among the phenological stages as a whole for trees, it was seen that post-reproductive stage had the highest Mg (14.51 mg/l) contents, followed by pre-reproductive stage (12.83 mg/l) and reproductive stage (11.32 mg/l). Tracing the trend on individual species basis, it was recorded that Mg contents progressively increased with the maturity in *Elaeagnus*, *Hippophae*, *Juniperus* and *Tamarix dioica*. Mg contents decreased from pre-reproductive to post-reproductive stage respectively with 12.54 mg/l, 11.05 mg/l and 10.95 mg/l in *Betula*. Maximum Mg contents among shrubs, were recorded in *Myricaria elegans* (23.59 mg/l) at post-reproductive stage, followed by *Haloxylon griffithii* (19.46 mg/l) at pre-reproductive stage and *Capparis spinosa* (14.85 mg/l) at post-reproductive stage. Based on the overall

averages for shrubs, it was found that *Myricaria*, *Haloxylon* and *Capparis* respectively had 21.56 mg/l, 17.41 mg/l and 13.22 mg/l Mg contents. Various phenological stages indicated that there was 13.96 mg/l, 13.42 mg/l and 13.24 mg/l Mg contents respectively at post-reproductive, reproductive and pre-reproductive stages (Table 21). The concentration of Mg in individual species showed that Mg contents increased with the maturity in *Capparis*, *Ephedra* and *Myricaria*. *Acantholimon*, *Berberis*, *Rosa* and *Sophora* exhibited the highest concentration at reproductive stage than at other stages. Mg was highest (19.46 mg/l) at pre-reproductive stage, less (13.91 mg/l) at reproductive stage and medium (18.86 mg/l) at post-reproductive stage in *Haloxylon*. In herbs, highest level of Mg was found in *Datura stramonium* (24.16 mg/l) at reproductive stage, followed by *Nepeta cataria* (20.39 mg/l) at post-reproductive stage and *Artemisia parviflora* (20.12 mg/l) at reproductive stage. Based on the average value *Datura*, *Artemisia* and *Nepeta* respectively had 20.75 mg/l, 15.55 mg/l and 15.17 mg/l Mg contents. Among the various phenological stages the concentration was 12.87 mg/l, 12.81 mg/l and 12.36 mg/l Mg contents respectively at reproductive, post-reproductive and pre-reproductive stages. Thinking of individual species, it was recorded that Mg contents increased with the maturity in *Cichorium*, *Glycyrrhiza*, *Mentha*, *Nepeta* and *Verbascum thapsus*. *Artemisia*, *Datura*, *Ferula* and *Trifolium repens* had maximum level of Mg at reproductive stage than the other stages. *Rheum emodi* and *Salvia nubicola* recorded highest concentration at pre-reproductive stage than the other stages. In grasses, Mg was highest in *Phragmites karka* (12.80 mg/l) at pre-reproductive stage, followed by *Calamogrostris pseudophragmites* (9.874 mg/l) at pre-reproductive stage and *Cynodon dactylon* (9.797 mg/l) at pre-reproductive stage. On the average, *Phragmites*, *Cynodon* and *Calamogrostris* respectively had 9.78 mg/l, 9.73 mg/l and 9.20 mg/l Mg contents. The various phenological stages exhibited 9.93 mg/l, 9.12 mg/l and 8.24 mg/l Mg contents. In the case of individual species, it was observed that *Calamogrostris*, *Cynodon* and *Phragmites* had the highest Mg contents at pre-reproductive stage than the other stages. *Saccharum spontaneum* showed the highest (8.413 mg/l) concentration at reproductive stage, medium (7.337 mg/l) at post-reproductive stage and (7.266) mg/l at pre-reproductive stage (Fig. 10, Table 21). Statistical analysis revealed that Mg contents

showed non-significant variation among the phenological stages at α 0.05 and exhibited highly significant variation among the plant species at α 0.01 (Table 32).

b. Microminerals

1. Aluminum (Al)

Among trees, the highest level of Al was 7.164 mg/l recorded in *Tamarix dioica* at post-reproductive stage, which was followed by 5.124 mg/l at reproductive stage of *Juniperus excelsa* and by *Betula utilis* with 2.721 mg/l at pre-reproductive stage (Table 22). On the average, *Juniperus excelsa* had the highest level of Al (3.286 mg/l), followed by *Tamarix dioica* (2.97 mg/l) and *Betula utilis* (1.849 mg/l). Considering the phenological stages as a whole for trees, it was seen that post-reproductive stage had the highest (2.785 mg/l) Al contents, followed by reproductive stage (2.042 mg/l) and pre-reproductive stage (1.508 mg/l). Taking the trend in individual species, it was observed that in *Betula utilis* Al contents decreased from pre-reproductive to post-reproductive stage respectively with 2.721 mg/l, 1.611 mg/l and 1.215 mg/l. Al contents progressively increased towards maturity in *Hippophae rhamnoides* and *Tamarix dioica*. While in *Elaeagnus angustifolia* Al was highest at post-reproductive stage, lowest at reproductive stage and inbetween them was pre-reproductive stage. *Juniperus excelsa* has highest Al at reproductive stage (5.124 mg/l), lowest at post-reproductive stage (2.128 mg/l) and medium at pre-reproductive stage (2.605 mg/l). Among the shrubs, maximum Al contents were found in *Myricaria elegans* (10.17 mg/l) at post-reproductive stage, followed by (7.223 mg/l) and (4.430 mg/l) at post-reproductive and reproductive stages by *Acantholimon longiscapum*. Considering the overall average for shrubs it was seen that *Myricaria*, *Acantholimon* and *Ephedra* respectively had 5.710 mg/l, 5.174 mg/l and 1.653 mg/l Al contents. As a whole, among the various stages Al contents were 3.231 mg/l, 1.840 mg/l and 1.34 mg/l, respectively at post-reproductive, reproductive and pre-reproductive stages (Table 22). Considering the trend for accumulation of Al in individual shrubs, it was seen that there was progressive increase with the maturity of plants in *Acantholimon*, *Berberis*, *Haloxylon*, *Myricaria* and *Sophora mollis*.

Table 20. K (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan..

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	26.95	26.97	26.97	26.96
2.	<i>Elaeagnus angustifolia</i> L.	26.91	26.95	26.94	26.93
3.	<i>Hippophae rhamnoides</i> L.	26.98	26.99	27.03	27
4.	<i>Juniperus excelsa</i> M. Bieb.	26.99	26.98	27.02	26.99
5.	<i>Tamarix dioica</i> Rox ex Roth.	26.97	27.02	1.627	18.54
	Average	26.96	26.98	21.92	25.28
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	27.05	27.03	19.09	24.39
7.	<i>Berberis lycium</i> Royle.	27.00	26.90	26.98	26.96
8.	<i>Capparis spinosa</i> L.	26.77	26.80	26.89	26.82
9.	<i>Ephedra gerardiana</i> L.	26.88	26.96	26.96	26.93
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	26.87	26.85	27.03	26.92
11.	<i>Myricaria elegans</i> Royle.	27.03	27.02	27.07	27.04
12.	<i>Rosa webbiana</i> Wall ex Royle.	27.01	27.04	26.98	27.01
13.	<i>Sophora mollis</i> (Royle) Baker.	27.07	27.05	27.08	27.07
	Average	26.96	26.96	26.01	26.64

14.	C. Herbs / Forbs				
15.	<i>Artemisia parviflora</i> Roxb.	27.00	26.89	27.07	26.99
16.	<i>Cichorium intybus</i> L.	26.74	26.76	26.82	26.77
17.	<i>Datura stramonium</i> L.	27.03	26.85	26.86	26.91
18.	<i>Ferula jaeschkeana</i> Vatke.	26.69	26.71	26.70	26.7
19.	<i>Glycyrrhiza glabra</i> L.	27.01	26.88	26.98	26.96
20.	<i>Mentha longifolia</i> (L.) Huds.	26.80	26.86	26.91	26.86
21.	<i>Nepeta cataria</i> L.	26.83	26.88	26.89	26.87
	<i>Rheum emodi</i> Wall ex Meissn.	26.80	26.80	6.481	20.02
22.	<i>Salvia nubicola</i> Wall ex Sweet.	26.88	26.70	26.78	26.79
23.	<i>Trifolium repens</i> L.				
24.	<i>Verbascum thapsus</i> L.	26.74	26.77	26.87	26.79
		26.92	26.91	6.162	19.99
Average		26.86	26.82	23.14	25.60
	D. Grasses				
25.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	26.88	26.95	15.13	22.99
26.	<i>Cynodon dactylon</i> (L.) Pers.	26.74	26.83	26.89	26.82
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	26.87	26.92	8.454	20.75
28.	<i>Saccharum spontaneum</i> L.	26.91	26.93	26.94	26.93
Average		26.85	26.91	19.35	24.37

Table 21. Mg (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	12.54	11.05	10.95	11.51
2.	<i>Elaeagnus angustifolia</i> L.	13.14	12.68	15.31	13.71
3.	<i>Hippophae rhamnoides</i> L.	9.081	6.789	11.22	9.03
4.	<i>Juniperus excelsa</i> M. Bieb.	11.42	10.78	14.13	12.11
5.	<i>Tamarix dioica</i> Rox ex Roth.	17.98	15.31	20.92	18.07
Average		12.83	11.32	14.51	12.89
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	8.008	8.867	8.355	8.41
7.	<i>Berberis lycium</i> Royle.	8.685	11.34	10.59	10.20
8.	<i>Capparis spinosa</i> L.	10.86	13.96	14.85	13.22
9.	<i>Ephedra gerardiana</i> L.	13.27	12.73	13.28	13.09
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	19.46	13.91	18.86	17.41
11.	<i>Myricaria elegans</i> Royle.	22.28	18.80	23.59	21.56
12.	<i>Rosa webbiana</i> Wall ex Royle.	11.64	14.43	9.833	11.97
13.	<i>Sophora mollis</i> (Royle.) Baker.	11.71	13.30	12.36	12.46
Average		13.24	13.42	13.96	13.54

	C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i> Roxb.	15.86	20.12	10.68	15.55
15.	<i>Cichorium intybus</i> L.	10.68	10.25	10.76	10.56
16.	<i>Datura stramonium</i> L.	18.19	24.16	19.90	20.75
17.	<i>Ferula jaeschkeana</i> Vatke.	10.13	10.62	9.097	9.94
18.	<i>Glycyrrhiza glabra</i> L.	10.24	11.63	12.59	11.49
19.	<i>Mentha longifolia</i> (L.) Huds.	11.57	11.28	11.94	11.60
20.	<i>Nepeta cataria</i> L.	13.94	11.17	20.39	15.17
21.	<i>Rheum emodi</i> Wall ex Meissn.	13.25	10.37	12.73	12.12
22.	<i>Salvia nubicola</i> Wall ex Sweet.	11.45	10.34	11.18	10.99
23.	<i>Trifolium repens</i> L.	10.61	10.98	10.95	10.85
24.	<i>Verbascum thapsus</i> L.	10.01	10.58	10.67	10.42
Average		12.36	12.87	12.81	12.68
	D. Grasses				
25.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	9.874	8.535	9.193	9.20
26.	<i>Cynodon dactylon</i> (L.) Pers.	9.797	9.697	9.709	9.73
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	12.80	9.840	6.712	9.78
28.	<i>Saccharum spontaneum</i> L.	7.266	8.413	7.337	7.67
Average		9.93	9.12	8.24	9.09

In *Capparis spinosa* and *Rosa webbiana* Al was highest at reproductive stage than other stages. In herbs, maximum Al contents were found in *Verbascum thapsus* (16.96 mg/l) at post-reproductive stage, followed by (14.71 mg/l) and (9.791 mg/l) by *Mentha longifolia* and *Rheum emodi* at post-reproductive and pre-reproductive stages. Considering the overall averages for herbs, it was seen that *Verbascum thapsus*, *Mentha longifolia* and *Salvia nubicola*, respectively had 9.285 mg/l, 7.638 mg/l and 4.456 mg/l Al contents. As a whole various stages had 5.632 mg/l, 3.621 mg/l and 2.837 mg/l, respectively at post-reproductive, pre-reproductive and reproductive stages. Taking the trend for accumulation of Al in individual herbs, it was observed that there was progressive increase in Al concentration with the maturity of plants in *Artemisia parviflora*, *Datura stramonium*, *Glycyrrhiza glabra*, *Mentha longifolia*, *Nepeta cateria*, *Salvia nubicola* and *Verbascum thapsus*. In *Cichorium intybus*, *Rheum emodi* and *Trifolium repens* Al contents were highest at pre-reproductive stages while in *Ferula jaeschkeana* it was highest at reproductive stage. In grasses, maximum Al content was observed in *Cynodon dactylon* (6.126 mg/l) at post-reproductive stage, followed by *Phragmites karka* (5.022 mg/l) and *Calamogrostris pseudophragmites* (3.329 mg/l) at post-reproductive stages. The overall averages for grasses showed that *Cynodon*, *Phragmites* and *Saccharum spontaneum* had 3.435 mg/l, 3.058 mg/l and 2.344 mg/l Al contents. As a whole among various stages (Fig. 11, Table 22), Al level was 4.315 mg/l, 2.438 mg/l and 1.409 mg/l, respectively at post-reproductive, reproductive and pre-reproductive stages. It was observed that Al contents increased with the maturity in all the grasses. Anova showed that Al contents exhibited highly significant variation among the phenological stages and plant species at α 0.01 (Table 32).

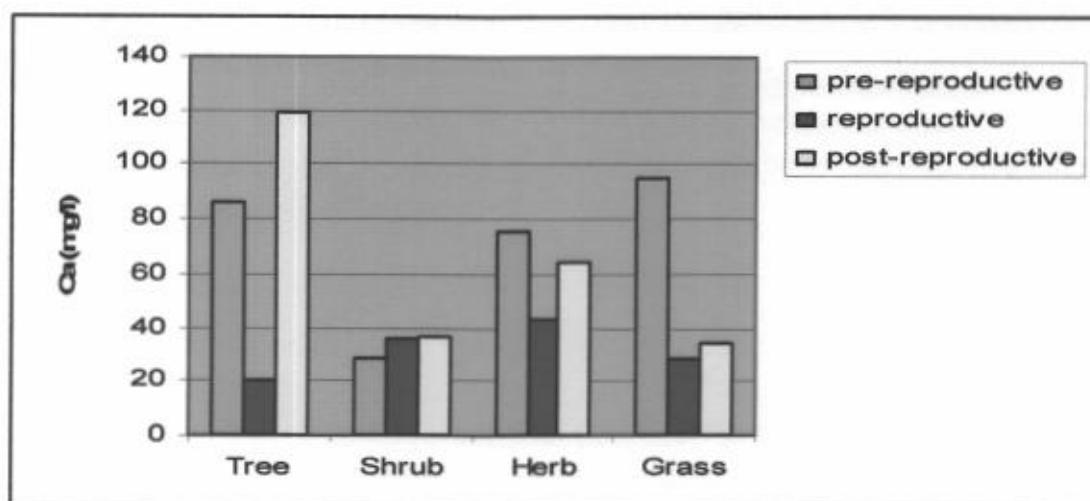


Fig. 8. Graphical representation of Ca contents in different plant species at three phenological stages.

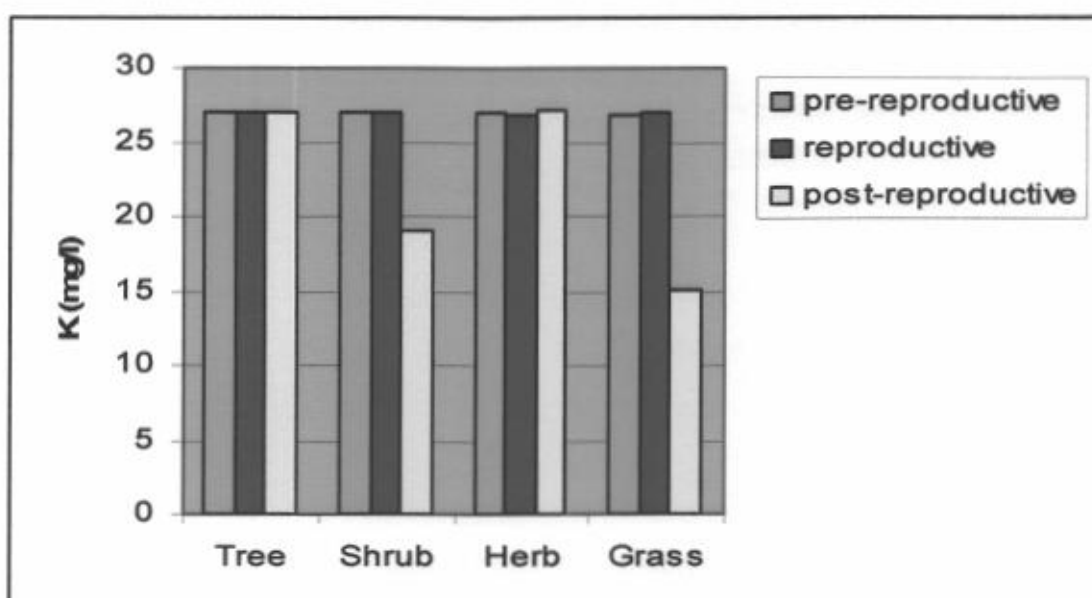


Fig. 9. Graphical representation of K contents in different plant species at three phenological stages.

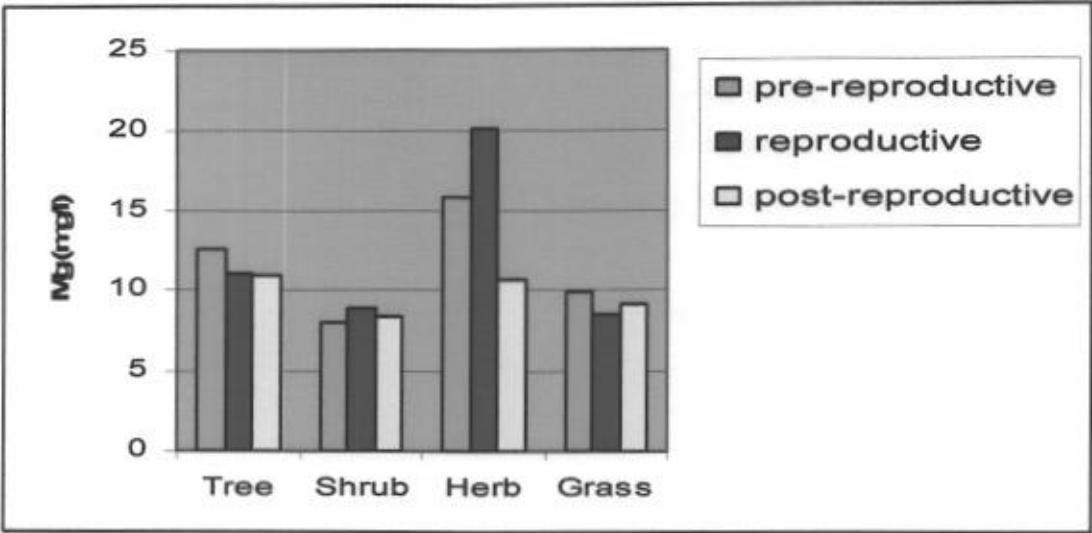


Fig. 10. Graphical representation of Mg contents in different plant species at three phenological stages.

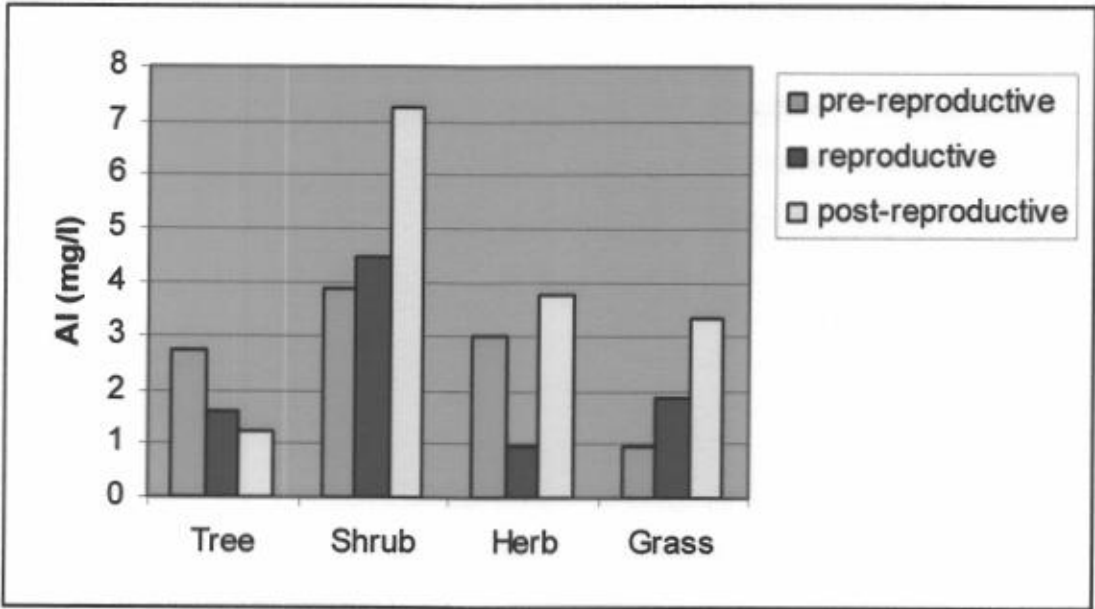


Fig. 11. Graphical representation of Al contents in different plant species at three phenological stages.

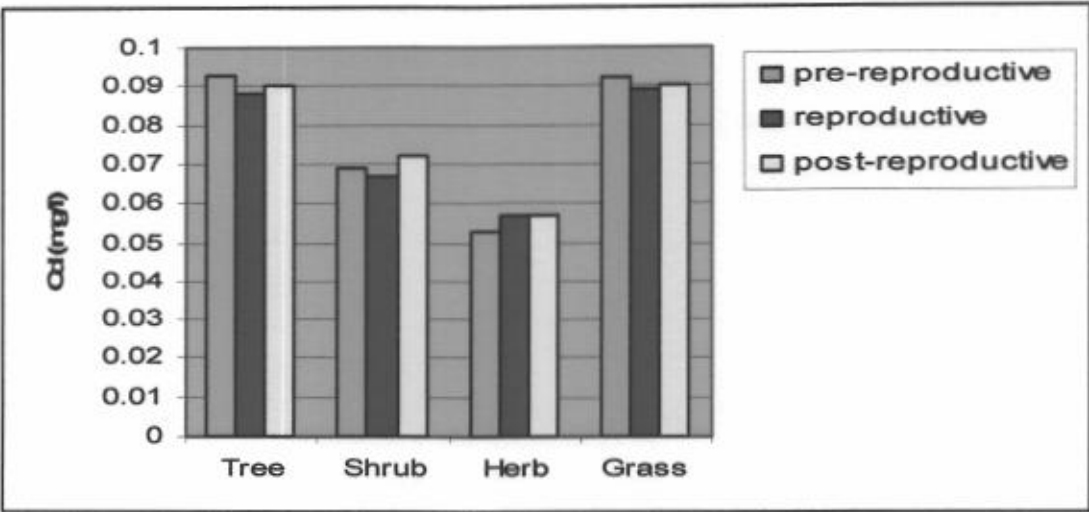


Fig. 12. Graphical representation of Cd contents in different plant species at three phenological stages.

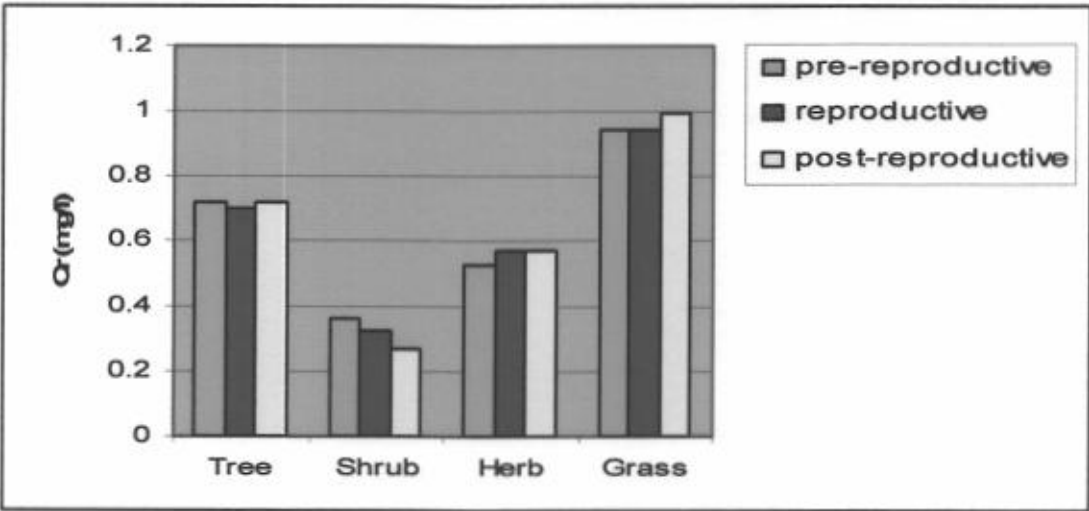


Fig. 13. Graphical representation of Cr contents in different plant species at three phenological stages.

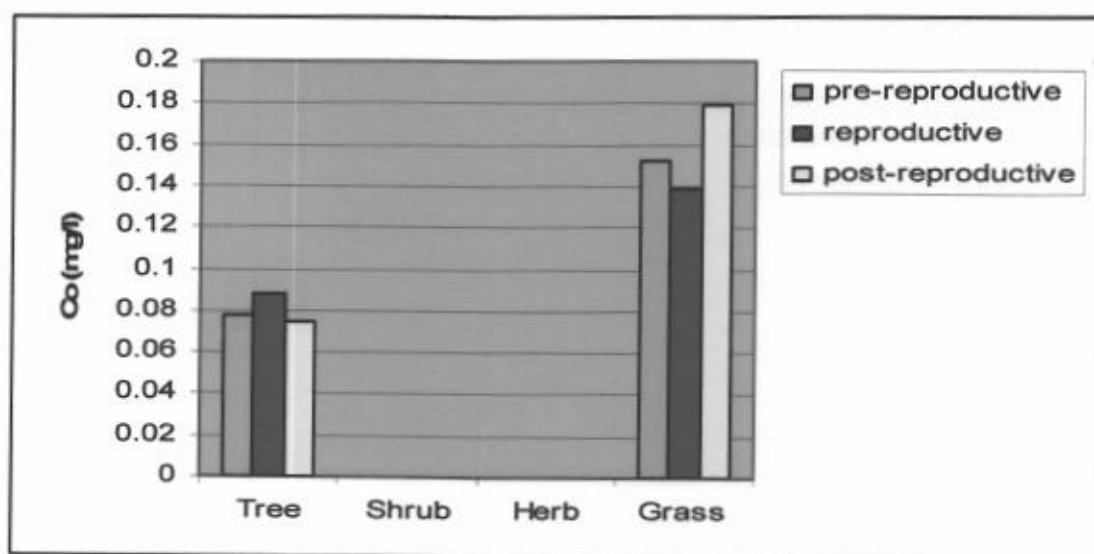


Fig. 14. Graphical representation of Co contents in different plant species at three phenological stages.

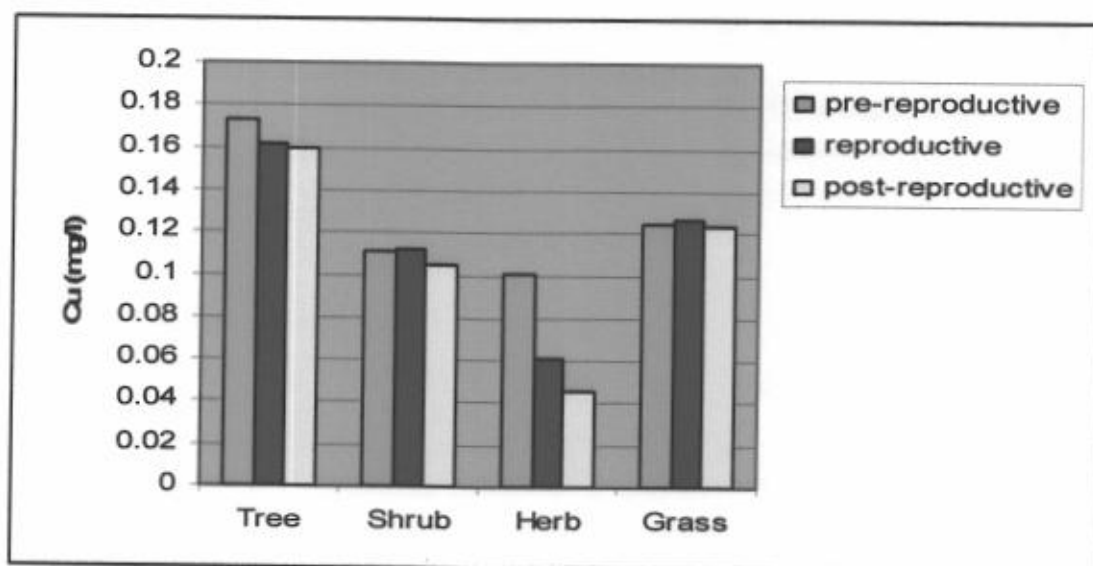


Fig. 15. Graphical representation of Cu contents in different plant species at three phenological stages.

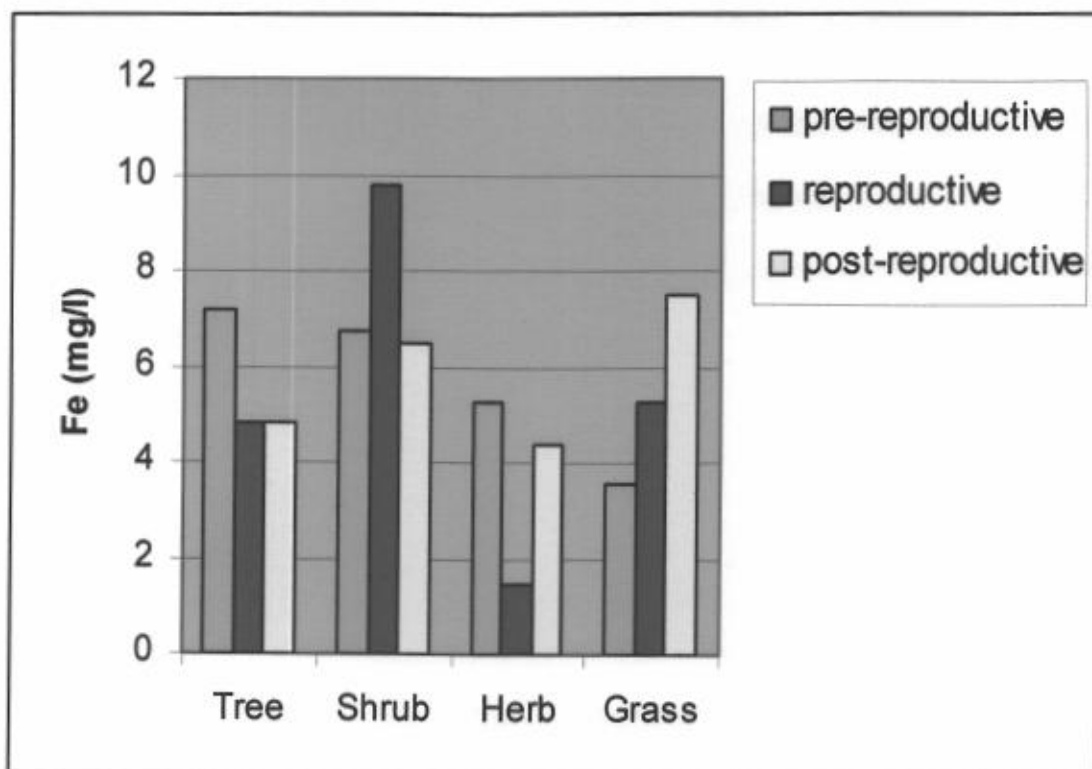


Fig. 16. Graphical representation of Fe contents in different plant species at three phenological stages.

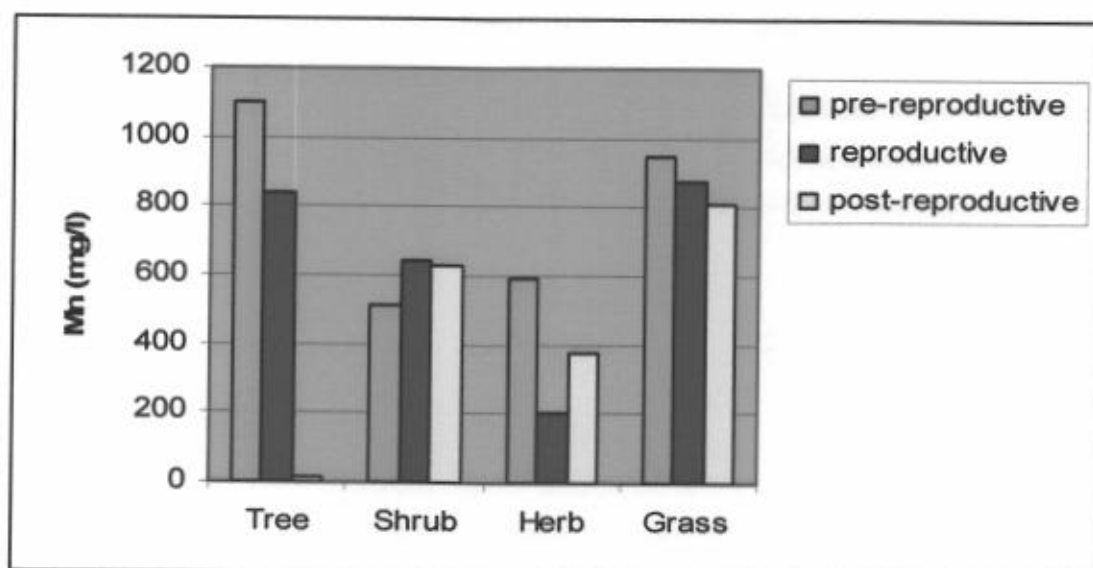


Fig. 17. Graphical representation of Mn contents in different plant species at three phenological stages.

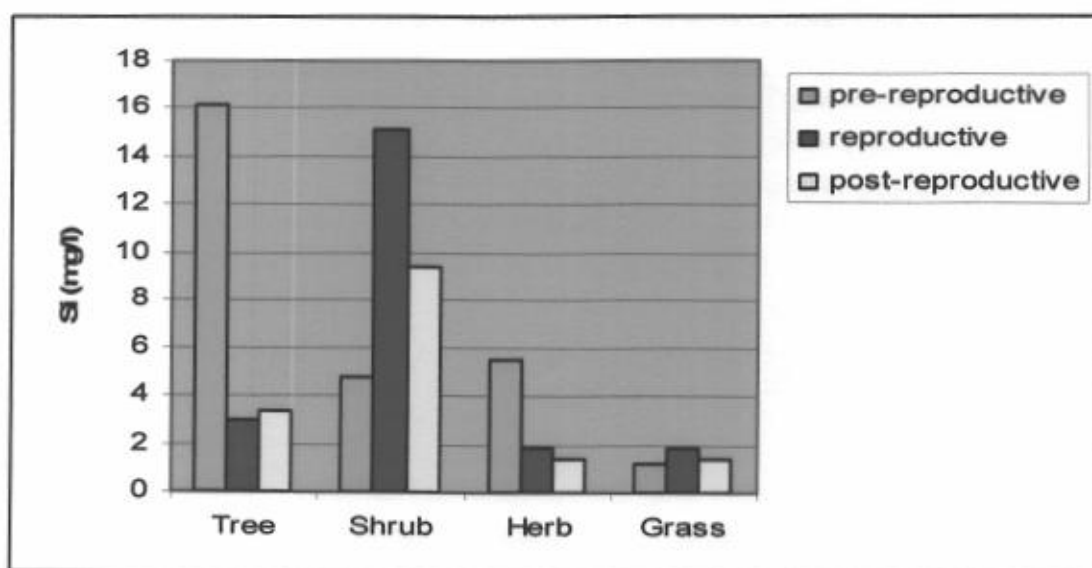


Fig. 18. Graphical representation of Si contents in different plant species at three phenological stages.

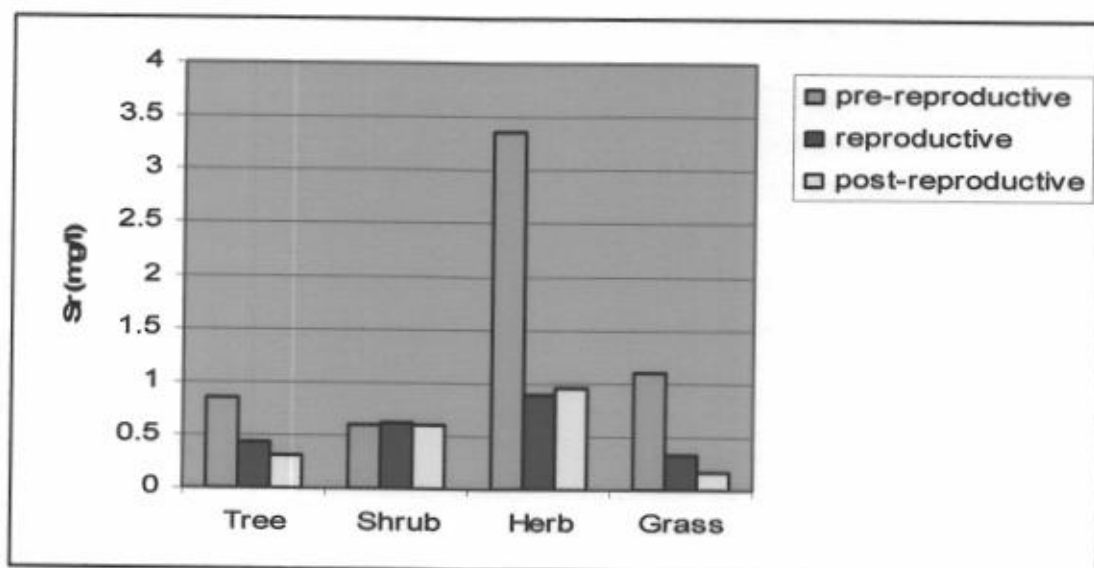


Fig. 19. Graphical representation of Sr contents in different plant species at three phenological stages.

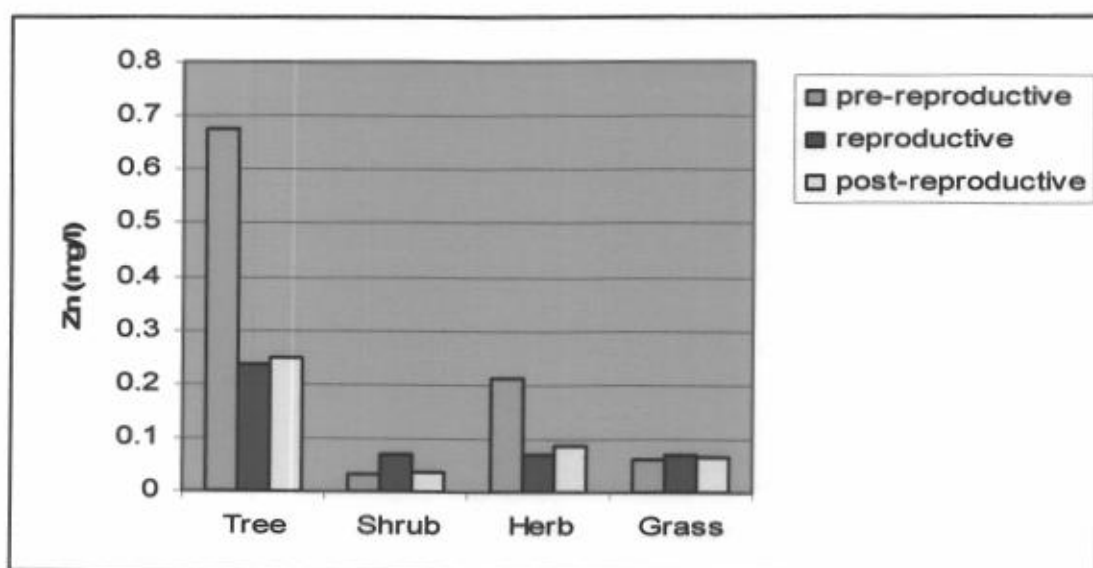


Fig. 20. Graphical representation of Zn contents in different plant species at three phenological stages.

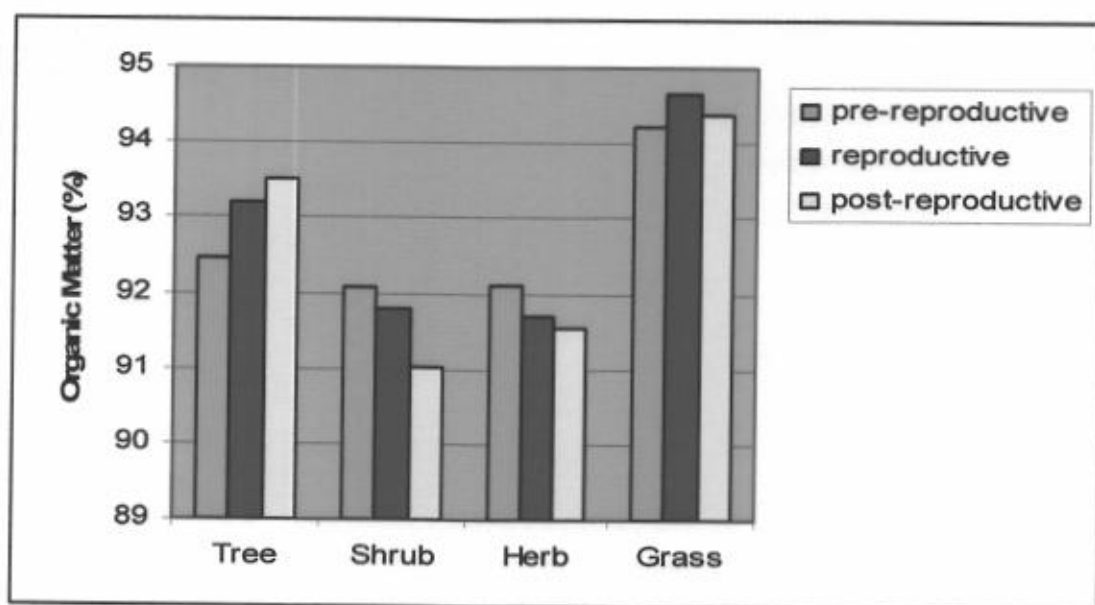


Fig. 21. Graphical representation of Organic matter contents in different plant species at three phenological stages.

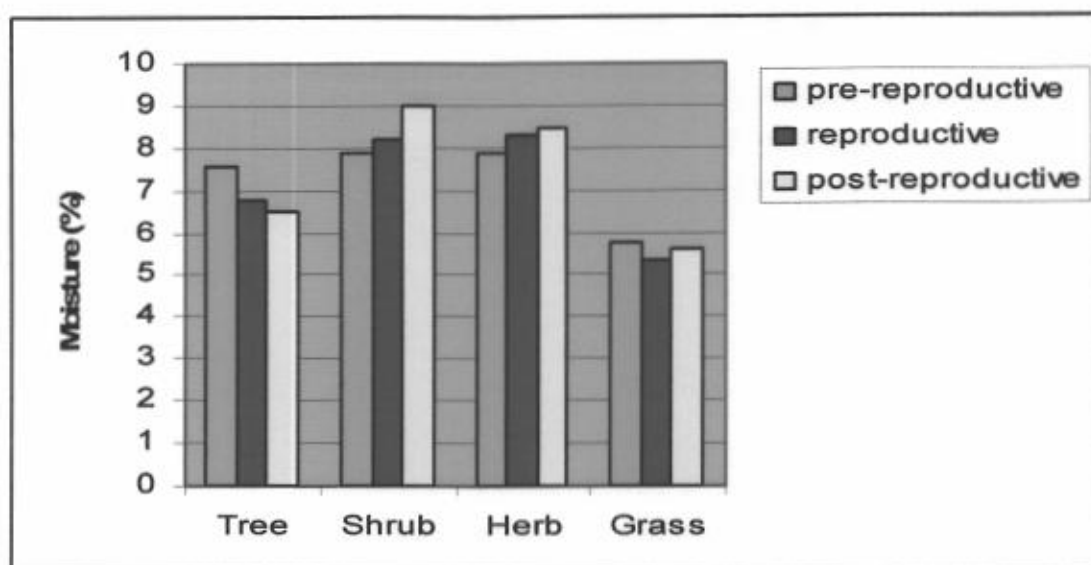


Fig. 22. Graphical representation of Moisture contents in different plant species at three phenological stages.

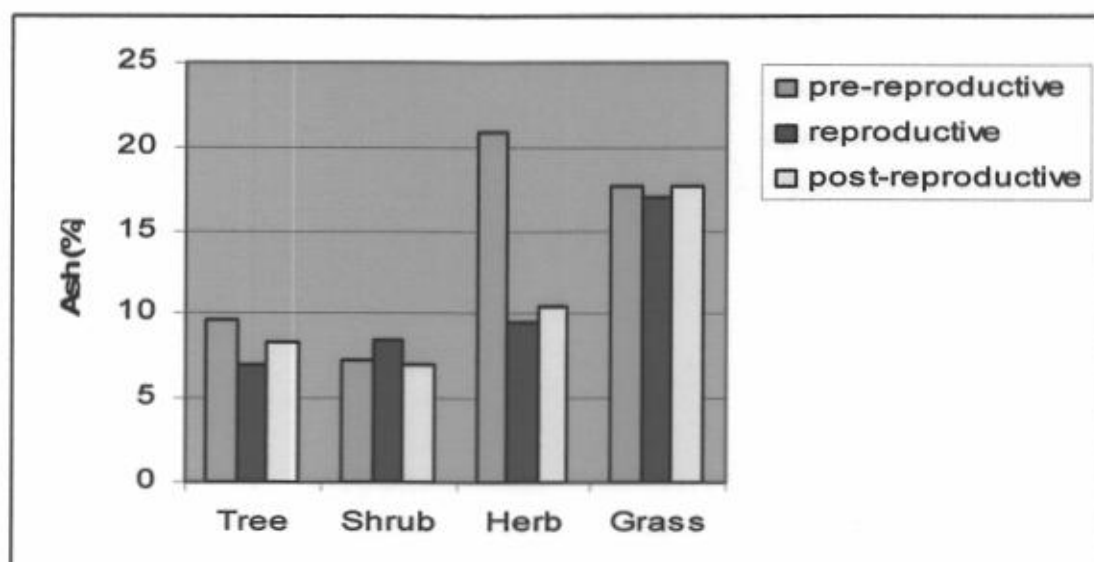


Fig. 23. Graphical representation of Ash contents in different plant species at three phenological stages.

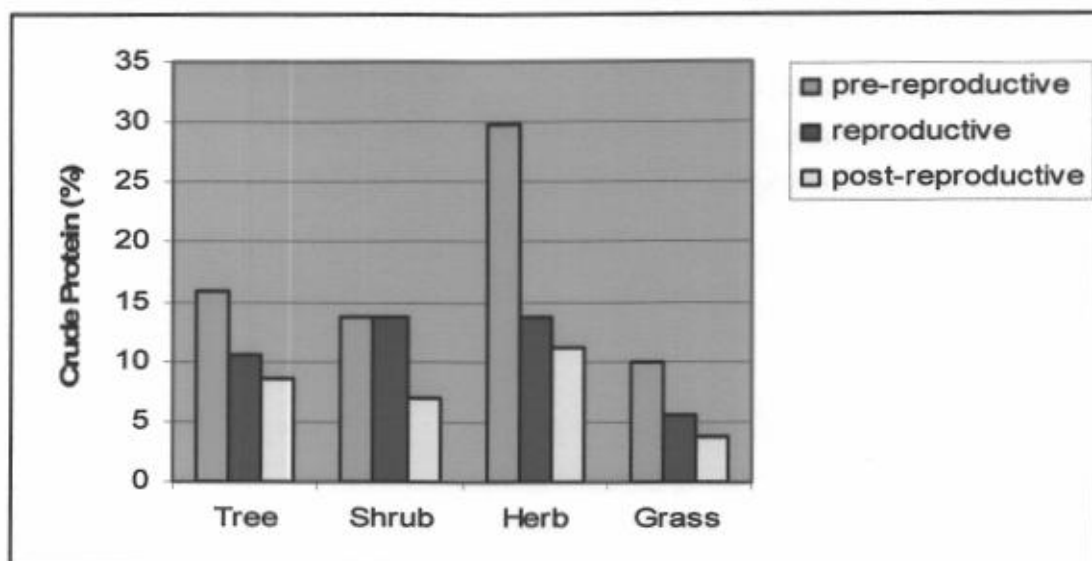


Fig. 24. Graphical representation of Crude protein contents in different plant species at three phenological stages.

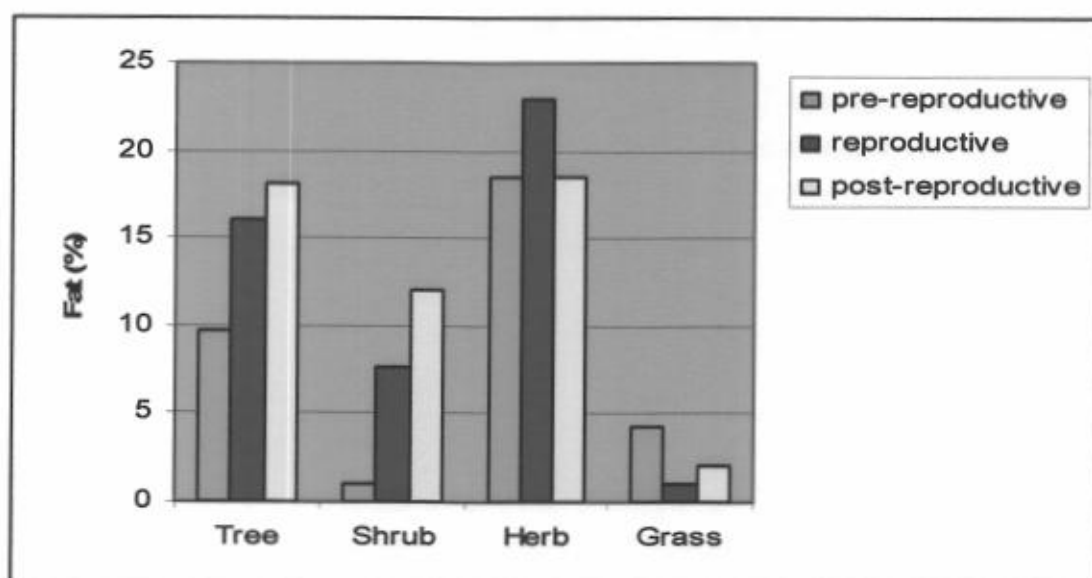


Fig. 25. Graphical representation of Fat contents in different plant species at three phenological stages.

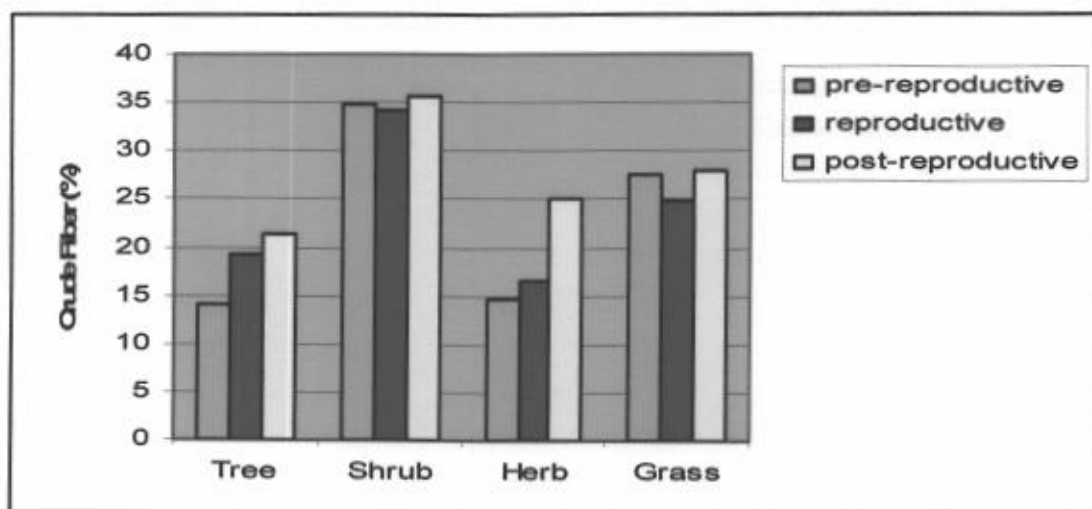


Fig. 26. Graphical representation of Crude fiber contents in different plant species at three phenological stages.

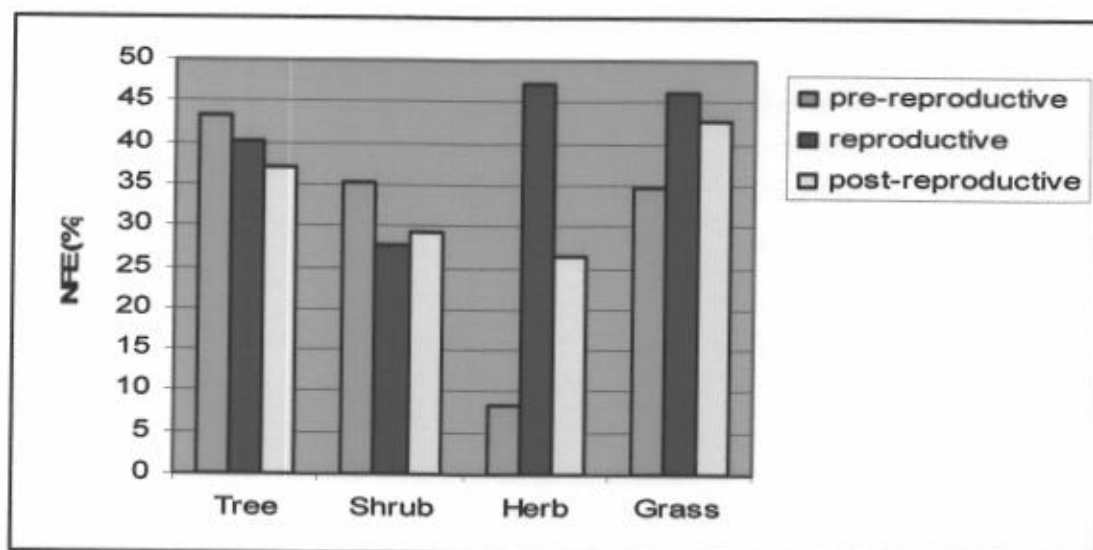


Fig. 27. Graphical representation of NFE contents in different plant species at three phenological stages.

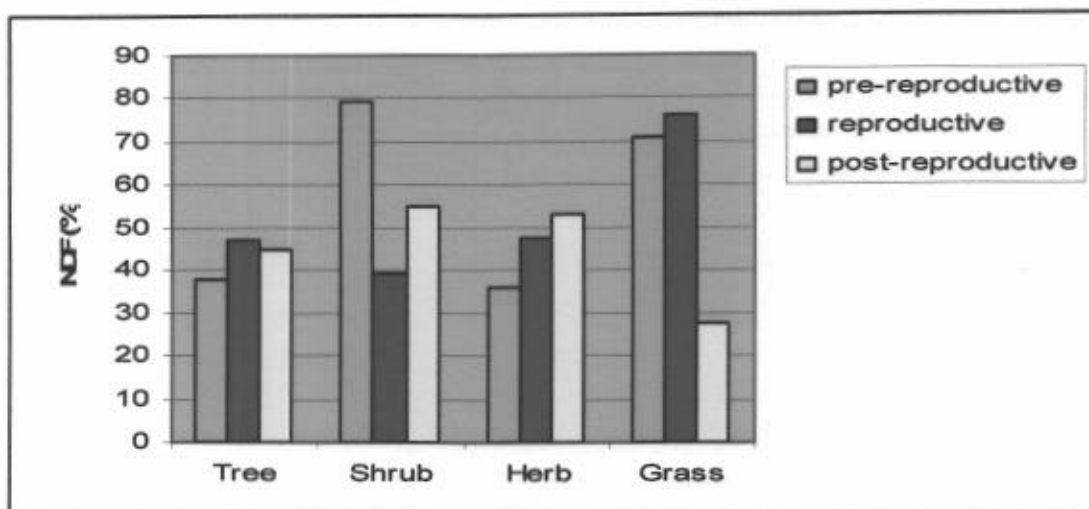


Fig. 28. Graphical representation of NDF contents in different plant species at three phenological stages.

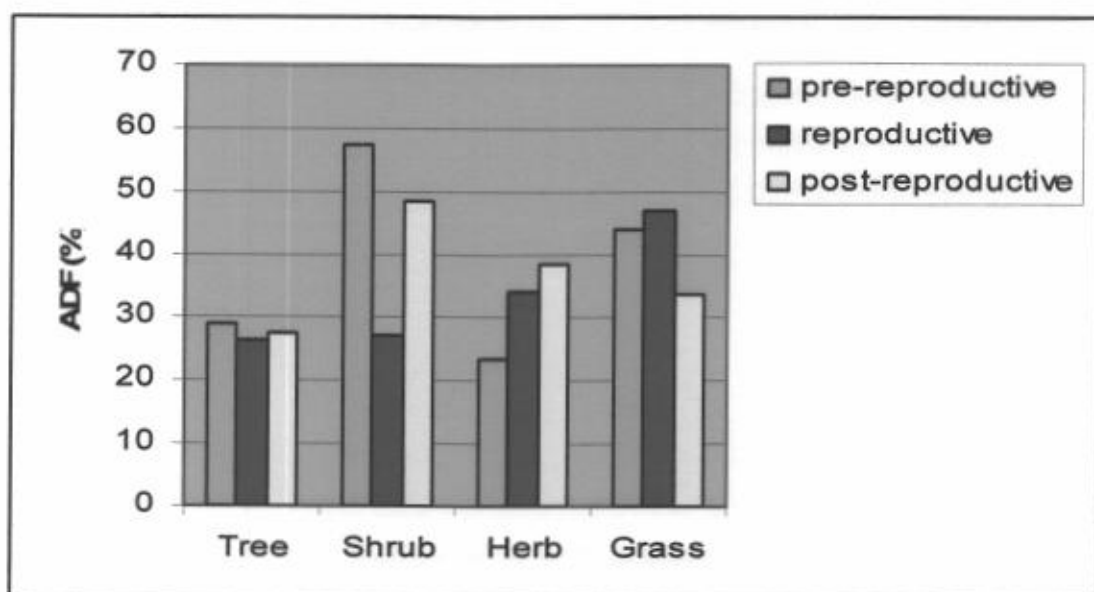


Fig. 29. Graphical representation of ADF contents in different plant species at three phenological stages.

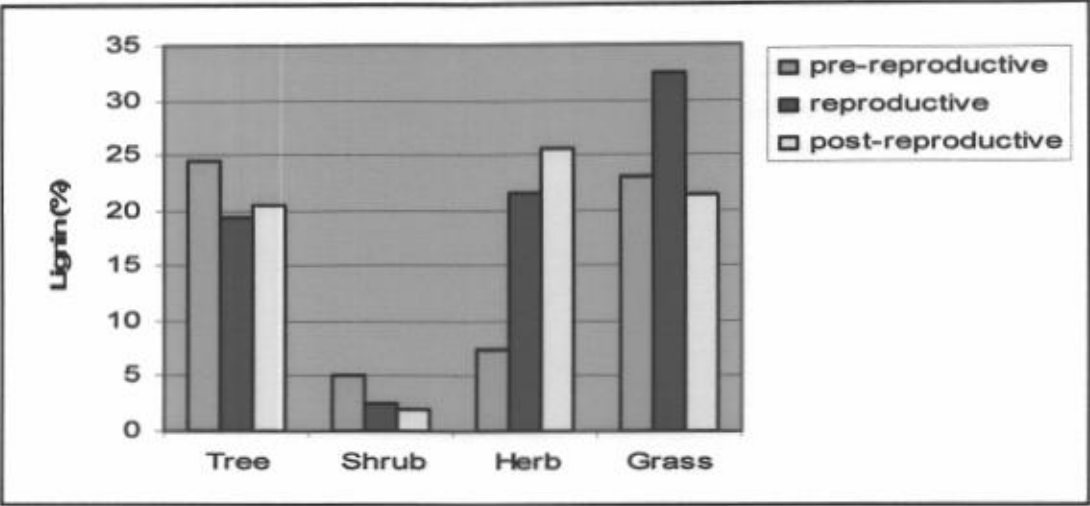


Fig. 30. Graphical representation of Lignin contents in different plant species at three phenological stages.

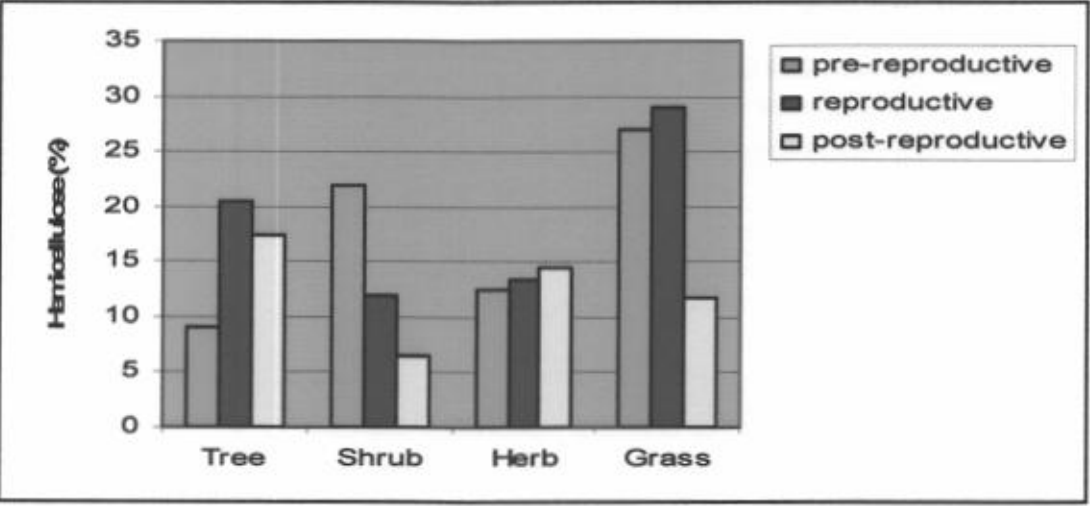


Fig. 31. Graphical representation of Hemicellulose contents in different plant species at three phenological stages.

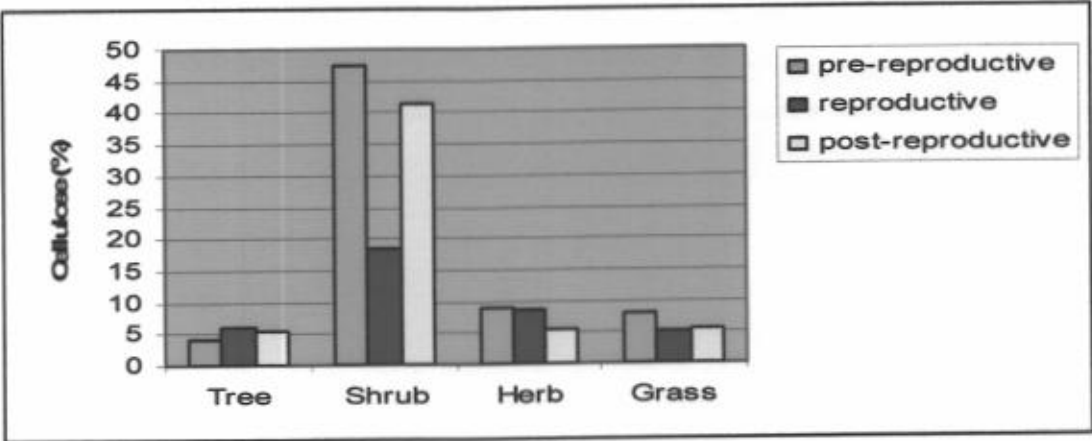


Fig. 32. Graphical representation of Cellulose contents in different plant species at three phenological stages.

Table 22. Al (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S.No.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post-reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	2.721	1.611	1.215	1.849
2.	<i>Elaeagnus angustifolia</i> L.	1.174	0.840	1.345	1.120
3.	<i>Hippophae rhamnoides</i> L.	0.627	1.304	2.074	1.335
4.	<i>Juniperus excelsa</i> M. Bieb.	2.605	5.124	2.128	3.286
5.	<i>Tamarix dioica</i> Rox ex Roth.	0.413	1.333	7.164	2.97
	Average	1.508	2.042	2.785	2.112
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	3.868	4.430	7.223	5.174
7.	<i>Berberis lycium</i> Royle.	0.622	1.181	1.839	1.214
8.	<i>Capparis spinosa</i> L.	0.00	0.927	0.522	0.483
9.	<i>Ephedra gerardiana</i> L.	1.129	0.867	2.963	1.653
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.231	0.676	1.317	0.741
11.	<i>Myricaria elegans</i> Royle.	3.801	3.188	10.17	5.710
12.	<i>Rosa webbiana</i> Wall ex Royle.	0.938	2.701	0.537	1.392
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.113	0.747	1.284	0.715
	Average	1.34	1.840	3.231	2.135

	C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i> Roxb.	2.997	0.952	3.782	2.577
15.	<i>Cichorium intybus</i> L.	3.940	1.283	2.602	2.608
16.	<i>Datura stramonium</i> L.	1.489	1.421	2.548	1.819
17.	<i>Ferula jaeschkeana</i> Vatke.	3.875	4.011	1.627	3.171
18.	<i>Glycyrrhiza glabra</i> L.	1.264	1.089	2.802	1.718
19.	<i>Mentha longifolia</i> (L.) Huds.	4.403	3.802	14.71	7.638
20.	<i>Nepeta cataria</i> L.	3.017	3.321	6.112	4.15
21.	<i>Rheum emodi</i> Wall ex Meissn.	9.791	0.920	1.802	4.171
22.	<i>Salvia nubicola</i> Wall ex Sweet.	2.948	3.264	7.155	4.456
	<i>Trifolium repens</i> L.				
23.	<i>Verbascum thapsus</i> L.	3.674	2.683	1.857	2.738
24.		2.435	8.459	16.96	9.285
Average		3.621	2.837	5.632	4.030
	D. Grasses				
25.	<i>Calamogrostris</i> <i>pseudophragmites</i> Hall. f. Koeler	0.946	1.865	3.329	2.047
26.	<i>Cynodon dactylon</i> (L.) Pers.	1.364	2.815	6.126	3.435
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	1.701	2.451	5.022	3.058
28.	<i>Saccharum spontaneum</i> L.	1.627	2.620	2.784	2.344
Average		1.409	2.438	4.315	2.721

2. Cadmium (Cd)

The results for Cd concentration is shown in Table 23. It was seen that among trees, the highest level of Cd was recorded for *Betula utilis* (0.093 mg/l) at pre-reproductive stage. It was followed by 0.090 mg/l at post-reproductive stage and 0.088 mg/l at reproductive stage. On the average, *Betula* had the maximum 0.090 mg/l level of Cd, which was followed by *Hippophae rhamnoides* (0.075 mg/l) and *Tamarix dioica* (0.021 mg/l). Across the phenological stages as a whole for trees, it was seen that post-reproductive stages had the highest level of Cd (0.040 mg/l), followed by pre-reproductive stage (0.038 mg/l) and reproductive stage (0.036 mg/l). Taking the trend in individual species (Table 23), it was observed that Cd contents increased with maturity of plants in *Elaeagnus angustifolia* and *Tamarix dioica*. In *Betula utilis* Cd was maximum (0.093 mg/l) at pre-reproductive stage, less (0.088 mg/l) at reproductive stage and medium (0.090 mg/l) at post-reproductive stage. Similar trend was also observed for *Hippophae rhamnoides*, while in *Juniperus excelsa* Cd was absent. Among shrubs, the maximum Cd contents was found in *Capparis spinosa* (0.088 mg/l) at reproductive stage. Considering the overall average among the shrubs (Table 23) it was seen that *Capparis spinosa*, *Berberis lycium* and *Acantholimon longiscapum* respectively had 0.086 mg/l, 0.083 mg/l and 0.069 mg/l Cd contents. As a whole various stages had 0.055 mg/l, 0.054 mg/l and 0.051 mg/l Cd contents respectively at post-reproductive stage, reproductive stage and pre-reproductive stages. Considering the trend for accumulation of Cd in individual shrubs, it was seen that there was a progressive increase with the maturity of plants in *Acantholimon*, *Haloxylon*, *Myricaria*, *Rosa* and *Sophora mollis*. In *Berberis lycium* and *Capparis spinosa* Cd was highest at reproductive stage than the other stages. In *Ephedra gerardiana* Cd was absent. In herbs, maximum Cd contents was found in *Cichorium intybus* (0.094 mg/l) at reproductive stage, which was followed by *Trifolium repens* (0.091 mg/l) at pre-reproductive stage and *Salvia nubicola* (0.090 mg/l) at post-reproductive stage. When the overall average was taken for herbs, it was observed that *Cichorium intybus*, *Mentha longifolia* and *Salvia nubicola* respectively had 0.091 mg/l and 0.087 mg/l Cd contents. Across various phenological stages the concentration was 0.077 mg/l, 0.076 mg/l and 0.074 mg/l respectively at post-reproductive, reproductive and pre-reproductive stages. On species basis, the trend for accumulation of Cd showed

that it increased with the maturity of plants in *Artemisia parviflora*, *Cichorium intybus*, *Ferula jaeschkeana*, *Glycyrrhiza glabra*, *Mentha longifolia*, *Rheum emodi* and *Salvia nubicola*. While in *Datura stramonium* and *Verbascum thapsus* Cd was highest at reproductive stage than the other stages. In *Nepeta cataria* Cd was highest (0.085 mg/l) at pre-reproductive stage, less (0.076 mg/l) at reproductive stage and medium (0.077 mg/l) at post-reproductive stage. Among the grasses, the highest concentration of Cd was observed in *Phragmites karka* (0.095 mg/l) at pre-reproductive stage, which was followed by *Calamogrostris pseudophragmites* (0.092 mg/l) at pre-reproductive stage. When the overall average for grasses was considered (Table 23), it was seen that *Calamogrostris pseudophragmites*, *Phragmites karka* and *Saccharum spontaneum* respectively had 0.090 mg/l, 0.089 mg/l and 0.088 mg/l Cd contents. Among the various phenological stages the overall concentration of Cd was 0.090 mg/l, 0.087 mg/l and 0.086 mg/l respectively. The trend for accumulation of Cd on individual species basis showed that Cd contents increased with maturity in *Saccharum spontaneum*. In *Calamogrostris* and *Phragmites* Cd was highest at pre-reproductive stage than the other stages. While in *Cynodon dactylon* maximum Cd (0.084 mg/l) was found at pre-reproductive stage, less (0.081 mg/l) at reproductive stage and medium (0.083 mg/l) at post-reproductive stage (Fig. 12, Table 23). Cd contents revealed non-significant variation among the phenological stages at α 0.05 and showed highly significant variation at α 0.01 among the plant species (Table 32).

3. Chromium (Cr)

Table 24 shows the concentration of Cr among investigated plants. Among the trees, the highest of Cr contents (0.724 mg/l) was recorded for *Betula utilis* at pre-reproductive stage, which was followed by *Hippophae rhamnoides* (0.302 mg/l) at pre-reproductive stage and *Tamarix dioica* (0.114 mg/l) at post-reproductive stage. On the average *Betula* had the highest concentration (0.715 mg/l), followed by *Hippophae rhamnoides* (0.294 mg/l) and *Tamarix dioica* (0.094 mg/l). Across the phenological stages for trees as a whole, it was seen that post-reproductive stage had the highest level (0.242 mg/l) of Cr contents, followed by pre-reproductive stage (0.235 mg/l) and reproductive stage (Table 24). On individual species basis, it was observed that Cr

contents increased with the maturity of plants in *Elaeagnus angustifolia* and *Tamarix dioica*. In *Betula utilis* and *Hippophae rhamnoides* it was maximum at pre-reproductive stage than other stages. In *Juniperus excelsa*, Cr was highest (0.032 mg/l) at reproductive stage, less (0.020 mg/l) at post-reproductive stage and medium (0.028 mg/l) at pre-reproductive stage. In shrubs, maximum Cr content was found in *Ephedra gerardiana* (0.611 mg/l) at post-reproductive stage, followed by *Rosa webbiana* (0.551 mg/l) at pre-reproductive stage and *Sophora mollis* (0.505 mg/l) at post-reproductive stage. On the average *Capparis spinosa*, *Sophora mollis* and *Rosa webbiana* respectively had 0.588 mg/l, 0.452 mg/l and 0.435 mg/l Cr contents. As a whole various phenological stages had 0.325 mg/l, 0.320 mg/l and 0.272 mg/l Cr contents respectively at post-reproductive, reproductive and pre-reproductive stages. Considering the trend for accumulation of Cr in individual species, it was seen that Cr contents increased with the maturity of plants in *Berberis lycium*, *Capparis spinosa* and *Sophora mollis*. While in *Acantholimon longiscapum* and *Rosa webbiana* Cr contents was maximum at pre-reproductive stage than the other stages. In *Ephedra gerardiana* highest (0.089 mg/l) Cr was found at reproductive stage, less (0.048 mg/l) at post-reproductive stage and medium (0.059 mg/l) at pre-reproductive stage. For herbs, maximum Cr contents was found in *Trifolium repens* (0.847 mg/l) at post-reproductive stage, followed by *Cichorium intybus* (0.798 mg/l) at post-reproductive stage and *Mentha longifolia* (0.706 mg/l) at post-reproductive stage. Considering the overall averages for herbs, it was found that *Trifolium repens*, *Cichorium intybus* and *Mentha longifolia* had respectively 0.821 mg/l, 0.786 mg/l and 0.658 mg/l Cr contents. Considering the trend in individual species, it was found that Cr contents increased with the maturity in *Cichorium*, *Datura*, *Glycyrrhiza*, *Mentha*, *Nepeta*, *Rheum*, *Salvia*, *Trifolium* and *Verbascum thapsus*. *Artemisia parviflora* and *Ferula jaeschkeana* had maximum Cr contents at reproductive stage. In grasses, the highest Cr content was found in *Phragmites karka* (1.108 mg/l) at post-reproductive stage, followed by *Saccharum spontaneum* (1.037 mg/l) at post-reproductive stage and *Calamogrostris pseudophragmites* (0.994 mg/l) at post-reproductive stage.

Table 23. Cd (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
A. Trees					
1.	<i>Betula utilis</i> D. Don.	0.093	0.088	0.090	0.090
2.	<i>Elaeagnus angustifolia</i> L.	0.009	0.003	0.011	0.007
3.	<i>Hippophae rhamnoides</i> L.	0.078	0.072	0.076	0.075
4.	<i>Juniperus excelsa</i> M. Bieb.	0.00	0.00	0.00	0.00
5.	<i>Tamarix dioica</i> Rox ex Roth.	0.012	0.024	0.027	0.021
Average		0.038	0.036	0.040	0.038
B. Shrubs					
6.	<i>Acantholimon longiscapum</i> Bokhari.	0.069	0.067	0.072	0.069
7.	<i>Berberis lycium</i> Royle.	0.080	0.084	0.078	0.083
8.	<i>Capparis spinosa</i> L.	0.084	0.088	0.085	0.086
9.	<i>Ephedra gerardiana</i> L.	0.00	0.00	0.00	0.00
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.033	0.035	0.042	0.037
11.	<i>Myricaria elegans</i> Royle.	0.030	0.031	0.036	0.032
12.	<i>Rosa webbiana</i> Wall ex Royle.	0.062	0.070	0.072	0.068
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.051	0.057	0.057	0.055
Average		0.051	0.054	0.055	0.053

	C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i> Roxb.	0.053	0.057	0.057	0.057
15.	<i>Cichorium intybus</i> L.	0.088	0.094	0.091	0.091
16.	<i>Datura stramonium</i> L.	0.041	0.053	0.047	0.047
17.	<i>Ferula jaeschkeana</i> Vatke.	0.081	0.087	0.087	0.085
18.	<i>Glycyrrhiza glabra</i> L.	0.054	0.058	0.066	0.059
19.	<i>Mentha longifolia</i> (L.) Huds.	0.085	0.087	0.089	0.087
20.	<i>Nepeta cataria</i> L.	0.085	0.076	0.077	0.079
21.	<i>Rheum emodi</i> Wall ex Meissn.	0.075	0.075	0.081	0.077
22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.086	0.086	0.090	0.087
23.	<i>Trifolium repens</i> L.	0.091	0.085	0.083	0.086
24.	<i>Verbascum thapsus</i> L.	0.081	0.083	0.082	0.082
Average		0.074	0.076	0.077	0.076
	D. Grasses				
25.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	0.092	0.089	0.090	0.090
26.	<i>Cynodon dactylon</i> (L.) Pers.	0.084	0.081	0.083	0.083
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	0.095	0.090	0.082	0.089
28.	<i>Saccharum spontaneum</i> L.	0.088	0.088	0.089	0.088
Average		0.090	0.087	0.086	0.087

On the average *Phragmites karka* had the highest level of Cr (1.088 mg/l), followed by *Saccharum spontaneum* (1.018 mg/l) and *Calamogrostris pseudophragmites* (0.963 mg/l). Considering the phenological stages as a whole for grasses, it was seen that post-reproductive stage had the highest (1.009 mg/l) Cr content, followed by reproductive stage (0.986 mg/l) and pre-reproductive stage (0.977 mg/l). Considering the trend for accumulation of Cr in individual species, it was observed that Cr contents enhanced with the maturity of plants in all the species (Fig. 13, Table 24). Cr contents showed highly significant variation at α 0.01 among the phenological stages and plant species (Table 32).

4. Cobalt (Co)

The analysis of Co concentration is provided in Table 25. Among trees, the highest level of Co was (0.088 mg/l) recorded for *Betula utilis* at reproductive stage, which was followed by (0.043 mg/l) of *Hippophae rhamnoides* at post-reproductive stage. *Betula* on the average had the highest level (0.080 mg/l) of Co, followed by *Hippophae rhamnoides* (0.014 mg/l). On individual species basis, it was found that *Betula utilis* had the highest (0.088 mg/l) contents at reproductive stage, less (0.075 mg/l) at post-reproductive stage and medium (0.078 mg/l) at pre-reproductive stage. In *Hippophae rhamnoides* Co was recorded only at post-reproductive stage (0.043 mg/l) and absent at other stages. In shrubs, maximum Co was found in *Capparis spinosa* (0.072 mg/l) at reproductive stage, which was followed by *Berberis lycium* (0.030 mg/l) at post-reproductive stage and *Ephedra gerardiana* (0.016 mg/l) at pre-reproductive stage. The overall average for shrubs, it was observed that *Capparis*, *Berberis* and *Ephedra* respectively had 0.046 mg/l, 0.012 mg/l and 0.05 mg/l Co contents. As a whole among various phenological stages 0.009 mg/l, 0.009 mg/l and 0.005 mg/l Co contents were respectively recorded for post-reproductive, reproductive and pre-reproductive stages. Taking individual species, it was seen that *Berberis* had the highest (0.030 mg/l) at post-reproductive stage, less (0.005 mg/l) at pre-reproductive stage and was absent at reproductive stage. *Capparis spinosa* had maximum (0.072 mg/l) at reproductive stage, less (0.023 mg/l) at pre-reproductive stage and medium (0.042 mg/l) at post-reproductive stage. In *Ephedra gerardiana* Co was present only at pre-reproductive stage, while in rest of the cases it was absent. In herbs, highest level of Co was recorded in *Salvia nubicola* (0.274 mg/l) at post-

reproductive stage, which was followed by *Ferula jaeschkeana* (0.248 mg/l) at post-reproductive stage and *Trifolium repens* (0.127 mg/l) at post-reproductive stage. On the average *Salvia*, *Ferula* and *Trifolium* respectively had 0.265 mg/l, 0.242 mg/l and 0.122 mg/l Co contents. Across the phenological stages as a whole for herbs, it was seen that post-reproductive stage had the highest (0.093 mg/l) Co contents, followed by pre-reproductive stage (0.086 mg/l) and reproductive stage (0.08 mg/l). Taking the individual species, it was found that Co contents increased with the maturity of plants in *Ferula*, *Mentha*, *Nepeta*, *Salvia*, *Trifolium* and *Verbascum thapsus*. *Cichorium intybus* and *Rheum emodi* had maximum at pre-reproductive stage than the other stages. In grasses, highest level of Co contents was found in *Phragmites karka* (0.211 mg/l) at post-reproductive stage. It was followed by *Cynodon dactylon* (0.180 mg/l) at post-reproductive stage and *Calamogrostris pseudophragmites* (0.179 mg/l) at post-reproductive stage (Fig. 14, Table 25). On the average, *Phragmites* had the highest Co contents (0.199 mg/l), followed by *Saccharum spontaneum* (0.159 mg/l) and *Calamogrostris* (0.157 mg/l). Taking the phenological stages, it was seen that post-reproductive stage had the highest level of Co (0.183 mg/l), followed by pre-reproductive stage (0.153 mg/l) and reproductive stage (0.16 mg/l). Thinking the trend for accumulation of Co in individual species, it was observed that Co contents increased with the maturity in *Calamogrostris*, *Cynodon* and *Phragmites*. *Saccharum spontaneum* had maximum Co contents (0.169 mg/l) at reproductive stage, less (0.147 mg/l) at pre-reproductive stage and medium (0.161 mg/l) at post-reproductive stage. Co contents showed highly significant variation ($P < 0.01$) among the phenological stages and plant species (Table 32).

Table 24. Cr (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S.NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	0.724	0.702	0.719	0.715
2.	<i>Elaeagnus angustifolia</i> L.	0.049	0.037	0.059	0.048
3.	<i>Hippophae rhamnoides</i> L.	0.302	0.279	0.301	0.294
4.	<i>Juniperus excelsa</i> M. Bieb.	0.028	0.032	0.020	0.027
5.	<i>Tamarix dioica</i> Rox ex Roth.	0.070	0.099	0.114	0.094
Average		0.235	0.230	0.242	0.235
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	0.358	0.326	0.265	0.316
7.	<i>Berberis lycium</i> Royle.	0.342	0.391	0.400	0.378
8.	<i>Capparis spinosa</i> L.	0.563	0.591	0.611	0.588
9.	<i>Ephedra gerardiana</i> L.	0.059	0.089	0.048	0.065
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.185	0.237	0.232	0.218
11.	<i>Myricaria elegans</i> Royle.	0.062	0.142	0.127	0.110
12.	<i>Rosa webbiana</i> Wall ex Royle.	0.551	0.344	0.411	0.435
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.412	0.439	0.505	0.452
Average		0.272	0.320	0.325	0.320

C. Herbs / Forbs					
14.	<i>Artemisia parviflora</i> Roxb.	0.530	0.575	0.570	0.558
15.	<i>Cichorium intybus</i> L.	0.771	0.788	0.798	0.786
16.	<i>Datura stramonium</i> L.	0.319	0.378	0.416	0.371
17.	<i>Ferula jaeschkeana</i> Vatke.	1.127	1.238	1.201	1.189
18.	<i>Glycyrrhiza glabra</i> L.	0.570	0.616	0.635	0.607
19.	<i>Mentha longifolia</i> (L.) Huds.	0.632	0.637	0.706	0.658
20.	<i>Nepeta cataria</i> L.	0.324	0.342	0.353	0.340
21.	<i>Rheum emodi</i> Wall ex Meissn.	0.439	0.425	0.454	0.439
22.	<i>Salvia nubicola</i> Wall ex Sweet.	1.231	1.238	1.286	1.252
23.	<i>Trifolium repens</i> L.	0.800	0.817	0.847	0.821
24.	<i>Verbascum thapsus</i> L.	0.487	0.486	0.554	0.509
Average		0.657	0.685	0.711	0.684
D. Grasses					
25.	<i>Calamagrostis</i> <i>pseudophragmites</i> Hall. f. Koeler.	0.948	0.947	0.994	0.963
26.	<i>Cynodon dactylon</i> (L.) Pers.	0.890	0.894	0.898	0.894
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	1.071	1.084	1.108	1.088
28.	<i>Saccharum spontaneum</i> L.	0.998	1.020	1.037	1.018
Average		0.977	0.986	1.009	0.991

5. Copper (Cu)

The concentration of Cu is depicted in Table 26. Among the trees, the highest Cu contents (0.173 mg/l) were recorded for *Betula utilis* at pre-reproductive stage. It was followed by (0.118 mg/l) at reproductive stage of *Hippophae rhamnoides* and by *Juniperus excelsa* with (0.069 mg/l) at post-reproductive stage (Table 26). On the average, *Betula* had the highest Cu (0.165 mg/l) contents, followed by *Hippophae* (0.116 mg/l) and *Juniperus* (0.060 mg/l). Across the phenological stages for trees, it was obvious that all the three stages had similar concentration of Cu (0.089 mg/l). The trend in individual species showed that *Betula*, *Elaeagnus* and *Tamarix* had highest concentration at pre-reproductive stage than at other stages. Cu contents increased with the maturity in *Juniperus*. *Hippophae rhamnoides* had the highest (0.118 mg/l) concentration at reproductive stage, less (0.114 mg/l) at pre-reproductive stage and medium (0.117 mg/l) at post-reproductive stage. Among shrubs, maximum Cu was found in *Capparis spinosa* (0.150 mg/l) at reproductive stage, followed by *Berberis lyieum* (0.128 mg/l) at post-reproductive stage and *Rosa webbiana* (0.120 mg/l) at reproductive stage. On the average *Capparis*, *Berberis* and *Rosa webbiana* respectively had 0.149 mg/l, 0.126 mg/l and 0.117 mg/l Cu contents. As a whole various phenological stages had 0.091 mg/l, 0.086 mg/l and 0.083 mg/l Cu contents respectively at pre-reproductive, post-reproductive and reproductive stages. The accumulation trend of Cu on individual shrubs species, it was clear that there was progressive increase with the maturity in *Berberis* and *Sophora mollis*. *Acantholimon*, *Capparis* and *Rosa* had the highest Cu level at reproductive stage than the other stages, while in *Ephedra*, *Haloxylon* and *Myricaria* Cu was highest at pre-reproductive stage. The highest level of Cu contents among herbs was recorded for *Trifolium repens* (0.194 mg/l) at pre-reproductive stage, followed by *Mentha longifolia* (0.190 mg/l) at post-reproductive stage and *Cichorium intybus* (0.188 mg/l) at pre-reproductive stage. The overall trend for average values for herbs showed that *Trifolium*, *Cichorium* and *Mentha* respectively had 0.190 mg/l, 0.186 mg/l and 0.183 mg/l Cu contents. As a whole various phenological stages had 0.134 mg/l, 0.127 mg/l and 0.126 mg/l Cu contents, respectively at pre-reproductive, post-reproductive and reproductive stages.

Table 25. Co (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S.NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	0.078	0.088	0.075	0.080
2.	<i>Elaeagnus angustifolia</i> L.	0.00	0.00	0.00	0.00
3.	<i>Hippophae rhamnoides</i> L.	0.00	0.00	0.043	0.014
4.	<i>Juniperus excelsa</i> M. Bieb.	0.00	0.00	0.00	0.00
5.	<i>Tamarix dioica</i> Rox ex Roth.	0.00	0.00	0.00	0.00
Average		0.016	0.018	0.015	0.016
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	0.00	0.00	0.00	0.00
7.	<i>Berberis lycium</i> Royle.	0.005	0.00	0.030	0.012
8.	<i>Capparis spinosa</i> L.	0.023	0.072	0.042	0.046
9.	<i>Ephedra gerardiana</i> L.	0.016	0.00	0.00	0.005
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.00	0.00	0.00	0.00
11.	<i>Myricaria elegans</i> Royle.	0.00	0.00	0.00	0.00
12.	<i>Rosa webbiana</i> Wall ex Royle.	0.00	0.00	0.00	0.00
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.00	0.00	0.00	0.00
Average		0.005	0.009	0.009	0.007
	C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i>	0.00	0.00	0.00	0.00

	Roxb.	0.108	0.106	0.103	0.106
15.	<i>Cichorium intybus</i> L.				
16.	<i>Datura stramonium</i> L.	0.00	0.00	0.00	0.00
17.	<i>Ferula jaeschkeana</i> Vatke.	0.242	0.236	0.248	0.242
18.	<i>Glycyrrhiza glabra</i> L.	0.00	0.00	0.00	0.00
19.	<i>Mentha longifolia</i> (L.) Huds.	0.063	0.049	0.087	0.066
20.	<i>Nepeta cataria</i> L.	0.030	0.025	0.041	0.032
21.	<i>Rheum emodi</i> Wall ex Meissn.	0.095	0.031	0.083	0.063
22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.266	0.254	0.274	0.265
23.	<i>Trifolium repens</i> L.	0.115	0.123	0.127	0.122
24.	<i>Verbascum thapsus</i> L.	0.028	0.056	0.065	0.050
Average		0.086	0.08	0.093	0.086
D. Grasses					
25.	<i>Calamogrostris</i> <i>pseudophragmites</i> Hall. f. Koeler	0.152	0.139	0.179	0.157
26.	<i>Cynodon dactylon</i> (L.) Pers.	0.131	0.129	0.180	0.147
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	0.184	0.203	0.211	0.199
28.	<i>Saccharum spontaneum</i> L.	0.147	0.169	0.161	0.159
Average		0.153	0.16	0.183	0.165

Based on individual species, it was found that in *Artemisia*, *Cichorium*, *Datura*, *Glycyrrhiza*, *Rheum*, *Salvia* and *Trifolium* Cu contents was highest at pre-reproductive stage than the other stages. *Nepeta cataria* and *Verbascum thapsus* had maximum concentration at reproductive stage. *Ferula* and *Mentha* exhibited increased level of Cu with the maturity. Among grasses, highest level of Cu was observed in *Cynodon dactylon* (0.138 mg/l) at pre-reproductive stage, which was followed by *Calamogrostris pseudophragmites* (0.126 mg/l) at reproductive stage and *Phragmites karka* (0.124 mg/l) at reproductive stage. On the average *Cynodon*, *Calamogrostris* and *Phragmites* respectively had 0.131 mg/l, 0.124 mg/l and 0.121 mg/l Cu contents. The various phenological stages respectively had 0.126 mg/l, 0.124 mg/l and 0.120 mg/l Cu contents at pre-reproductive, reproductive and post-reproductive stages. The trend on individual species basis showed that *Cynodon dactylon* and *Saccharum spontaneum* had the highest contents at pre-reproductive stage, while in *Calamogrostris* and *Phragmites* it was highest at reproductive stage (Fig. 15, Table 26). Cu contents showed non-significant variation among the phenological stages at α 0.05 and showed highly significant variation at α 0.01 among the plant species (Table 32).

6. Iron (Fe)

Among the trees, the highest Fe contents (7.160 mg/l) were recorded for *Betula utilis* at pre-reproductive stage, which was followed by *Tamarix dioica* (6.189 mg/l) at post-reproductive stage and *Juniperus excelsa* (5.266 mg/l) at reproductive stage (Table 27). On the average, *Betula* had the highest (5.59 mg/l) Fe contents, followed by *Juniperus* (4.58 mg/l) and *Tamarix* (3.71 mg/l) among trees. As a whole for phenological stages among trees the post-reproductive stage had the highest Fe (4.58 mg/l), followed by pre-reproductive stage (3.81 mg/l) and reproductive stage (3.54 mg/l). Taking the trend in individual species, it was observed that Fe contents progressively increased with the maturity in *Elaeagnus angustifolia*, *Hippophae rhamnoides* and *Tamarix dioica*. In *Betula* Fe concentration was maximum (7.160 mg/l) at pre-reproductive stage, less (4.801 mg/l) at reproductive stage and medium (4.823 mg/l) at post-reproductive stage. *Juniperus* exhibited highest Fe contents at reproductive stage (5.266 mg/l), medium (4.695 mg/l) at pre-reproductive stage and less (3.786 mg/l) at post-reproductive stage.

Among shrubs, Fe contents were maximum in *Myricaria elegans* ((17.22 mg/l) at post-reproductive stage, followed by *Acantholimon longiscapum* (9.806 mg/l) at reproductive stage and *Ephedra gerardiana* (6.483 mg/l) at post-reproductive stage. The overall average for shrubs showed that *Myricaria*, *Acantholimon* and *Ephedra*, respectively had 8.62 mg/l, 7.66 mg/l and 4.20 mg/l Fe contents. Across the various phenological stages the concentration were had 5.64 mg/l, 4.40 mg/l and 2.92 mg/l respectively at post-reproductive, reproductive and pre-reproductive stages (Table 27). Taking shrubs, it was concluded that there was progressive increase with advancing maturity in *Berberis lyceum*, *Ephedra gerardiana*, *Myricaria elegans* and *Sophora mollis*. *Acantholimon*, *Capparis* and *Haloxylon griffithii* highest concentration at reproductive stage than the other stages. Among herbs, the maximum Fe contents was recorded in *Verbascum thapsus* (29.10 mg/l) at post-reproductive stage. It was followed by *Mentha longifolia* (22.89 mg/l) at post-reproductive stage and *Nepeta cataria* (11.06 mg/l) at post-reproductive stage. On the average, *Verbascum*, *Mentha* and *Nepeta* respectively had 16.74 mg/l, 14.46 mg/l and 7.80 mg/l Fe contents. Considering the individual species, Fe contents increased progressively with the maturity in *Datura*, *Glycyrrhiza*, *Mentha*, *Nepeta*, *Rheum*, *Salvia* and *Verbascum thapsus*. *Artemisia parviflora*, *Cichorium intybus* and *Trifolium repens* showed highest contents at pre-reproductive stage. Fe was highest (8.715 mg/l) at reproductive stage, less (2.634 mg/l) at post-reproductive stage and medium (4.194 mg/l) at pre-reproductive stage in *Ferula*. The highest level of Fe contents among grasses was recorded for *Calamogrostris pseudophragmites* (7.467 mg/l) at post-reproductive stage, followed by *Cynodon dactylon* (6.131 mg/l) at post-reproductive stage and *Phragmites karka* (5.544 mg/l) at post-reproductive stage. On the average, *Cynodon*, *Calamogrostris* and *Phragmites* respectively had 5.79 mg/l, 5.42 mg/l and 3.49 mg/l Fe contents. Across the various phenological stages there was 5.53 mg/l, 4.89 mg/l and 2.70 mg/l Fe concentration at post-reproductive, reproductive and pre-reproductive stages. On individual species basis it was observed that Fe contents increased with the maturity in *Calamogrostris* and *Phragmites*, while in *Cynodon dactylon* and *Saccharum spontaneum* it was highest at reproductive stage than the other stages (Fig. 16, Table 27). Fe contents showed highly significant variation at α 0.01 among the phenological stages and plant species (Table 32).

Table 26. Cu (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S.NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
A. Trees					
1.	<i>Betula utilis</i> D. Don.	0.173	0.162	0.160	0.165
2.	<i>Elaeagnus angustifolia</i> L.	0.063	0.054	0.060	0.059
3.	<i>Hippophae rhamnoides</i> L.	0.114	0.118	0.117	0.116
4.	<i>Juniperus excelsa</i> M. Bieb.	0.047	0.065	0.069	0.060
5.	<i>Tamarix dioica</i> Rox ex Roth.	0.050	0.044	0.037	0.044
Average		0.089	0.089	0.089	0.089
B. Shrubs					
6.	<i>Acantholimon longiscapum</i> Bokhari.	0.111	0.112	0.105	0.109
7.	<i>Berberis lycium</i> Royle.	0.127	0.123	0.128	0.126
8.	<i>Capparis spinosa</i> L.	0.149	0.150	0.147	0.149
9.	<i>Ephedra gerardiana</i> L.	0.080	0.045	0.050	0.058
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.060	0.036	0.034	0.043
11.	<i>Myricaria elegans</i> Royle.	0.060	0.043	0.053	0.052
12.	<i>Rosa webbiana</i> Wall. ex Royle.	0.113	0.120	0.118	0.117
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.030	0.033	0.057	0.04
Average		0.091	0.083	0.086	0.087

	C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i> Roxb.	0.101	0.061	0.046	0.069
15.	<i>Cichorium intybus</i> L.	0.188	0.182	0.187	0.186
16.	<i>Datura stramonium</i> L.	0.074	0.042	0.068	0.061
17.	<i>Ferula jaeschkeana</i> Vatke.	0.123	0.118	0.130	0.124
18.	<i>Glycyrrhiza glabra</i> L.	0.040	0.036	0.031	0.036
19.	<i>Mentha longifolia</i> (L.) Huds.	0.174	0.185	0.190	0.183
20.	<i>Nepeta cataria</i> L.	0.128	0.133	0.132	0.131
21.	<i>Rheum emodi</i> Wall ex Meissn.	0.144	0.136	0.122	0.134
22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.143	0.129	0.141	0.138
23.	<i>Trifolium repens</i> L.	0.194	0.188	0.187	0.190
24.	<i>Verbascum thapsus</i> L.	0.163	0.175	0.165	0.168
Average		0.134	0.126	0.127	0.129
	D. Grasses				
25.	<i>Calamogrostris</i> <i>pseudophragmites</i> Hall, f. Koeler	0.124	0.126	0.123	0.124
26.	<i>Cynodon dactylon</i> (L.) Pers.	0.138	0.128	0.126	0.131
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	0.121	0.124	0.118	0.121
28.	<i>Saccharum spontaneum</i> L.	0.120	0.119	0.114	0.118
Average		0.126	0.124	0.120	0.123

7. Manganese (Mn)

Manganese varied among the species and phenological stages (Table 28). The highest level of Mn contents were found in *Betula utilis* (1097 mg/l) at pre-reproductive stage among trees. It was followed by *Tamarix dioica* (1043 mg/l) at post-reproductive stage and *Hippophae rhamnoides* (711.5 mg/l) at post-reproductive stage. On the average, *Betula*, *Tamarix* and *Hippophae* respectively had 649.013 mg/l, 636.733 mg/l and 466.133 mg/l Mn contents. For trees, the phenological stages as a whole showed that pre-reproductive stage had the highest (553.06 mg/l) Mn contents, followed by post-reproductive stage (502.59 mg/l) and reproductive stage (412.46 mg/l). On individual species basis, it was seen that Mn contents increased with the maturity in *Hippophae*, *Juniperus* and *Tamarix*. *Betula utilis* and *Elaeagnus angustifolia* had maximum Mn contents at pre-reproductive stage than at other stages. In shrubs, maximum Mn contents were recorded in *Myricaria elegans* (1781 mg/l) at reproductive stage, followed by *Capparis spinosa* (1477 mg/l) at post-reproductive stage and *Haloxylon griffithii* (1254 mg/l) at post-reproductive stage. For shrubs, the overall averages showed that *Myricaria*, *Capparis* and *Haloxylon* respectively had 1108.67 mg/l, 1074.4 mg/l and 820.1 mg/l Mn contents. Among the various phenological stages on the average exhibited 807.82 mg/l, 754.97 mg/l and 471.01 mg/l Mn contents respectively at post-reproductive, reproductive and pre-reproductive stages. On individual basis, it was clear that Mn contents increased with the maturity in *Berberis*, *Capparis*, *Ephedra*, *Haloxylon* and *Sophora mollis*. In *Acantholimon*, *Myricaria* and *Rosa webbiana* Mn was maximum at reproductive stage than the other stages. Among herbs, the maximum Mn contents were found in *Rheum emodi* (9863 mg/l) at pre-reproductive stage, followed by *Datura stramonium* (1305 mg/l) at post-reproductive stage and *Mentha longifolia* (1286 mg/l) at post-reproductive stage. On the average, *Rheum*, *Datura* and *Mentha* respectively had 5061.73 mg/l, 1192 mg/l and 1043.33 mg/l Mn contents. Across the various phenological stages there were 1573.31 mg/l, 1126.30 mg/l and 680.64 mg/l Mn contents respectively at pre-reproductive, post-reproductive and reproductive stages. The trend in individual species basis exhibited that Mn contents increased with the maturity in *Datura*, *Mentha*, *Nepeta*, *Salvia* and *Verbascum thapsus*. *Artemisia*, *Cichorium*, *Glycyrrhiza* and *Rheum emodi* had maximum Mn contents at pre-reproductive stage than the other stages.

Table 27. Fe (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S.NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	7.160	4.801	4.823	5.59
2.	<i>Elaeagnus angustifolia</i> L.	2.992	2.036	4.268	3.10
3.	<i>Hippophae rhamnoides</i> L.	2.023	2.855	3.839	2.90
4.	<i>Juniperus excelsa</i> M. Bieb.	4.695	5.266	3.786	4.58
5.	<i>Tamarix dioica</i> Rox ex Roth.	2.196	2.748	6.189	3.71
Average		3.81	3.54	4.58	3.98
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	6.717	9.806	6.470	7.66
7.	<i>Berberis lycium</i> Royle.	1.659	2.583	5.533	3.26
8.	<i>Capparis spinosa</i> L.	2.034	5.525	2.098	3.22
9.	<i>Ephedra gerardiana</i> L.	3.019	3.111	6.483	4.20
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	1.757	2.733	2.558	2.35
11.	<i>Myricaria elegans</i> Royle.	4.339	4.312	17.22	8.62
12.	<i>Rosa webbiana</i> Wall ex Royle.	2.466	4.900	1.817	3.06
13.	<i>Sophora mollis</i> (Royle.) Baker.	1.373	2.258	2.980	2.20
Average		2.92	4.40	5.64	4.32

	C. Herbs / Forbs				
14.	<i>Artemisia parviflora</i> Roxb.	5.290	1.463	4.406	3.72
15.	<i>Cichorium intybus</i> L.	8.807	2.922	4.971	5.57
16.	<i>Datura stramonium</i> L.	5.140	4.302	6.674	5.37
17.	<i>Ferula jaeschkeana</i> Vatke.	4.194	8.715	2.634	5.18
18.	<i>Glycyrrhiza glabra</i> L.	2.990	2.699	4.547	3.41
19.	<i>Mentha longifolia</i> (L.) Huds.	11.20	9.280	22.89	14.46
20.	<i>Nepeta cataria</i> L.	6.043	6.309	11.06	7.80
21.	<i>Rheum emodi</i> Wall ex Meissn.	3.786	2.998	6.138	4.31
22.	<i>Salvia nubicola</i> Wall. ex Sweet.	5.880	6.281	8.361	6.84
23.	<i>Trifolium repens</i> L.	7.287	5.922	6.178	6.46
24.	<i>Verbascum thapsus</i> L.	7.040	14.07	29.10	16.74
Average		6.15	5.90	9.72	7.26
	D. Grasses				
25.	<i>Calamogrostris</i> <i>pseudophragmites</i> Hall. f. Koeler.	3.545	5.262	7.467	5.42
26.	<i>Cynodon dactylon</i> (L.) Pers.	3.309	7.931	6.131	5.79
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	1.952	2.986	5.544	3.49
28.	<i>Saccharum spontaneum</i> L.	2.010	3.369	2.987	2.79
Average		2.70	4.89	5.53	4.37

Mn was highest (1275 mg/l) at reproductive stage, less (457.0 mg/l) at post-reproductive stage and medium (979.7 mg/l) at pre-reproductive stage in *Ferula*. Among grasses, maximum Mn contents were found in *Phragmites karka* (4007 mg/l) at pre-reproductive stage, followed by *Calamogrostris pseudophragmites* (944.4 mg/l) at pre-reproductive stage and *Cynodon dactylon* (789.6 mg/l) at post-reproductive stage. On the average, *Phragmites*, *Calamogrostris* and *Cynodon* respectively had 1851.13 mg/l, 875.77 mg/l and 728.03 mg/l Mn contents. Among the phenological stages on average basis there were 1556.55 mg/l, 805.7 mg/l and 636.52 mg/l Mn contents respectively at pre-reproductive, post-reproductive and reproductive stages. Mn contents in individual grasses increased with the maturity in *Cynodon dactylon* and *Saccharum spontaneum*. Mn was highest at pre-reproductive stage than the other stages in *Calamogrostris* and *Phragmites karka* (Fig. 17, Table 28). Mn contents showed non-significant variation among the phenological stages at α 0.05 and showed highly significant variation at α 0.01 among the plant species (Table 32).

8. Silicon (Si)

The highest level of Si among trees (17.17 mg/l) was obtained for *Juniperus excelsa* at post-reproductive stage. It was followed by *Betula utilis* (16.11 mg/l) at pre-reproductive stage and *Elaeagnus angustifolia* (4.912 mg/l) at post-reproductive stage (Table 29). On the whole, the average for trees showed that *Juniperus*, *Betula* and *Elaeagnus*, respectively had 7.86 mg/l, 7.50 mg/l and 4.525 mg/l Si contents. The various phenological stages had 6.237 mg/l, 5.371 mg/l and 3.111 mg/l Si contents, respectively at post-reproductive, pre-reproductive and reproductive stages. While considering the accumulation trend for Si in individual tree species, it was observed that Si contents increased with maturity in *Elaeagnus*, *Hippophae*, *Juniperus* and *Tamarix dioica*. *Betula utilis* had highest Si (16.11 mg/l) at pre-reproductive stage, 3.353 mg/l at post-reproductive stage and 3.027 mg/l at reproductive stage. Maximum Si contents among the shrubs was found in *Capparis spinosa* (32.90 mg/l) at reproductive stage. It was approached by *Ephedra gerardiana* (28.40 mg/l) at reproductive stage and *Acantholimon longiscapum* (15.08 mg/l) at reproductive stage (Table 29). The overall averages for shrubs showed that *Capparis*, *Ephedra* and *Acantholimon* respectively had 12.229 mg/l, 11.620 mg/l and 9.767 mg/l Si contents. Various phenological stages exhibited 11.122

mg/l, 4.556 mg/l and 2.699 mg/l Si contents respectively at reproductive, post-reproductive and pre-reproductive stages. The accumulation trend for Si in individual shrub species showed that Si contents increased with the maturity in *Haloxylon*, *Rosa* and *Sophora mollis*. *Acantholimon*, *Capparis*, *Ephedra* and *Myricaria* had highest Si contents at reproductive stage than the other stages. *Berberis lycium* had the highest Si contents (2.596 mg/l) at pre-reproductive stage. Maximum level of Si contents among herbs were recorded for *Rheum emodi* (95.19 mg/l) at pre-reproductive stage. *Cichorium intybus* followed it (54.49 mg/l) at reproductive stage. *Mentha longifolia* had (8.220 mg/l) Si at post-reproductive stage. On the average, *Rheum*, *Cichorium* and *Glycyrrhiza* respectively showed 33.051 mg/l, 22.834 mg/l and 3.999 mg/l Si contents. There were 10.571 mg/l, 7.104 mg/l and 4.448 mg/l Si contents respectively at pre-reproductive, reproductive and post-reproductive stages. The trend for individual species revealed that Si contents increased with the maturity in *Datura*, *Ferula*, *Glycyrrhiza*, *Mentha*, *Nepeta* and *Salvia*. In *Artemisia*, *Rheum* and *Trifolium* Si was highest at pre-reproductive stage than the other stages. *Cichorium* and *Verbascum* had highest Si at reproductive stage. Si contents among grasses were highest (6.466 mg/l) in *Phragmites karka* at reproductive stage. *Saccharum spontaneum* (4.514 mg/l) at pre-reproductive stage and *Calamogrostris pseudophragmites* (1.844 mg/l) at reproductive stage followed it. The overall average for grasses exhibited that *Phragmites*, *Saccharum* and *Calamogrostris* respectively had 3.618 mg/l, 2.68 mg/l and 1.508 mg/l Si contents. The Si concentration was 2.854 mg/l, 2.333 mg/l and 1.616 mg/l respectively at reproductive, pre-reproductive and post-reproductive stages. Considering the trend in individual species, *Cynodon* and *Saccharum* had the highest Si contents at pre-reproductive stage than the other stages. *Calamogrostris* and *Phragmites* had the highest Si level at reproductive stages (Fig. 18, Table 29). Anova showed that Si contents exhibited non-significant variation at α 0.05 among the phenological stages and plant species (Table 32)

Table 28. Mn (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post reproductive stage	
A. Trees					
1.	<i>Betula utilis</i> D. Don.	1097	836.5	13.54	649.013
2.	<i>Elaeagnus angustifolia</i> L.	381.6	221.0	271.3	291.3
3.	<i>Hippophae rhamnoides</i> L.	464.6	222.3	711.5	466.133
4.	<i>Juniperus excelsa</i> M. Bieb.	373.3	364.1	473.6	403.667
5.	<i>Tamarix dioica</i> Rox ex Roth.	448.8	418.4	1043	636.733
Average		553.06	412.46	502.59	449.37
B. Shrubs					
6.	<i>Acantholimon longiscapum</i> Bokhari.	510.1	641.0	629.4	593.3
7.	<i>Berberis lycium</i> Royle.	312.7	546.9	779.1	546.23
8.	<i>Capparis spinosa</i> L.	844.2	902.0	1477	1074.4
9.	<i>Ephedra gerardiana</i> L.	227.5	266.1	312.7	268.77
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	430.0	776.3	1254	820.1
Average		471.01	754.97	807.82	677.94
C. Herbs / Forbs					
14.	<i>Artemisia parviflora</i> Roxb.	593.3	200.0	379.4	390.9
15.	<i>Cichorium intybus</i> L.	686.1	458.4	516.9	553.8
16.	<i>Datura stramonium</i> L.	1241	1030	1305	1192
17.	<i>Ferula jaeschkeana</i> Vatke.	979.7	1275	457.0	903.9
18.	<i>Glycyrrhiza glabra</i> L.	483.9	278.1	420.0	394
19.	<i>Mentha longifolia</i> (L.) Huds.	993.0	851.0	1286	1043.33
20.	<i>Nepeta cataria</i> L.	506.9	611.7	671.1	596.57
21.	<i>Rheum emodi</i> Wall ex Meissn.	9863	686.2	4636	5061.73
22.	<i>Salvia nubicola</i> Wall ex Sweet.	739.6	738.8	1050	842.8

23.	<i>Trifolium repens</i> L.	628.0	616.1	548.0	597.37
24.	<i>Verbascum thapsus</i> L.	592.0	741.8	1120	817.93
Average		1573.31	680.64	1126.30	1126.76
D. Grasses					
25.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	944.4	873.2	809.7	875.77
26.	<i>Cynodon dactylon</i> (L.) Pers.	730.9	663.6	789.6	728.03
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	4007	477.4	1069	1851.13
28.	<i>Saccharum spontaneum</i> L.	543.9	531.9	554.5	543.43
Average		1556.55	636.52	805.7	999.59

9. Strontium (Sr)

The concentration of Sr is tabulated in Table 30. Among trees, the highest level of Sr was 3.516 mg/l recorded for *Hippophae rhamnoides* at post-reproductive stage, which was followed by 1.980 mg/l at pre-reproductive stage of *Juniperus excelsa* and by *Elaeagnus angustifolia* with 1.756 mg/l at post-reproductive stage. On the average, *Hippophae* had the highest level (1.738 mg/l) of Sr. It was followed by *Tamarix* (1.382 mg/l) and *Juniperus* (1.244 mg/l). Across the phenological stages among trees, it was observed that post-reproductive stage had the highest (1.523 mg/l) Sr contents, followed by pre-reproductive stage (0.958 mg/l) and reproductive stage (0.894 mg/l). The trend in individual species exhibited Sr contents increased with the maturity in *Elaeagnus*, *Hippophae* and *Tamarix*, while in *Betula utilis* Sr decreased towards maturity. *Juniperus* had the highest (1.198 mg/l) contents at reproductive stage, less (0.554 mg/l) at post-reproductive stage and medium (1.980 mg/l) at pre-reproductive stage. In shrubs, maximum Sr contents were found in *Rosa webbiana* (4.063 mg/l) at pre-reproductive stage, followed by *Ephedra gerardiana* (2.153 mg/l) at post-reproductive stage and *Myricaria elegans* (1.727 mg/l) at post-reproductive stage. The overall average for shrubs showed that *Rosa*, *Ephedra* and *Myricaria* respectively had 2.733 mg/l, 1.847 mg/l and 1.651 mg/l Sr contents. As a whole various stages had 1.210 mg/l, 1.189 mg/l and 1.185 mg/l Sr contents respectively at post-reproductive, reproductive and pre-reproductive stages. The accumulation trend of Sr for individual shrub species, it was observed that Sr progressively increased towards maturity of plants in *Berberis*, *Capparis*, *Ephedra* and *Myricaria*. In *Rosa webbiana* it decreased towards maturity. In *Acantholimon* and *Sophora* Sr was highest at reproductive stage than at other stages. *Datura stramonium* had maximum (7.016 mg/l) at pre-reproductive stage among herbs. It was followed by *Nepeta cataria* (5.104 mg/l) at pre-reproductive stage and *Cichorium intybus* (3.450 mg/l) at post-reproductive stage. On the average basis, *Nepeta*, *Datura* and *Cichorium* respectively had 3.856 mg/l, 2.898 mg/l and 2.766 mg/l Sr contents (Table 30). Phenological stages showed that there were 2.257 mg/l, 1.636 mg/l and 1.449 mg/l Sr contents respectively at pre-reproductive, post-reproductive and reproductive stages. For individual species, it was obvious that Sr contents increased with the maturity in *Cichorium*, *Glycyrrhiza*, *Mentha* and *Salvia nubicola*. While in *Artemisia*, *Datura*,

Nepeta and *Verbascum thapsus* Sr contents was highest at pre-reproductive stage than the other stages. In *Ferula* and *Trifolium* Sr was highest at reproductive stage. *Calamogrostris pseudophragmites* had the highest Sr contents (1.106 mg/l) at pre-reproductive stage among grasses. It was followed by *Phragmites karka* (0.764 mg/l) and *Cynodon dactylon* (0.656 mg/l) at pre-reproductive stages (Table 30). The average showed that *Cynodon*, *Calamogrostris* and *Phragmites* respectively had 0.584 mg/l, 0.537 mg/l and 0.475 mg/l Sr contents. The various stages had 0.673 mg/l, 0.427 mg/l and 0.349 mg/l Sr contents respectively at pre-reproductive, reproductive and post-reproductive stages. Considering the trend in individual species, it was observed that Sr contents decreased towards maturity of plants in *Calamogrostris*, *Cynodon* and *Phragmites*, while in *Saccharum spontaneum* Sr contents increased towards maturity (Fig. 19, Table 30). Sr contents showed non-significant variation among the phenological stages at α 0.05 and showed highly significant variation at α 0.01 among the plant species (Table 32).

Table 29. Si (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
A. Trees					
1.	<i>Betula utilis</i> D. Don.	16.11	3.027	3.353	7.50
2.	<i>Elaeagnus angustifolia</i> L.	4.047	4.618	4.912	4.525
3.	<i>Hippophae rhamnoides</i> L.	2.196	2.285	2.461	2.314
4.	<i>Juniperus excelsa</i> M. Bieb.	2.190	4.215	17.17	7.86
5.	<i>Tamarix dioica</i> Rox ex Roth.	2.312	1.412	3.429	2.384
Average		5.371	3.111	6.237	4.917
B. Shrubs					
6.	<i>Acantholimon longiscapum</i>	4.797	15.08	9.424	9.767
7.	Bokhari.	2.596	1.526	1.825	1.980
8.	<i>Berberis lycium</i> Royle.	2.438	32.90	1.348	12.229
9.	<i>Capparis spinosa</i> L.	1.413	28.40	5.049	11.620
10.	<i>Ephedra gerardiana</i> L.	2.807	1.688	3.502	2.665
	<i>Haloxylon griffithii</i> (Moq.)				
11.	Bunge.ex Boiss.	3.337	3.399	1.931	2.889
12.	<i>Myricaria elegans</i> Royle.	2.095	3.344	4.636	3.358
13.	<i>Rosa webbiana</i> Wall ex Royle.	2.113	2.643	8.732	4.359
Average		2.699	11.122	4.556	6.108
C. Herbs / Forbs					
14.	<i>Artemisia parviflora</i> Roxb.	5.519	1.837	1.406	2.920
15.	<i>Cichorium intybus</i> L.	1.402	54.49	12.61	22.834
16.	<i>Datura stramonium</i> L.	1.736	1.615	3.157	2.169
17.	<i>Ferula jaeschkeana</i> Vatke.	2.329	1.605	2.832	2.255
18.	<i>Glycyrrhiza glabra</i> L.	2.098	3.837	6.034	3.999
19.	<i>Mentha longifolia</i> (L.) Huds.	1.352	1.982	8.220	3.851
20.	<i>Nepeta cataria</i> L.	2.158	3.088	4.136	3.127
21.	<i>Rheum emodi</i> Wall ex Meissn.	95.19	2.359	1.613	33.051
22.	<i>Salvia nubicola</i> Wall ex Sweet.	1.668	2.091	5.564	3.107
23.	<i>Trifolium repens</i> L.	1.314	1.296	1.205	1.271
24.	<i>Verbascum thapsus</i> L.	1.518	3.941	2.147	2.535
Average		10.571	7.104	4.448	7.374
D. Grasses					
25.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	1.239	1.844	1.441	1.508
26.	<i>Cynodon dactylon</i> (L.) Pers.	1.428	1.239	1.228	1.298
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	2.154	6.466	2.233	3.618
28.	<i>Saccharum spontaneum</i> L.	4.514	1.867	1.564	2.648
Average		2.333	2.854	1.616	2.268

10. Zinc (Zn)

Table 31 shows the Zn level in investigated plants. The highest level of Zn among trees was 0.676 mg/l recorded for *Betula utilis* at pre-reproductive stage, *Juniperus excelsa* at reproductive stage (0.090 mg/l) and *Tamarix dioica* at pre-reproductive stage (0.089 mg/l) followed it. *Betula* on the average had the highest concentration of Zn (0.387 mg/l), followed by *Juniperus* (0.084 mg/l) and *Tamarix* (0.075 mg/l). Across the phenological stages among trees, it was obvious that reproductive stage had the highest Zn (0.108 mg/l), followed by post-reproductive stage (0.093 mg/l) and pre-reproductive stage (0.070 mg/l). It was observed that Zn contents decreased with the maturity in *Elaeagnus*, *Hippophae* and *Tamarix*. In *Betula* Zn was highest (0.676 mg/l) at pre-reproductive stage, while *Juniperus* had highest value at reproductive stage. Maximum Zn contents among shrubs were recorded for *Ephedra gerardiana* (0.149 mg/l) at pre-reproductive stage, which was followed by *Sophora mollis* (0.121 mg/l) at reproductive stage and *Capparis spinosa* (0.112 mg/l) at pre-reproductive stage (Table 31). Considering the overall averages for shrubs, it was observed that *Ephedra*, *Capparis* and *Sophora* respectively had 0.099 mg/l, 0.098 mg/l and 0.095 mg/l Zn contents. Phenological stages showed 0.087 mg/l, 0.074 mg/l and 0.061 mg/l Zn contents respectively at pre-reproductive, reproductive and post-reproductive stages. The accumulation trend of Zn in individual species showed that it decreased with the maturity in *Berberis*, *Capparis*, *Ephedra*, *Haloxylon* and *Rosa webbiana*. In *Acantholimon* and *Sophora* Zn was highest at reproductive stage than at other stages. While in *Myricaria elegans* Zn was highest at pre-reproductive stage. The highest Zn contents among herbs was found in *Verbascum thapsus* (6.647 mg/l) at reproductive stage, which was followed by *Cichorium intybus* (0.251 mg/l) at post-reproductive stage and *Trifolium repens* (0.225 mg/l) at post-reproductive stage. On the average, *Verbascum*, *Trifolium* and *Cichorium* respectively contained 2.297 mg/l, 0.216 mg/l and 0.210 mg/l Zn contents. The overall phenological stages of herbs showed that reproductive stage contained the highest (0.714 mg/l) Zn contents, followed by pre-reproductive (0.165 mg/l) and post-reproductive stages (0.125 mg/l). Zn contents increased with advancing maturity in *Cichorium*, *Mentha* and *Trifolium*, while it decreased towards maturity in *Datura*, *Ferula*, *Glycyrrhiza* and *Rheum emodi*.

Table 30. Sr (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
A. Trees					
1.	<i>Betula utilis</i> D. Don.	0.844	0.434	0.305	0.528
2.	<i>Elaeagnus angustifolia</i> L.	0.209	0.232	1.756	0.732
3.	<i>Hippophae rhamnoides</i> L.	0.466	1.233	3.516	1.738
4.	<i>Juniperus excelsa</i> M. Bieb.	1.980	1.198	0.554	1.244
5.	<i>Tamarix dioica</i> Rox ex Roth.	1.289	1.373	1.485	1.382
Average		0.958	0.894	1.523	1.125
B. Shrubs					
6.	<i>Acantholimon longiscapum</i> Bokhari.	0.606	0.617	0.599	0.607
7.	<i>Berberis lycium</i> Royle.	0.654	0.881	1.368	0.968
8.	<i>Capparis spinosa</i> L.	0.363	0.352	0.673	0.463
9.	<i>Ephedra gerardiana</i> L.	1.533	1.854	2.153	1.847
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.464	0.628	0.614	0.569
11.	<i>Myricaria elegans</i> Royle.	1.512	1.713	1.727	1.651
12.	<i>Rosa webbiana</i> Wall ex Royle.	4.063	3.011	1.125	2.733
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.288	0.455	1.423	0.722
Average		1.185	1.189	1.210	1.195
C. Herbs / Forbs					
14.	<i>Artemisia parviflora</i> Roxb.	3.360	0.891	0.951	1.734
15.	<i>Cichorium intybus</i> L.	2.285	2.564	3.450	2.766
16.	<i>Datura stramonium</i> L.	7.016	0.895	3.782	2.898
17.	<i>Ferula jaeschkeana</i> Vatke.	0.297	0.376	0.148	0.274
18.	<i>Glycyrrhiza glabra</i> L.	1.165	2.710	2.743	2.206
19.	<i>Mentha longifolia</i> (L.) Huds.	0.641	0.395	1.180	0.739
20.	<i>Nepeta cateria</i> L.	5.104	4.121	2.344	3.856
21.	<i>Rheum emodi</i> Wall ex Meissn.	1.297	0.219	0.705	0.740

22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.390	0.449	0.839	0.559
23.	<i>Trifolium repens</i> L.	2.836	3.048	1.522	2.469
24.	<i>Verbascum thapsus</i> L.	0.435	0.271	0.334	0.347
Average		2.257	1.449	1.636	1.690
D. Grasses					
25.	<i>Calamogrostris pseudophragmites</i> Hall. f Koeler.	1.106	0.340	0.164	0.537
26.	<i>Cynodon dactylon</i> (L.) Pers.	0.656	0.600	0.496	0.584
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	0.764	0.440	0.222	0.475
28.	<i>Saccharum spontaneum</i> L.	0.168	0.327	0.513	0.336
Average		0.673	0.427	0.349	0.483

Zn was highest at pre-reproductive stage in *Artemisia*, *Nepeta* and *Salvia* than the other stages. *Verbascum thapsus* contained highest contents at reproductive stage. Maximum level of Zn contents among grasses were recorded in *Cynodon dactylon* (0.124 mg/l) at pre-reproductive stage. *Phragmites karka* (0.116 mg/l) at reproductive stage and *Saccharum spontaneum* (0.108 mg/l) at post-reproductive stage followed it. On the average, *Cynodon*, *Phragmites* and *Saccharum* respectively had 0.109 mg/l, 0.082 mg/l and 0.074 mg/l Zn contents. As a whole various phenological stages had 0.091 mg/l, 0.084 mg/l and 0.074 mg/l Zn contents respectively at reproductive, post-reproductive and pre-reproductive stages. Considering the trend in individual species, it was seen that in *Calamogrostris* and *Phragmites* Zn concentration was highest at reproductive stage than the other stages, while in *Cynodon* Zn was highest at pre-reproductive stage. In *Saccharum spontaneum* Zn contents increased with advancing maturity (Fig. 20, Table 31). Anova showed that Zn contents exhibited non-significant variation at α 0.05 among the phenological stages and plant species (Table 32).

Minerals are essential not only for the normal growth and development of plants but also for the growth, maintenance and productivity of grazing livestock in the rangelands. It is obvious that mineral composition not only affects the palatability of species but also reduces health growth, productivity and reproductive capacity of grazing animals. The mineral concentration of forage plants generally increased/decreased inconsistently with the advancing phenological growth stages in most plants (Hussain & Durrani, 2008). Many studies have been made on the mineral composition of forage plants. Hussain & Durrain (2008) stated that the concentration of Cu was higher in shrubs than grasses, while Mn was higher in grasses. Khan *et al.* (2010) assessed the Ca and Mg concentration in forage plants and plasma of lactating cows in Sarghodha, Punjab. Abara (2011) determined proximate composition and mineral contents *Dioscorea Bulbifera*. Fardous *et al.* (2011) assessed Fe, Co and Mn in soil and forage at a rural livestock farm in Sarghodha, Punjab. These minerals were enough for the requirement of forage as well as for grazing livestock. Gjorgieva *et al.* (2011) determined 9 trace elements in four plant species. Mg, Ca and K were in high concentration. Imelouane *et al.* (2011) reported that concentration of macronutrients varied from 0.36 to 46.87 %. The minerals are usually

required in small amount for the development of the plants and organisms. Excessive uptake of trace elements by plants affects the metaboloic activities of plants as well as animals (Sharma *et al.*, 2011).

It is concluded that poor livestock productivity in Mastuj Valley is partially due to insufficient amount of mineral in forage. It is suggested that fertilization of soil and vegetation with additional source of commercial fertilizers will not only improve the overall vegetation cover but also improve the health and productivity of livestock in this rangeland.

Table 31. Zn (mg/l) contents at three phenological stages in some forage plants of Mastuj Valley, Hindukush Range, Pakistan.

S. NO.	Plant species	Phenological stages			Average
		Pre-reproductive stage	Reproductive stage	Post - reproductive stage	
	A. Trees				
1.	<i>Betula utilis</i> D. Don.	0.676	0.238	0.248	0.387
2.	<i>Elaeagnus angustifolia</i> L.	0.059	0.068	0.040	0.056
3.	<i>Hippophae rhamnoides</i> L.	0.054	0.063	0.035	0.051
4.	<i>Juniperus excelsa</i> M. Bieb.	0.074	0.090	0.089	0.084
5.	<i>Tamarix dioica</i> Rox ex Roth.	0.089	0.082	0.053	0.075
Average		0.070	0.108	0.093	0.130
	B. Shrubs				
6.	<i>Acantholimon longiscapum</i> Bokhari.	0.032	0.072	0.038	0.047
7.	<i>Berberis lycium</i> Royle.	0.085	0.079	0.076	0.08
8.	<i>Capparis spinosa</i> L.	0.112	0.103	0.080	0.098
9.	<i>Ephedra gerardiana</i> L.	0.149	0.075	0.075	0.099
10.	<i>Haloxylon griffithii</i> (Moq.) Bunge. ex Boiss.	0.052	0.028	0.020	0.033
11.	<i>Myricaria elegans</i> Royle.	0.109	0.074	0.093	0.092
12.	<i>Rosa webbiana</i> Wall ex Royle.	0.061	0.044	0.035	0.047
13.	<i>Sophora mollis</i> (Royle.) Baker.	0.093	0.121	0.072	0.095
Average		0.087	0.074	0.061	0.038

C. Herbs / Forbs					
14.	<i>Artemisia parviflora</i> Roxb.	0.211	0.072	0.089	0.124
15.	<i>Cichorium intybus</i> L.	0.199	0.181	0.251	0.210
16.	<i>Datura stramonium</i> L.	0.238	0.099	0.077	0.138
17.	<i>Ferula jaeschkeana</i> Vatke.	0.084	0.051	0.035	0.057
18.	<i>Glycyrrhiza glabra</i> L.	0.077	0.060	0.039	0.059
19.	<i>Mentha longifolia</i> (L.) Huds.	0.164	0.189	0.199	0.184
20.	<i>Nepeta cataria</i> L.	0.174	0.123	0.130	0.142
21.	<i>Rheum emodi</i> Wall ex Meissn.	0.177	0.088	0.064	0.110
22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.171	0.130	0.145	0.149
23.	<i>Trifolium repens</i> L.	0.208	0.214	0.225	0.216
24.	<i>Verbascum thapsus</i> L.	0.118	6.647	0.126	2.297
Average		0.165	0.714	0.125	0.153
D. Grasses					
25.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	0.062	0.072	0.068	0.067
26.	<i>Cynodon dactylon</i> (L.) Pers. <i>Phragmites karka</i> (Retz.)	0.124	0.100	0.102	0.109
27.	Trin ex Steud.	0.073	0.116	0.057	0.082
28.	<i>Saccharum spontaneum</i> L.	0.037	0.076	0.108	0.074
Average		0.074	0.091	0.084	0.083

Table 32. ANOVA showing mean square values and P values for mineral contents, proximate composition and cell wall constituents of different plant species at three phenological stages of Mastuj Valley, District Chitral.

Mineral Contents														
Source of variation	Degree of freedom	Mean Square Values (P values)												
		Al	Ca	Cd	Cr	Co	Cu	Fe	Mg	Mn	K	Si	Sr	Zn
B/W Phenological stages	2	31.59 (P=0.005)	9679.5 (P=0.01)	0.00 (P=0.10)	0.006 (P=0.005)	0.001 (P=0.009)	0.00 (P=0.052)	57.45 (P=0.004)	2.54 (P=0.549)	125.24 (P=0.271)	127.91 (P=0.00)	48.54 (P=0.742)	0.92 (P=0.328)	0.45 (P=0.413)
B/W Plant species	27	13.02 (P=0.00)	7323.7 (P=0.00)	0.003 (P=0.00)	0.378 (P=0.00)	0.019 (P=0.00)	0.007 (P=0.00)	33.83 (P=0.00)	36.68 (P=0.00)	236.21 (P=0.001)	20.21 (P=0.49)	148.05 (P=0.590)	3.26 (P=0.00)	0.52 (P=0.448)
Error	54	5.529	1938.9	0.00	0.001	0.00	0.00	9.58	4.20	937.02	20.31	161.96	0.81	0.51
Coefficient of variation		80.33%	40.21%	5.71%	6.04%	20.37%	8.67%	57.10%	16.47%	111.86%	17.56%	216.70%	68.76%	380.74%
Proximate Composition														
Source of variation	Degree of freedom	Mean Square Values (P values)												
		Organic matter		Moisture		Ash		Crude protein		Fat		Crude fiber		NFE
B/W Phenological stages	2	0.434 (P=0.650)		0.404 (P=0.671)		28.542 (P=0.266)		367.574 (P=0.00)		89.966 (P=0.041)		19.416 (P=0.491)		39.811 (P=0.600)
B/W Plant species	27	3.369 (P=0.00)		3.348 (P=0.00)		55.775 (P=0.00)		122.183 (P=0.00)		185.208 (P=0.00)		167.887 (P=0.00)		394.835 (P=0.00)
Error	54	1.00		1.007		21.042		18.088		26.590		26.960		77.377
Coefficient of variation		1.08%		13.63%		37.15%		28.35%		35.04%		26.09%		28.69%
Cell Wall Constituents														
Source of variation	Degree of freedom	Mean Square Values (P values)												
		NDF		ADF		Lignin		Hemicellulose				Cellulose		
B/W Phenological stages	2	77.940 (P=0.697)		109.875 (P=0.283)		155.126 (P=0.152)		4.271 (P=0.912)				13.437 (P=0.359)		
B/W Plant species	27	310.404 (P=0.124)		280.090 (P=0.00)		214.702 (P=0.00)		142.648 (P=0.00)				94.966 (P=0.00)		
Error	54	214.839		85.036		79.491		46.657				12.873		
Coefficient of variation		31.47%		28.90%		53.81%		44.04%				41.92%		

C. Proximate composition

The results for proximate composition are shown in Table 33.

1. Dry Matter (DM %)

Table 33 shows that the dry matter among trees ranged from 87.21 % (*Elaeagnus angustifolia*) to 93.58 % (*Juniperus excelsa*). On the average, *Betula utilis* had the highest dry matter (93.05 %) contents. It was followed by *Juniperus excelsa* (93.03 %) and *Hippophae rhamnoides* (91.92 %). In *Betula* and *Juniperus* the dry matter increased from pre-reproductive stage to post-reproductive stage whereas in *Elaeagnus* and *Tamarix* highest dry matter was achieved at reproductive stage than the other stages. In *Hippophae* maximum dry matter was observed at pre-reproductive stage (92.44 %), followed by post-reproductive stage (92.34 %) and reproductive stage (90.98 %). The dry matter among shrubs ranged from 91.02 % (*Acantholimon longiscapum*) to 94.33 % (*Capparis spinosa*). The average values showed that *Capparis* had the highest dry matter (93.84 %), which was followed by *Haloxylon griffithii* (92.56 %) and *Sophora mollis* (92.29 %). In *Acantholimon*, *Berberis*, *Capparis*, *Ephedra*, *Myricaria* and *Rosa webbiana* the amount of dry matter decreased towards the maturity. In *Haloxylon* and *Sophora mollis* the dry matter increased towards the maturity of plants. Among herbs, the amount of dry matter varied from 91.42 % (*Rheum emodi*) to 94.91 % (*Ferula jaeschkeana*). As a whole *Mentha longifolia* had the highest level of dry matter (93.94 %), *Verbascum thapsus* (93.88 %) and *Ferula jaeschkeana* (93.85 %) followed it. In *Cichorium*, *Mentha*, *Salvia* and *Verbascum thapsus* the dry matter progressively increased with maturity (Table 32). On the contrary, the dry matter decreased in *Artemisia* and *Datura* from pre-reproductive stage to post-reproductive stage. *Ferula*, *Nepeta* and *Trifolium* had highest dry matter at reproductive stage. The dry matter in *Glycyrrhiza* and *Rheum* was highest at pre-reproductive stage. The dry matter among grasses fluctuated from 89.11 % to 94.71 % (*Saccharum spontaneum*). Maximum average dry matter was observed for *Calamogrostris pseudophragmites* and *Phragmites karka* (94.42 %), which was followed by *Cynodon dactylon* (93.81 %). The amount of dry matter increased towards maturity in *Cynodon* and *Phragmites*. *Calamogrostris* had highest at reproductive stage. *Saccharum*

had highest dry matter at pre-reproductive stage (Fig.21, Table 33). Statistical analysis showed that organic matter exhibited non-significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32).

2. Moisture contents (%)

The moisture contents among trees ranged from 6.42 % (*Juniperus excelsa*) to 12.79 % (*Elaeagnus angustifolia*). The overall average for trees, showed *Elaeagnus* and *Tamarix dioica* had the highest (9.07 %) moisture contents (Table 33). They were followed by *Hippophae rhamnoides* (8.08 %). *Betula*, *Elaeagnus* and *Tamarix* had the highest moisture contents at pre-reproductive stage. *Hippophae* and *Juniperus* had highest moisture contents at reproductive stage. In shrubs, moisture contents ranged from 5.67 % (*Capparis spinosa*) to 9.94 % (*Myricaria elegans*). The average values showed that *Myricaria* had the maximum moisture contents (9.03 %), which was followed by *Rosa webbiana* (8.52 %) and *Acantholimon longiscapum* (8.36 %). The moisture contents decreased with maturity in *Haloxylon griffithii* and *Sophora mollis*, while in rest of the species the moisture contents progressively increased towards the maturity of plants (Table 33). Among herbs, moisture contents ranged from 5.09 % (*Ferula jaeschkeana*) to 8.58 % (*Rheum emodi*). The average values showed that *Artemisia parviflora* had the highest moisture contents (8.20 %), closely appeared by *Nepeta cataria* (8.12 %) and *Datura stramonium* (7.97 %). The moisture contents increased in *Artemisia* and *Datura* with maturity. On the contrary the moisture contents decreased with maturity in *Mentha*, *Salvia* and *Verbascum*. The moisture contents were highest at pre-reproductive stage in *Cichorium*, *Ferula*, *Nepeta* and *Trifolium*. *Glycyrrhiza* and *Rheum emodi* had the highest moisture contents values at reproductive stage. The moisture contents ranged from 5.29 % to 10.89 % in *Saccharum spontaneum* in grasses. The average values showed that *Saccharum* had the highest moisture contents (7.33 %), followed by *Cynodon dactylon* (6.18 %) and *Calamogrostris pseudophragmites* (5.58 %). *Calamogrostris* and *Phragmites* had highest moisture contents at pre-reproductive stage, whereas *Cynodon* and *Saccharum* had maximum moisture contents at reproductive stage (Fig. 22, Table 33). Statistical analysis revealed that moisture

exhibited non-significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32).

3. Ash contents (%)

The ash contents varied from 4.25 % (*Hippophae rhamnoides*) to 13.43 % (*Tamarix dioica*) among trees (Table 33). *Tamarix* on the average had the highest ash contents (11.81 %), which was followed by *Juniperus excelsa* (9.53 %) and *Elaeagnus angustifolia* (9.33 %). *Betula* and *Juniperus* exhibited highest ash contents at pre-reproductive stage, while *Elaeagnus* and *Hippophae* had maximum at post-reproductive stage. *Tamarix* gave maximum ash contents at reproductive stage (13.43 %), followed by post-reproductive stage (11.23 %) and pre-reproductive stage (10.79 %). Among shrubs, ash contents fluctuated from 5.20 % (*Berberis lycium*) to 30.32 % (*Sophora mollis*). The average values exhibited that *Capparis spinosa* had the highest ash contents (23.56 %), *Sophora mollis* (15.84 %) and *Haloxylon griffithii* (14.75 %) were respectively next in order. *Acantholimon*, *Berberis*, *Capparis* and *Rosa webbiana* contained highest ash contents at reproductive stage. *Ephedra*, *Haloxylon* and *Myricaria* exhibited highest ash contents at pre-reproductive stage (Table 32). While *Rosa webbiana* had maximum at reproductive stage (11.90 %). The ash contents in *Sophora mollis* enhanced with maturity. The ash contents among herbs varied from 2.40 % (*Cichorium intybus*) to 28.20 % (*Verbascum thapsus*). The average values showed that *Ferula jaeschkeana* contained the highest ash contents (18.56 %), *Mentha longifolia* (18.8 %) and *Verbascum thapsus* (18.03 %) were next in order (Table 33). The ash contents increased towards the maturity in *Glycyrrhiza*, *Nepeta* and *Verbascum*. *Artemisia*, *Salvia* and *Trifolium* highest ash contents at pre-reproductive stage, while *Datura* and *Ferula* had highest value at reproductive stage. In *Mentha longifolia* and *Rheum emodi* ash contents were highest at post-reproductive stage. Among grasses, ash contents varied from 4.85 % (*Saccharum spontaneum*) to 18.98 % (*Phragmites karka*). The average values indicated that *Calamogrostris* exhibited the highest ash contents (17.50 %). It was followed by *Phragmites karka* (15.14 %) and *Cynodon dactylon* (9.55 %), respectively. *Cynodon* and *Phragmites* had the highest ash contents at reproductive stage. *Calamogrostris* showed the maximum at post-reproductive stage and *Saccharum* at pre-reproductive stage (Fig. 23, Table 33). Anova showed that ash exhibited non-significant variation at α 0.05

among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32).

4. Crude Protein (%)

The crude protein among trees fluctuated from 4.99 % (*Tamarix dioica*) to 24.21 % (*Hippophae rhamnoides*). The overall average for trees (Table 33) observed that *Elaeagnus angustifolia* contained the highest crude protein (19.51 %), followed by *Hippophae rhamnoides* (18.46 %) and *Betula utilis* (11.64 %). The crude protein decreased with maturity in *Betula* and *Elaeagnus*. *Hippophae* and *Tamarix* had highest value at pre-reproductive stage. For *Juniperus excelsa* the highest amount of crude protein was found at post-reproductive stage (10.07 %), followed by pre-reproductive stage (8.67 %) and reproductive stage (7.54 %). Among shrubs, the crude protein fluctuated from 6.87 % (*Acantholimon longiscapum*) to 34.40 % (*Capparis spinosa*). On the whole *Capparis* contained the highest crude protein (22.55 %), followed by *Sophora mollis* (20.64 %) and *Haloxylon griffithii* (19.35 %). *Acantholimon*, *Berberis* and *Myricaria* contained highest crude protein at reproductive stage. *Capparis*, *Ephedra* and *Rosa webbiana* was highest at pre-reproductive stage. The crude protein decreased towards maturity in *Haloxylon*, on the other hand *Sophora* showed increased crude protein with the maturity. Crude protein in herbs ranged from 0.02 % (*Mentha longifolia*) to 40.96 % (*Datura stramonium*). Based on the average the highest crude protein (32.81 %) was showed by *Datura*, *Glycyrrhiza glabra* (26.63 %) and *Trifolium repens* (21.33 %) followed it. Crude protein decreased with advancing age in *Artemisia*, *Cichorium*, *Datura*, *Glycyrrhiza*, *Nepeta*, *Salvia*, *Trifolium* and *Verbascum thapsus*. *Mentha longifolia* and *Rheum emodi* exhibited the highest crude protein at reproductive stage. *Ferula* had the highest value at pre-reproductive stage. Crude protein among grasses varied from 3.70 % (*Calamogrostris pseudophragmites*) to 20.01 % (*Cynodon dactylon*). On the average *Cynodon* had the highest crude protein (13.48 %), followed by *Phragmites karka* (9.24 %) and *Saccharum spontaneum* (7.27 %). The crude protein contents generally decreased with advancing age in grasses (Fig. 24, Table 33). Anova showed that crude protein revealed highly significant variation at α 0.01 among the phenological stages and plant species (Table 32).

5. Fat (%)

Among trees, fat contents ranged from 2.16 % (*Hippophae rhamnoides*) to 30.16 % (*Juniperus excelsa*). *Juniperus* on the average showed the highest fat (24.34 %). It was approached by *Elaeagnus angustifolia* (21.73 %) and *Tamarix dioica* (16.48 %). The amount of fat enhanced with maturity in *Betula* and *Hippophae*. The fat contents was highest at pre-reproductive stage (27.49 %) in *Elaeagnus*. *Juniperus* had the maximum fats at reproductive stage (30.16 %) and *Tamarix* had the highest (26.37 %) at post-reproductive stage. The fat contents ranged from 1.08 % (*Acantholimon longiscapum*) to 33.75 % (*Rosa webbiana*) in shrubs. On average basis *Myricaria* contained the highest fats (29.17 %). *Rosa* (27.24 %) and *Haloxylon* (15.79 %) followed it. The fat contents progressively increased with seasonal changes of plants in *Acantholimon*, *Berberis*, *Haloxylon* and *Sophora mollis*. *Capparis* and *Myricaria* showed decreased towards maturity. *Ephedra* and *Rosa webbiana* exhibited highest fats at reproductive stage. The fat contents varied from 1.07 % (*Trifolium repens*) to 38.99 % (*Verbascum thapsus*) among herbs. The averages showed that *Glycyrrhiza glabra* had the highest fat contents (24.93 %), closely approached by *Verbascum* (24.81 %) and *Mentha longifolia* (22 %). *Datura* and *Nepeta* exhibited increase in fats with season. In rest of the species fat contents were highest at reproductive stage. Among grasses, fat contents fluctuated between 1.06 % (*Calamogrostris pseudophragmites*) and 12.83 % (*Cynodon dactylon*). Taking the averages, *Cynodon* contained the highest fat contents (10.65 %), *Saccharum spontaneum* (10.05 %) and *Phragmites karka* (8.83 %) followed it. Fat contents decreased with advancing phenological stages in *Phragmites* and *Saccharum spontaneum*. *Calamogrostris* showed maximum at pre-reproductive stage (4.25 %). It was highest at reproductive stage in *Cynodon dactylon* (Fig. 25, Table 33). Fat showed significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32).

6. Crude Fiber (CF)

Crude fiber among the trees varied from 5.50 % (*Hippophae* and *Tamarix*) to 39.84 % (*Juniperus excelsa*). On average, (Table 33) *Juniperus* showed the highest crude fiber (27.94 %), followed by *Betula utilis* (18.24 %) and *Elaeagnus angustifolia* (15.12

%). The crude fiber contents increased towards the maturity in *Betula* and *Elaeagnus*. *Juniperus* showed decreased CF towards the maturity. *Hippophae* contained maximum CF at pre-reproductive stage, while it was highest at reproductive stage in *Tamarix*. In shrubs crude fiber ranged from 7.08 % (*Rosa webbiana*) to 35.71 % (*Acantholimon longiscapum*). *Acantholimon* had the highest average crude fiber contents (34.90 %). It was approached by *Myricaria elegans* (24.94 %) and *Haloxylon griffithii* (22.84 %). Crude fiber contents increased with advancing phenology in *Acantholimon*, *Haloxylon*, *Myricaria*, *Rosa* and *Sophora mollis*. While *Ephedra* decreased with the maturity. *Berberis* contained highest CF at post-reproductive stage and *Capparis* at reproductive stage. In herbaceous species CF ranged from minimum of 7.08 % (*Datura stramonium*) to 37.00 % (*Salvia nubicola*). Across the species *Verbascum thapsus* had the highest (29.46 %), followed by *Cichorium intybus* (27.01 %) and *Salvia nubicola* (26.54 %). Crude fiber contents generally enhanced with age in *Artemisia*, *Cichorium*, *Ferula* and *Rheum emodi*. *Glycyrrhiza*, *Mentha* and *Trifolium* had highest ranks at reproductive stage. *Nepeta*, *Salvia* and *Verbascum* exhibited highest at pre-reproductive stage. The crude fiber contents in grasses ranged from 21.23 % (*Cynodon dactylon*) to 39.26 % (*Saccharum spontaneum*). On the basis of average *Saccharum* displayed the highest (36.20 %) crude fiber. It was approached by *Phragmites karka* (29.3 %) and *Calamogrostris pseudophragmites* (26.81 %). *Cynodon dactylon* showed decreased with age. The crude fiber was highest at post-reproductive stage (28.08 %) in *Calamogrostris*. *Phragmites* had highest at pre-reproductive stage (38.26 %) and *Saccharum spontaneum* showed the maximum at reproductive stage (Fig. 26, Table 33). Statistical analysis exhibited that crude fiber showed non-significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32).

7. Nitrogen Free Extract (NFE %)

NFE among trees enhanced from 15.33 % (*Elaeagnus angustifolia*) to maximum of 65.71 % (*Hippophae rhamnoides*). Averagly, *Hippophae* had the highest NFE (54.64 %), followed by *Tamarix dioica* (42.60 %) and *Betula utilis* (40.19 %). The trend of individual species, it was recorded that NFE decreased with age in *Betula utilis* and

increased in *Juniperus excelsa*. NFE was highest at reproductive stage in *Elaeagnus*, *Hippophae* and *Tamarix*. Among shrubs, NFE changed from 6.74 % (*Myricaria elegans*) to 55.82 % (*Berberis lycium*). On the average, *Berberis* had the highest NFE (55.17 %), followed by *Ephedra gerardiana* (44.43 %) and *Rosa webbiana* (34.05 %). There was a progressive increase in NFE with advancing age in *Capparis*, *Ephedra* and *Rosa webbiana*, while *Sophora mollis* showed decrease (Table 33). NFE was highest at reproductive stage in *Berberis* and *Haloxylon*, at pre-reproductive stage in *Acantholimon* and it was highest at post-reproductive stage in *Myricaria*. The NFE among herbs varied from 5.24 % (*Verbascum thapsus*) to 47.23 % (*Artemisia parviflora*). The average showed that *Ferula jaeschkeana* contained the highest NFE (40.19 %). Next were *Cichorium intybus* (33.78 %) and *Artemisia parviflora* (27.29 %). NFE decreased in *Ferula* and *Rheum emodi*, while *Nepeta* showed increase with growing age. In *Artemisia*, *Datura* and *Salvia* NFE had highest values at reproductive stage, *Cichorium*, *Mentha*, *Trifolium* and *Verbascum* at pre-reproductive stage. It was highest at post-reproductive stage (28.19 %) in *Glycyrrhiza glabra*. In grasses, NFE ranged from 19.72 % (*Phragmites karka*) to 46.30 % (*Cynodon dactylon*). The average showed that *Calamogrostris pseudophragmites* contained the highest NFE (41.22 %), followed by *Cynodon dactylon* (37.58 %) and *Saccharum spontaneum* (32.76 %). *Cynodon* and *Phragmites* increased NFE with age. NFE was highest (46.23 %) at reproductive stage in *Calamogrostris* and it was (38.45 %) at post-reproductive stage in *Saccharum spontaneum* (Fig. 27, Table 33). Anova showed that NFE exhibited non-significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32).

Range animal productivity depends upon the amount of nutritive quality of vegetation available to grazing animals. The nutritional demands of livestock vary with age and physiological functions of the grazing animals such as growth maintenance, gestation, fattening and lactation etc. Plant material is divisible into fibrous and non-fibrous fractions. In ruminants, fibre fractions that provide energy are important as celluloses and hemi-celluloses are easily digestible. The phenolic polymers like lignin are almost indigestible that may hinder carbohydrate digestion. Most rangelands of Pakistan have insufficient forage of low palatability due to overstocking (Hussain & Durrani,

2009). Hussain & Durrani (2009) analyzed some fodder species for proximate composition and cell wall constituents from Harboi rangeland, Kalat, Balochistan. Grasses had more DM, CF, NFE, NDF, ADF, carbohydrates and hemicelluloses than shrubs, while shrubs were generally high in ash, CP, EE, N, GE and ADL contents than grasses. Adnan *et al.* (2010) analyzed five medicinal plants for proximate composition and mineral contents from northwest Pakistan. Abara (2011) analyzed proximate and mineral element composition of the tissue and peel of *Dioscorea bulbifera* tuber. The calculated tissue/peel ratios for the proximate principles in the wet and dry samples were below 1.0 except for carbohydrates and energy value which were greater than 1.0, while for the ash, crude protein and crude fat, the tissue/peel ratio was not significantly different for the wet and dry samples. Azim *et al.* (2011) while analyzing fifteen tree leaves and shrubs for proximate composition stated that compared to grasses, fodder trees, shrubs and herbs had relatively higher concentration of CP, NDF, minerals, while their average concentration in ADF and dry matter were lower. This agree with the present study. Bahadur *et al.* (2011) reported proteins, crude fibers, fats and oils, moisture, ash contents, carbohydrates and 16 elements in 5 fodder plant species. Cheema *et al.* (2011) determined the nutritive value of *Morus alba*, *Acacia nilotica*, *Syzygium cumuni* and *Zizyphus jujube* leaves. Foguekem *et al.* (2011) reported that crude protein contents in forage plants varied from 2.97 to 12.76 %, NDF 41.58 to 7.93 % and ADF contents ranged from 32.26 to 56.27 %.

It is concluded that there is great variation in the proximate composition of investigated plants and that this variation is dependent upon species, phenological stage and stage of growth of plants.

Table 33. Proximate composition (%) of some forage plants of Mastuj Valley, District Chitral, Pakistan.

S.No	Plant species	Phenological stages	Organic matter %	Moisture %	Ash %	Crude protein %	Fat %	Crude fiber %	NFE %
1.	A. Trees <i>Betula utilis</i> D. Don.	Pre-reproductive stage	92.46	7.54	9.59	15.82	9.71	14.05	43.28
		Reproductive stage	93.21	6.79	7.05	10.49	16.09	19.30	40.28
		Post-reproductive stage	93.50	6.50	8.31	8.61	18.16	21.39	37.03
		Average	93.05	6.94	8.31	11.64	14.65	18.24	40.19
2.	<i>Elaeagnus angustifolia</i> L.	Pre-reproductive stage	87.21	12.79	9.56	23.94	27.49	10.89	15.33
		Reproductive stage	92.84	7.16	8.60	19.94	17.23	16.69	30.37
		Post-reproductive stage	92.73	7.27	9.84	14.65	20.47	17.79	29.98
		Average	90.92	9.07	9.33	19.51	21.73	15.12	25.22
3.	<i>Hippophae rhamnoides</i> L.	Pre-reproductive stage	92.44	7.56	4.54	24.21	2.16	12.98	48.55
		Reproductive stage	90.98	9.02	4.25	11.13	4.40	5.50	65.71
		Post-reproductive stage	92.34	7.66	7.48	20.05	6.48	8.66	49.67
		Average	91.92	8.08	5.42	18.46	4.34	9.04	54.64
4.	<i>Juniperus excelsa</i> M. Bieb.	Pre-reproductive stage	92.77	7.23	10.47	8.67	14.01	39.84	19.78
		Reproductive stage	92.74	7.26	9.84	7.54	30.16	23.71	21.49
		Post-reproductive stage	93.58	6.42	8.30	10.07	28.85	20.27	26.09
		Average	93.03	6.97	9.53	8.76	24.34	27.94	22.45
5.	<i>Tamarix dioica</i> Roxb ex Roth.	Pre-reproductive stage	90.83	9.17	10.79	13.83	13.20	5.50	47.51
		Reproductive stage	91.04	8.96	13.43	4.99	9.89	13.73	49.00
		Post-reproductive stage	90.91	9.09	11.23	12.67	26.37	9.34	31.31
		Average	90.92	9.07	11.81	10.49	16.48	9.52	42.60
6.	B. Shrubs <i>Acantholimon longiscapum</i> Bokhari.	Pre-reproductive stage	92.09	7.91	7.34	13.64	1.08	34.75	35.27
		Reproductive stage	91.80	8.20	8.53	13.69	7.63	34.26	27.69
		Post-reproductive stage	91.02	8.98	6.96	6.87	12.09	35.71	29.39
		Average	91.63	8.36	7.61	11.4	6.93	34.90	30.78
7.	<i>Berberis lycium</i> Royle.	Pre-reproductive stage	91.64	8.36	5.20	15.61	1.09	14.18	55.56
		Reproductive stage	92.64	7.36	8.56	16.93	2.15	9.17	55.82
		Post-reproductive stage	91.50	8.50	8.36	8.78	3.28	16.94	54.14
		Average	91.92	8.07	7.37	13.77	2.17	13.43	55.17
8.	<i>Capparis spinosa</i> L.	Pre-reproductive stage	94.33	5.67	16.83	34.40	21.16	8.48	13.47
		Reproductive stage	93.68	6.32	27.25	16.05	13.85	17.60	18.92
		Post-reproductive stage	93.51	6.49	26.60	17.22	10.69	16.04	22.96
		Average	93.84	6.16	23.56	22.55	15.23	14.04	18.45
9.	<i>Ephedra gerardiana</i> L.	Pre-reproductive stage	92.06	7.94	9.54	12.14	13.02	16.29	41.07
		Reproductive stage	92.20	7.80	7.81	7.95	18.44	13.02	44.99

		Post-reproductive stage	91.92	8.08	7.13	8.74	14.13	14.68	47.24
		Average	92.06	7.94	8.16	9.61	15.19	14.66	44.43
10.	<i>Haloxylon</i>	Pre-reproductive stage	91.43	8.57	14.95	27.72	12.00	20.78	15.98
	<i>griffithii</i> (Moq.)	Reproductive stage	92.68	7.32	14.66	16.19	16.18	22.65	23.00
	Bunge ex Boiss.	Post-reproductive stage	93.58	6.42	14.64	14.14	19.20	25.11	20.49
		Average	92.56	7.43	14.75	19.35	15.79	22.84	19.82
11.	<i>Myricaria</i>	Pre-reproductive stage	91.59	8.41	13.00	19.09	30.51	20.75	8.24
	<i>elegans</i> Royle.	Reproductive stage	91.26	8.74	12.00	19.42	29.00	24.09	6.74
		Post-reproductive stage	90.06	9.94	12.00	11.25	28.00	29.98	8.83
		Average	90.97	9.03	12.33	16.58	29.17	24.94	7.93
12.	<i>Rosa webbiana</i>	Pre-reproductive stage	91.86	8.14	7.18	18.25	32.63	7.08	26.73
	Wall ex Royle.	Reproductive stage	91.49	8.51	11.90	7.25	33.75	9.83	28.76
		Post-reproductive stage	91.09	8.91	8.33	9.22	15.35	11.52	46.66
		Average	91.48	8.52	9.13	11.57	27.24	9.47	34.05
13.	<i>Sophora mollis</i>	Pre-reproductive stage	92.61	7.39	7.25	19.89	10.79	9.17	45.51
	(Royle.) Baker.	Reproductive stage	91.61	8.39	9.97	20.25	13.09	9.27	39.04
		Post-reproductive stage	92.66	7.34	30.32	21.78	16.17	10.79	13.60
		Average	92.29	7.70	15.84	20.64	13.35	9.74	32.71
14.	C. Herbs/Forbs								
	<i>Artemisia</i>	Pre-reproductive stage	92.12	7.88	20.86	29.92	18.47	14.65	8.21
	<i>parviflora</i>	Reproductive stage	91.71	8.29	9.52	13.70	22.90	16.64	47.23
	Roxb.	Post-reproductive stage	91.56	8.44	10.39	11.04	18.57	25.11	26.45
		Average	91.79	8.20	13.59	18.22	19.98	18.8	27.29
15.	<i>Cichorium</i>	Pre-reproductive stage	92.98	7.02	2.40	16.55	6.45	21.49	46.09
	<i>intybus</i> L.	Reproductive stage	93.01	6.99	13.38	14.19	10.73	27.94	26.77
		Post-reproductive stage	93.31	6.69	12.34	12.29	8.57	31.60	28.50
		Average	93.1	6.9	9.37	14.34	8.58	27.01	33.78
16.	<i>Datura</i>	Pre-reproductive stage	92.58	7.42	10.00	40.96	17.27	15.00	9.36
	<i>stramonium</i> L.	Reproductive stage	91.85	8.15	11.00	31.60	17.42	7.08	24.76
		Post-reproductive stage	91.64	8.36	9.00	25.89	19.64	18.01	19.09
		Average	92.02	7.97	10	32.81	18.11	13.36	17.73
17.	<i>Ferula</i>	Pre-reproductive stage	93.15	6.85	18.33	16.01	2.15	13.41	43.24
	<i>jaeschkeana</i>	Reproductive stage	94.91	5.09	22.52	7.74	7.37	16.86	40.41
	Vatke.	Post-reproductive stage	93.51	6.49	14.85	8.57	2.14	31.01	36.93
		Average	93.85	6.14	18.56	10.77	3.88	14.42	40.19
18.	<i>Glycyrrhiza</i>	Pre-reproductive stage	93.06	6.94	8.00	31.81	22.59	12.00	18.66
	<i>glabra</i> L.	Reproductive stage	91.69	8.31	9.40	26.18	30.54	15.78	9.79
		Post-reproductive stage	92.34	7.66	11.40	21.90	21.66	9.19	28.19
		Average	92.36	7.63	9.6	26.63	24.93	12.32	18.88
19.	<i>Mentha</i>	Pre-reproductive stage	93.78	6.22	19.10	0.02	21.31	15.99	37.37
	<i>longifolia</i> (L.)	Reproductive stage	93.52	6.48	15.46	13.85	24.59	21.38	18.24
	Huds.	Post-reproductive stage	94.53	5.47	21.84	8.52	20.10	21.11	22.96

Average			93.94	6.05	18.8	7.46	22	19.49	26.19
20.	<i>Nepeta cataria</i> L.	Pre-reproductive stage	91.66	8.34	16.57	23.18	8.73	23.46	19.72
		Reproductive stage	92.17	7.83	16.57	19.75	9.76	20.60	25.48
		Post-reproductive stage	91.79	8.21	17.97	14.48	9.80	17.00	32.54
Average			91.87	8.12	17.03	19.13	9.43	20.35	25.91
21.	<i>Rheum emodi</i> Wall ex Meissn.	Pre-reproductive stage	92.74	7.26	18.24	21.38	5.39	10.00	37.72
		Reproductive stage	91.42	8.58	9.55	26.80	6.55	14.22	34.29
		Post-reproductive stage	92.01	7.99	25.44	7.21	6.50	19.00	33.86
Average			92.05	7.94	17.74	18.46	6.14	14.40	35.29
22.	<i>Salvia nubicola</i> Wall ex Sweet.	Pre-reproductive stage	93.18	6.82	14.63	18.72	15.02	37.00	7.80
		Reproductive stage	93.72	6.28	9.64	8.57	25.61	15.46	34.44
		Post-reproductive stage	93.83	6.17	13.00	8.21	24.49	27.18	20.96
Average			93.57	6.42	12.42	11.83	21.70	26.54	21.06
23.	<i>Trifolium repens</i> L.	Pre-reproductive stage	93.05	6.95	13.54	25.55	1.07	17.72	35.17
		Reproductive stage	93.55	6.45	11.89	21.68	21.38	20.31	18.29
		Post-reproductive stage	93.26	6.74	10.87	16.77	19.00	18.76	27.86
Average			93.28	6.71	12.1	21.33	13.81	18.93	27.10
24.	<i>Verbascum thapsus</i> L.	Pre-reproductive stage	93.61	6.39	12.53	11.18	17.43	30.95	21.53
		Reproductive stage	93.91	6.09	13.38	9.68	38.99	26.62	5.24
		Post-reproductive stage	94.13	5.87	28.20	4.09	18.01	30.81	13.03
Average			93.88	6.11	18.03	8.31	24.81	29.46	13.26
25.	D. Grasses <i>Calamogrostris pseudophragmites</i> Hall. f.Koeler	Pre-reproductive stage	94.22	5.78	17.70	9.96	4.25	27.57	34.75
		Reproductive stage	94.66	5.34	17.03	5.54	1.06	24.80	46.23
		Post-reproductive stage	94.38	5.62	17.79	3.70	2.12	28.08	42.69
Average			94.42	5.58	17.50	6.4	2.47	26.81	41.22
26.	<i>Cynodon dactylon</i> (L.) Pers.	Pre-reproductive stage	93.81	6.19	10.99	20.01	7.45	25.01	30.34
		Reproductive stage	93.43	6.57	12.29	10.83	12.83	21.38	36.10
		Post-reproductive stage	94.20	5.80	5.38	9.62	11.67	21.23	46.30
Average			93.81	6.18	9.55	13.48	10.65	22.54	37.58
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	Pre-reproductive stage	93.95	6.05	13.19	10.03	12.76	38.26	19.72
		Reproductive stage	94.66	5.34	18.98	9.20	10.56	21.66	34.26
		Post-reproductive stage	94.66	5.34	13.26	8.49	3.17	27.98	41.76
Average			94.42	5.57	15.14	9.24	8.83	29.3	31.91
28.	<i>Saccharum spontaneum</i> L.	Pre-reproductive stage	94.71	5.29	7.85	8.08	12.66	32.20	33.91
		Reproductive stage	89.11	10.89	6.38	7.45	10.08	39.26	25.94
		Post-reproductive stage	94.18	5.82	4.85	6.29	7.43	37.16	38.45
Average			92.66	7.33	6.36	7.27	10.05	36.20	32.76

D. Cell wall constituents

1. Neutral Detergent Fiber (NDF %)

The NDF results are shown in Table 34. The NDF ranged from 23.99 % (*Tamarix dioica*) to 49.45 % (*Elaeagnus angustifolia*) among trees (Table 34). Across the species, it was observed that *Elaeagnus* exhibited maximum NDF (46.80 %). Next were *Betula utilis* (43.30 %) and *Hippophae rhamnoides* (39.47 %). The individual species behaviour showed that *Elaeagnus* had increasing trend with age. *Betula* and *Tamarix* contained highest at reproductive stage, *Hippophae* at pre-reproductive stage (47.95 %) and *Juniperus excelsa* at post-reproductive stage (38.00 %). The NDF among shrubs ranged from 21.97 % (*Myricaria elegans*) to 79.42 % (*Acantholimon longiscapum*). Averagely *Acantholimon* contained the maximum NDF (57.77 %), which was followed by *Sophora mollis* (52.98 %) and *Haloxylon griffithii* (44.09 %). In *Ephedra* and *Myricaria* NDF decreased, while in *Capparis* it increased with advancing age. NDF was maximum at post-reproductive stage in *Berberis* and *Sophora*, at reproductive stage in *Haloxylon* and *Rosa* and at pre-reproductive stage in *Acantholimon*. Among herbs, NDF rosed from 24.00 % to 94.50 % in *Ferula jaeschkeana*. The averages showed that *Rheum* had the highest NDF level (60.16 %), followed by *Datura* (60.13 %) and *Ferula* (58.83 %). *Artemisia*, *Datura* and *Glycyrrhiza* showed enhanced NDF, *Mentha* and *Trifolium* exhibited decreased with growing age (Table 34). NDF was highest at reproductive stage in *Nepeta*, *Salvia*, and *Verbascum*, at post-reproductive stage (85.47 %) in *Cichorium* and at pre-reproductive stage in *Ferula*. NDF ranged among grasses from 27.46 % (*Calamogrostris pseudophragmites*) to 80.84 % (*Phragmites karka*). The overall averages clarified that *Cynodon dactylon* contained the highest NDF contents (65.73 %). Next were *Phragmites karka* (62.36 %) and *Calamogrostris* (58.06 %). *Saccharum spontaneum* exhibited increasing trend with the maturity (Fig. 28, Table 34). Statistical analysis (Anova) showed that NDF contents exhibited non-significant variation at α 0.05 among the phenological stages and plant species (Table 32).

2. Acid Detergent Fiber (ADF %)

Table 34 contains ADF analysis of various species. ADF ranged from 17.98 % (*Hippophae rhamnoides*) to 46.50 % (*Elaeagnus angustifolia*) among trees (Table 34). The average showed that it was maximum in *Elaeagnus* (37.47 %), followed by *Betula utilis* (27.65 %) and *Juniperus excelsa* (26.32 %). There was increasing trend with advancing age in *Elaeagnus* and *Juniperus*. *Hippophae* and *Tamarix* contained the highest ADF at reproductive stage and *Betula* at pre-reproductive stage. Among the shrubs, ADF shifted from 13.50 % (*Myricaria elegans*) to 57.44 % (*Acantholimon longiscapum*). The averages showed that *Acantholimon* had the highest ADF (44.30 %), followed by *Sophora mollis* (39.65 %) and *Haloxylon griffithii* (25.96 %). The ADF contents were highest at pre-reproductive stage in *Acantholimon*, *Berberis*, *Ephedra* and *Rosa webbiana* and at post-reproductive stage in *Haloxylon*, *Myricaria* and *Sophora*. The herbs showed variation from 16.97 % (*Glycyrrhiza glabra*) to 72.50 % (*Ferula jaeschkeana*) among themselves. Thinking of averages the maximum ADF (53.64 %) were recorded for *Datura*, followed by *Rheum emodi* (44.5 %) and *Ferula* (44.4 %). There was increasing trend with advancing age in *Artemisia*, *Cichorium*, *Glycyrrhiza* and *Rheum emodi*. *Datura*, *Mentha*, *Nepeta*, *Salvia*, *Trifolium* and *Verbascum thapsus* exhibited highest ADF at reproductive stage and *Ferula* at pre-reproductive stage. The ADF contents changed from 16.97 % (*Cynodon dactylon*) to 59.88 % (*Phragmites karka*) among grasses. On average basis *Phragmites* contained the highest ADF (45.56 %), followed by *Calamogrostris pseudophragmites* (41.53 %) and *Saccharum spontaneum* (33.25 %). ADF increased with advancing age in *Saccharum spontaneum* (Fig. 29, Table 34). Anova showed that ADF contents exhibited non-significant variation at α 0.05 among phenological stages and highly significant variation at α 0.01 among plant species (Tabl 32).

3. Lignin (%)

Lignin increased from 3.00 % (*Hippophae rhamnoides* and *Tamarix dioica*) to 24.49 % (*Betula utilis*) among trees (Table 34). *Betula* showed highest lignin contents (21.48 %), closely approached by *Juniperus excelsa* (15.16 %) and *Elaeagnus angustifolia* (12.49 %). Lignins decreased with advancing age in *Elaeagnus angustifolia*.

Betula and *Hippophae* had highest at pre-reproductive stage, *Juniperus* at post-reproductive stage and *Tamarix* at reproductive stage. The shrubs showed that lignin raised from 2.00 % (*Acantholimon longiscapum* and *Myricaria elegans*) to 39.00 % (*Sophora mollis*) among themselves. When averaged *Sophora* displayed the highest lignin (27.32 %) contents, followed by *Haloxylon griffithii* (15.14 %) and *Ephedra gerardiana* (14.33 %). The trend in individual species showed that lignin contents progressively decreased in *Acantholimon*, *Capparis* and *Ephedra*, while it increased in *Haloxylon* and *Myricaria* with aging (Table 34). Lignin was highest at pre-reproductive stage in *Rosa webbiana* at post-reproductive stage in *Sophora mollis*. The lignin contents among herbs showed a drastic increase from 0.50 % (*Datura stramonium*) to 64.50 % (*Ferula jaeschkeana*). The averages showed that it was maximum (34.66 %) in *Ferula*. *Rheum emodi* (28.5 %) and *Cichorium intybus* (23.99 %) followed it. Lignin contents increased with aging in *Artemisia*, *Cichorium*, *Glycyrrhiza*, *Rheum* and *Trifolium*. However, *Nepeta cataria* showed decrease. In *Mentha*, *Salvia* and *Verbascum*, lignin contents were highest at reproductive stage. *Ferula* had highest at pre-reproductive stage. The lignin contents increased from 7.98 % (*Cynodon dactylon*) to 49.90 % (*Phragmites karka*) among grasses. When averaged *Phragmites* had the highest lignin contents (30.93 %), followed by *Saccharum spontaneum* (26.93 %) and *Calamogrostris pseudophragmites* (25.62 %). Lignin contents showed increase with aging in *Saccharum spontaneum* (Fig. 30, Table 34). Anova revealed that lignin contents exhibited non-significant variation at α 0.05 among phenological stages and highly significant variation at α 0.01 among plant species (Tabl 32).

4. Hemicellulose (%)

The hemicellulose contents were non detectable in *Juniperus excelsa* that enhanced to 29.97 % (*Hippophae rhamnoides*) among trees (Table 34). Across the tree species, it was observed that *Hippophae* had the highest hemicellulose (20.82 %) contents, which was followed by *Betula utilis* (15.65 %) and *Elaeagnus angustifolia* (9.33 %). *Elaeagnus angustifolia* and *Juniperus excelsa* exhibited increased hemicellulose with aging. It was highest at reproductive stage in *Betula* and *Tamarix*. Among shrubs, hemicellulose changed from 6.45 % (*Acantholimon longiscapum*) to

31.44 % (*Rosa webbiana*). The averages showed that *Rosa webbiana* exhibited the maximum hemicellulose (18.62 %) contents, followed by *Haloxylon griffithii* (18.13 %) and *Myricaria elegans* (15.72 %). The individual trend for species showed that there was decrease with aging in *Acantholimon* and *Ephedra*. It increased in *Berberis*, *Capparis*, *Myricaria* and *Sophora mollis*. *Haloxylon* and *Rosa webbiana* had highest at reproductive stage. Among herbs, hemicellulose ranged from 4.00 % (*Datura stramonium*) to 26.50 % (*Cichorium intybus* and *Trifolium repens*). When averaged *Trifolium* contained the highest hemicellulose (22.66 %) contents, followed by *Glycyrrhiza glabra* (20.96 %) and *Nepeta cataria* (19.82 %). Table 33 shows that there was increasing trend towards maturity in *Artemisia parviflora* and *Salvia nubicola*, while it decreased in *Trifolium repens*. Hemicellulose was maximum at post-reproductive stage in *Datura*, *Ferula* and *Rheum*, at pre-reproductive stage in *Cichorium* and *Mentha* while *Glycyrrhiza*, *Nepeta* and *Verbascum* had highest at reproductive stage. Hemicellulose shifted from 3.49 % (*Saccharum spontaneum*) to 42.94 % (*Cynodon dactylon*) among grasses. As a whole *Cynodon* had the highest hemicellulose (38.94 %) contents, followed by *Calamogrostris pseudophragmites* (22.53 %) and *Phragmites karka* (16.79 %). *Cynodon* and *Phragmites* exhibited highest hemicellulose at pre-reproductive stage (Fig. 31, Table 34). Anova showed that hemicellulose contents exhibited non-significant variation at α 0.05 among phenological stages and highly significant variation at α 0.01 among plant species (Table 32).

5. Cellulose (%)

The cellulose contents among trees (Table 34) rised from 4.00 % (*Betula utilis*) to 10.49 % (*Hippophae hamnoides*). The overall averages for trees showed that *Hippophae* contained the highest cellulose contents (9.16 %), followed by *Elaeagnus angustifolia* (8.32 %) and *Juniperus excelsa* (7.83 %). The trend for individual species showed that cellulose contents decreased with aging in *Elaeagnus angustifolia*, while it increased in *Tamarix dioica*. *Betula*, *Hippophae* and *Juniperus excelsa* contained highest cellulose at reproductive stage. Among shrubs cellulose varied from 3.60 % (*Rosa webbiana*) to 47.45 % (*Acantholimon longiscapum*). The averages showed that *Acantholimon* exhibited the highest cellulose contents (35.81 %). Next were *Berberis lycium* (9.66 %) and

Haloxylon griffithii (9.31 %). The cellulose contents decreased in *Berberis lycium*, while it increased in *Capparis* with advancing age. *Acantholimon*, *Ephedra* and *Sophora* exhibited highest at pre-reproductive stage, *Myricaria* at reproductive stage and *Haloxylon* at post-reproductive stage. The cellulose contents in herbs improved from 3.50 % (*Mentha longifolia*) to 16.50 % (*Rheum emodi*). The averages showed that *Rheum* had the maximum cellulose contents (11.33 %), followed by *Nepeta cateria* (9.99 %) and *Salvia nubicola* (8.99 %). *Artemisia*, *Glycyrrhiza*, *Mentha*, *Rheum*, *Salvia* and *Trifolium repens* showed decreasing trend towards the maturity. *Cichorium*, *Datura*, *Ferula* and *Nepeta* had highest cellulose at reproductive stage, *Verbascum* at pre-reproductive stage. The cellulose contents in grasses enhanced from 3.48 % (*Saccharum spontaneum*) to 7.99 % (*Calamogrostris pseudophragmites*). The average values showed that *Calamogrostris* contained the highest cellulose contents (6.09 %), followed by *Phragmites karka* (5.32 %) and *Saccharum spontaneum* (5.15 %). The cellulose contents decreased in *Cynodon dactylon* with maturity. The cellulose contents were maximum at reproductive stage in *Phragmites* and *Saccharum*, while *Calamogrostris* had highest at pre-reproductive stage (Fig. 32, Table 34). Anova showed that cellulose contents exhibited non-significant variation at α 0.05 among phenological stages and highly significant variation at α 0.01 among plant species (Tabl 32).

Statistical Analysis

Overall Anova showed that Al, Ca, Cr, Co and Fe contents exhibited highly significant variation among the three phenological stages and among the plant species at α 0.01. Cd, Cu, Mg, Mn and Sr showed non-significant variation among the phonological stages at α 0.05 and exhibited highly significant variation among the plant species at α 0.01. K contents showed highly significant variation among phenological stages at α 0.01 and non-significant variation among plant species at α 0.05. Si and Zn contents revealed non-significant variation both among the phenological stages and plant species (Table 32). Crude protein (CP) showed highly significant variation among the phenological stages and plant species at α 0.01. Fat exhibited significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species.

Organic matter, moisture, ash, crude fiber and NFF showed non-significant variation at α 0.05 among the phenological stages and highly significant variation at α 0.01 among the plant species (Table 32). ADF, lignin, hemicellulose and cellulose contents showed non-significant variation at α 0.05 among phenological stages and highly significant variation at α 0.01 among the plant species. NDF contents exhibited non-significant variation at α 0.05 among the phenological stages and among the plant species (Table 32).

Table 34. Cell wall constituents of some forage plants of Mastuj Valley, District Chitral, Pakistan.

S. No.	Plant species	Phenological stages	NDF %	ADF%	Lignin %	Hemi-cellulose %	Cellulose %
1.	A. Trees <i>Betula utilis</i> D. Don.	Pre-reproductive stage	37.98	28.99	24.49	9.00	4.00
		Reproductive stage	46.95	26.47	19.48	20.48	5.99
		Post-reproductive stage	44.98	27.49	20.49	17.49	5.50
		Average	43.30	27.65	21.48	15.65	5.16
2.	<i>Elaeagnus angustifolia</i> L.	Pre-reproductive stage	28.97	26.97	16.48	2.00	9.99
		Reproductive stage	49.45	38.96	10.99	10.49	7.99
		Post-reproductive stage	62.00	46.50	10.00	15.50	7.00
		Average	46.80	37.47	12.49	9.33	8.32
3.	<i>Hippophae rhamnoides</i> L.	Pre-reproductive stage	47.95	17.98	7.99	29.97	7.49
		Reproductive stage	32.98	19.99	3.00	12.99	10.49
		Post-reproductive stage	37.50	18.00	6.50	19.50	9.50
		Average	39.47	18.65	5.83	20.82	9.16
4.	<i>Juniperus excelsa</i> M. Bieb.	Pre-reproductive stage	27.47	23.48	15.48	4.00	6.99
		Reproductive stage	24.50	24.50	9.50	0.00	9.00
		Post-reproductive stage	38.00	31.00	20.50	7.00	7.50
		Average	29.99	26.32	15.16	3.66	7.83
5.	<i>Tamarix dioica</i> Roxb ex Roth.	Pre-reproductive stage	23.99	19.99	13.49	4.00	5.00
		Reproductive stage	37.46	30.47	19.98	6.99	5.49
		Post-reproductive stage	31.00	25.50	3.00	5.50	6.00
		Average	30.81	25.32	12.15	5.49	5.49
6.	B. Shrubs <i>Acantholimon longiscapum</i> Bokhari.	Pre-reproductive stage	79.42	57.44	5.00	21.98	47.45
		Reproductive stage	38.96	26.97	2.50	11.99	18.48
		Post-reproductive stage	54.95	48.50	2.00	6.45	41.51
		Average	57.77	44.30	3.16	13.47	35.81
7.	<i>Berberis lycium</i> Royle.	Pre-reproductive stage	39.48	27.49	13.99	11.99	11.49
		Reproductive stage	37.46	21.98	8.49	15.48	8.99
		Post-reproductive stage	42.98	26.99	16.49	15.99	8.50
		Average	39.97	25.48	12.99	14.48	9.66
8.	<i>Capparis spinosa</i> L.	Pre-reproductive stage	24.00	16.00	6.00	8.00	8.00
		Reproductive stage	36.50	22.50	6.00	14.00	8.50
		Post-reproductive stage	37.00	22.50	5.50	14.50	10.00
		Average	32.5	20.33	5.83	12.16	8.83
9.	<i>Ephedra gerardiana</i> L.	Pre-reproductive stage	46.48	31.48	21.49	14.99	6.00
		Reproductive stage	36.50	23.00	16.00	13.50	4.00
		Post-reproductive stage	34.50	23.00	5.50	11.50	5.50
		Average	39.16	25.82	14.33	13.33	5.16

10.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	Pre-reproductive stage	45.39	21.95	11.47	23.44	9.98
		Reproductive stage	48.45	20.48	12.99	27.97	6.49
		Post-reproductive stage	38.44	35.45	20.97	3.00	11.48
		Average	44.09	25.96	15.14	18.13	9.31
11.	<i>Myricaria elegans</i> Royle.	Pre-reproductive stage	33.43	18.46	2.00	14.97	8.98
		Reproductive stage	29.50	13.50	2.50	16.00	10.00
		Post-reproductive stage	21.97	24.46	15.48	16.21	7.99
		Average	28.3	18.80	6.66	15.72	8.99
12.	<i>Rosa webbiana</i> Wall ex Royle.	Pre-reproductive stage	42.94	28.50	19.41	14.44	3.60
		Reproductive stage	45.91	14.47	4.49	31.44	7.98
		Post-reproductive stage	27.94	17.96	8.48	9.98	7.49
		Average	38.93	20.31	10.79	18.62	6.35
13.	<i>Sophora mollis</i> (Royle.) Baker.	Pre-reproductive stage	47.98	34.98	24.49	12.99	9.50
		Reproductive stage	47.48	34.48	18.49	12.99	8.00
		Post-reproductive stage	63.50	49.50	39.00	14.00	9.00
		Average	52.98	39.65	27.32	13.32	8.83
14.	C. Herbs/Forbs <i>Artemisia</i> <i>parviflora</i> Roxb.	Pre-reproductive stage	36.00	23.50	7.50	12.50	9.00
		Reproductive stage	47.50	34.00	21.50	13.50	8.50
		Post-reproductive stage	53.00	38.50	25.50	14.50	5.50
		Average	45.5	32	18.16	13.5	7.66
15.	<i>Cichorium intybus</i> L.	Pre-reproductive stage	44.00	17.50	10.00	26.50	6.50
		Reproductive stage	25.49	40.48	29.49	15.01	9.00
		Post-reproductive stage	58.47	41.48	32.48	16.99	7.50
		Average	42.65	33.15	23.99	19.5	7.66
16.	<i>Datura stramonium</i> L.	Pre-reproductive stage	56.97	49.98	2.50	7.00	8.50
		Reproductive stage	60.47	56.47	0.50	4.00	9.50
		Post-reproductive stage	62.97	54.47	11.49	8.50	6.50
		Average	60.13	53.64	4.83	6.5	8.16
17.	<i>Ferula jaeschkeana</i> Vatke.	Pre-reproductive stage	94.50	72.50	64.50	22.00	5.50
		Reproductive stage	24.00	25.50	12.00	10.50	6.50
		Post-reproductive stage	58.00	35.00	27.50	23.00	6.00
		Average	58.83	44.4	34.66	18.5	6
18.	<i>Glycyrrhiza glabra</i> L.	Pre-reproductive stage	35.95	16.97	4.99	18.97	11.48
		Reproductive stage	45.41	19.96	10.48	25.45	6.49
		Post-reproductive stage	47.43	28.96	22.47	18.47	4.49
		Average	42.93	21.96	12.64	20.96	7.48
19.	<i>Mentha longifolia</i> (L.) Huds.	Pre-reproductive stage	36.50	25.50	9.00	11.00	11.00
		Reproductive stage	36.48	30.98	15.49	5.50	10.49
		Post-reproductive stage	34.48	25.99	11.49	8.50	3.50
		Average	35.82	27.49	11.99	8.33	8.33
20.	<i>Nepeta cataria</i> L.	Pre-reproductive stage	33.97	17.98	10.49	15.98	5.00

		Reproductive stage	49.00	24.50	8.00	24.50	13.50
		Post-reproductive stage	41.98	22.99	7.50	18.99	11.49
		Average	41.65	21.82	8.56	19.82	9.99
21.	<i>Rheum emodi</i> Wall ex Meissn.	Pre-reproductive stage	57.50	42.50	18.50	15.00	16.50
		Reproductive stage	55.50	45.50	33.00	10.00	9.00
		Post-reproductive stage	67.50	45.50	34.00	22.00	8.50
		Average	60.16	44.5	28.5	15.66	11.33
22.	<i>Salvia nubicola</i> Wall ex Sweet.	Pre-reproductive stage	38.48	33.48	18.49	5.00	11.99
		Reproductive stage	65.50	57.50	19.50	8.00	8.50
		Post-reproductive stage	38.48	29.99	14.99	8.50	6.50
		Average	47.48	40.32	17.66	7.16	8.99
23.	<i>Trifolium repens</i> L.	Pre-reproductive stage	48.00	21.50	8.00	26.50	7.50
		Reproductive stage	46.98	25.99	18.49	20.99	6.50
		Post-reproductive stage	45.50	25.00	19.50	20.50	4.50
		Average	46.82	24.16	15.33	22.66	6.16
24.	<i>Verbascum thapsus</i> L.	Pre-reproductive stage	52.00	37.50	19.00	14.50	9.50
		Reproductive stage	66.50	44.00	26.00	22.50	7.00
		Post-reproductive stage	49.00	39.00	19.00	10.00	7.50
		Average	55.83	40.16	21.33	15.66	8
25.	D. Grasses <i>Calamogrostris</i> <i>pseudophragmites</i> Hall. f. Koeler.	Pre-reproductive stage	70.93	43.96	22.98	26.97	7.99
		Reproductive stage	75.81	46.88	32.42	28.93	4.99
		Post-reproductive stage	27.46	33.75	21.47	11.71	5.29
		Average	58.06	41.53	25.62	22.53	6.09
26.	<i>Cynodon dactylon</i> (L.) Pers.	Pre-reproductive stage	76.88	33.95	26.96	42.94	4.99
		Reproductive stage	49.90	16.97	7.98	32.93	4.49
		Post-reproductive stage	70.43	29.47	22.98	40.96	3.50
		Average	65.73	26.79	19.30	38.94	4.32
27.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	Pre-reproductive stage	68.33	43.89	22.94	24.44	4.49
		Reproductive stage	37.92	32.93	19.96	4.99	7.49
		Post-reproductive stage	80.84	59.88	49.90	20.96	3.99
		Average	62.36	45.56	30.93	16.79	5.32
28.	<i>Saccharum</i> <i>spontaneum</i> L.	Pre-reproductive stage	27.93	22.89	17.91	5.04	3.48
		Reproductive stage	31.95	28.46	19.97	3.49	7.49
		Post-reproductive stage	80.34	48.40	42.91	31.94	4.49
		Average	46.74	33.25	26.93	13.49	5.15

Conservation status of Plants

Studies on the conservation status of plant species in Mastuj Valley revealed that out of 337 plant species, 307 (91.09 %) species were vulnerable, 26 (6.82 %) endangered and 4 (1.18 %) species were rare (Fig. 33, Table 35). *Datura stramonium*, *Cuscuta reflexa*, *Matricaria chamomila* and *Chrysanthemum cinerariifolium* were among the rare species. The maintenance of species in an environment and the durability of rangeland and fallow improvement depend on the choice of population used. The study of abundance and the relationship between the natural distribution of spontaneous legumes species of forage and/or pastoral interest and environmental factors is an important step for an adequate utilization of local genetic resources (Bennani, 2011). Haq (2011) reported that out of 37 species of 31 families from District Battagram, 14 species were critically endangered and 23 species were endangered. Malik *et al.* (2011) recorded 80 medicinal plants of 43 families from the northern region of Kashmir Himalayas. Among them, 9 species were critically endangered, 14 endangered, 24 vulnerable, 28 rare and only 5 were secure. These findings also support the present results.

Major threats to the plant biodiversity in Mastuj Valley are deforestation, overgrazing, loss of habitat and attack of pathogens. The inhabitants of the Valley depend on the plant resources for their various domestic uses and in this way many plants are near to extinction. Conservation and sustainable use of plant resources in the Valley need to be initiated.

Table 35. Conservation status of some plant species of Mastuj Valley, Chitral, Pakistan.

S.No	Plant species	Criteria					Conservation status
		Availability	Collection	Part used	Growth	Total score	
A. Pteridophyta							
1. Family Equisetaceae							
1.	<i>Equisetum ramossimum</i> Desf.	2	3	0	3	8	Vulnerable
2. Family Pteridaceae							
2.	<i>Adiantum venustum</i> D. Don.	0	3	0	3	6	Vulnerable
3.	<i>Pteris</i> sp.	1	3	0	3	7	Vulnerable
B. Gymnospermae							
3. Family Cupressaceae							
4.	<i>Juniperus excelsa</i> M.B.	2	0	0	0	2	Endangered
5.	<i>Juniperus communis</i> L.	1	1	0	0	2	Endangered
4. Family Ephedraceae							
6.	<i>Ephedra gerardiana</i> L.	3	1	0	2	6	Vulnerable
7.	<i>Ephedra intermedia</i> Schrenk & Meyer.	1	3	0	2	6	Vulnerable
C. Monocotyledonae							
5. Family Alliaceae							
8.	<i>Allium carolinianum</i> DC.	0	3	0	3	6	Vulnerable
9.	<i>Allium tuberosum</i> Rottler ex Spreng.	0	3	0	3	6	Vulnerable
6. Family Amaryllidaceae							
10.	<i>Isilirion montanum</i> (Labill.) Hab.	0	3	0	3	6	Vulnerable
7. Family Cyperaceae							
11.	<i>Carex infuscata</i> Nees.	1	2	0	3	6	Vulnerable
12.	<i>Carex diluta</i> M. Bieb.	1	2	0	3	6	Vulnerable
13.	<i>Schoenoplectus litoralis</i> (Schard.) Palla.	0	1	0	2	2	Vulnerable
14.	<i>Scirpus planifolius</i> Grimm.	0	1	0	3	2	Vulnerable
8. Family Iridaceae							
15.	<i>Iris ensata</i> Thunb.	3	0	0	3	6	Vulnerable
16.	<i>Iris germinia</i> L.	0	3	0	3	6	Vulnerable
9. Family Juncaceae							
17.	<i>Juncus articulata</i> L.	1	1	0	3	5	Vulnerable
18.	<i>Juncus himalensis</i> K. L. & Gracke.	0	1	0	3	2	Vulnerable
10. Family Juncaginaceae							
19.	<i>Triglochin palustris</i> L.	1	3	0	3	7	Vulnerable
11. Family Orchidaceae							
20.	<i>Cyperipedium cordigerum</i> D. Don.	1	3	0	3	7	Vulnerable

21.	<i>Dactylorhiza hatagirea</i> D. Don.	0	3	0	3	6	Vulnerable
12. Family Poaceae							
22.	<i>Aeluropus macrostachyus</i> Hack.	1	3	0	3	7	Vulnerable
23.	<i>Alloteropsis crimicina</i> (L.) Stapf.	0	3	0	3	6	Vulnerable
24.	<i>Aristida cynantha</i> Ness & Steud.	2	1	0	4	7	Vulnerable
25.	<i>Avena sativa</i> Retz.	2	1	0	3	6	Vulnerable
26.	<i>Avena barbata</i> Polt ex Link.	1	3	0	3	7	Vulnerable
27.	<i>Bromus gracillimus</i> Bunge.	3	1	0	3	7	Vulnerable
28.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	1	3	0	3	7	Vulnerable
29.	<i>Cynodon dactylon</i> (L.) Pers.	3	0	0	4	7	Vulnerable
30.	<i>Dactylis glomerata</i> L.	2	3	0	3	8	Vulnerable
31.	<i>Dichanthium annulatum</i> (Forssk) Stapf.	2	2	0	4	8	Vulnerable
32.	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	1	3	0	3	7	Vulnerable
33.	<i>Eragrostis minor</i> Host.	1	3	0	3	7	Vulnerable
34.	<i>Eragrostis nigra</i> Nees ex Steud.	0	3	0	3	6	Vulnerable
35.	<i>Eragrostis poaeoides</i> P. Beauv.	1	3	0	3	7	Vulnerable
36.	<i>Hordeum spontaneum</i> C. Koch.	2	2	0	3	7	Vulnerable
37.	<i>Hyparrhenia hirta</i> (L.) Stapf.	0	3	0	3	6	Vulnerable
38.	<i>Ischaemum timorens</i> Kunth.	0	3	0	3	6	Vulnerable
39.	<i>Koeleria gracillis</i> Pers.	1	3	0	3	7	Vulnerable
40.	<i>Lolium rigidum</i> Guad.	1	3	0	3	7	Vulnerable
41.	<i>Lolium persicum</i> Boiss & Hohen ex Boiss.	1	3	0	3	7	Vulnerable
42.	<i>Melica jacqmontii</i> (Regd.) Bar ex Jacq.	2	3	0	2	7	Vulnerable
43.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	3	0	0	3	6	Vulnerable
44.	<i>Poa bulbosa</i> L.	1	3	0	3	7	Vulnerable
45.	<i>Poa sinaica</i> Steud.	0	3	0	3	6	Vulnerable
46.	<i>Saccharum spontaneum</i> L.	3	0	0	3	6	Vulnerable
47.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	2	3	0	3	8	Vulnerable
48.	<i>Setaria intermedia</i> Roem & Schult.	1	3	0	3	7	Vulnerable

49.	<i>Setaria viridis</i> (L.) P. Beauv.	1	3	0	3	7	Vulnerable
13. Family Typhaceae							
50.	<i>Typha angustata</i> Borry. & Chaub.	3	0	0	2	5	Vulnerable
D. Dicotyledonae							
14. Family Amaranthaceae							
51.	<i>Amaranthus cruentus</i> L.	1	3	0	3	7	Vulnerable
52.	<i>Amaranthus hybridus</i> L.	0	3	0	3	6	Vulnerable
53.	<i>Amaranthus retrofractus</i> L.	0	3	0	3	6	Vulnerable
54.	<i>Amaranthus viridis</i> L.	2	2	0	3	7	Vulnerable
15. Family Anacardaceae							
55.	<i>Pistacia integerrima</i> (L.) Steward ex Brand.	2	1	0	0	3	Endangered
56.	<i>Pistacia khinjuk</i> Stock.	1	0	0	0	1	Endangered
16. Family Apiaceae							
57.	<i>Ammi visnaga</i> (L.) Lam.	1	1	2	3	7	Vulnerable
58.	<i>Anethum graveolens</i> L.	1	3	0	3	7	Vulnerable
59.	<i>Bunium persicum</i> (Boiss.) Fedtsch.	1	2	2	3	8	Vulnerable
60.	<i>Carum capticum</i> L.	1	2	2	3	8	Vulnerable
61.	<i>Carum carvi</i> L.	1	0	2	3	6	Vulnerable
62.	<i>Cortia schmidii</i> Nasir.	0	3	0	3	6	Vulnerable
63.	<i>Ferula jaeschkeana</i> Vatke.	2	0	0	3	5	Vulnerable
64.	<i>Ferula</i> Sp.	1	1	0	3	5	Vulnerable
65.	<i>Pleurospermum stylosum</i> Clarke.	0	3	0	3	6	Vulnerable
66.	<i>Primpinella stewartii</i> Dunn. Nasir.	0	3	0	3	6	Vulnerable
67.	<i>Prongus publaria</i> (Lind.) Hiroe.	0	3	0	2	5	Vulnerable
68.	<i>Seseli libanotis</i> (L.) Koch.	0	3	0	3	6	Vulnerable
69.	<i>Torilis arvensis</i> (Huds.) Link.	2	3	0	3	8	Vulnerable
70.	<i>Trachydium roylei</i> Lindl.	0	3	0	3	6	Vulnerable
71.	<i>Trachyspermum ammi</i> (L.) Spargue.	1	1	2	3	7	Vulnerable
17. Family Apocynaceae							
72.	<i>Trachomitum venetum</i> (L.) Woodson	3	0	0	3	6	Vulnerable
18. Family Araceae							
73.	<i>Arisaema jacquemontii</i> Blume.	0	3	0	3	6	Vulnerable
19. Family Asclepiadaceae							
74.	<i>Cynanchum acutum</i> L.	2	1	0	2	5	Vulnerable
75.	<i>Cynanchum arnottianum</i> Wight.	2	1	0	2	5	Vulnerable
20. Family Asteraceae							

76.	<i>Anaphalia gracilis</i> Haud & Mazz.	2	2	0	3	7	Vulnerable
77.	<i>Anthemis cotula</i> L.	1	3	0	3	7	Vulnerable
78.	<i>Anthemis tinctorica</i> L.	1	3	0	3	7	Vulnerable
79.	<i>Artemisia brevifolia</i> Wall ex DC.	3	0	0	2	5	Vulnerable
80.	<i>Artemisia maritima</i> L.	3	0	0	2	5	Vulnerable
81.	<i>Artemisia parviflora</i> Roxb.	3	1	0	3	7	Vulnerable
82.	<i>Artemisia scoparia</i> Waldst. & Kit.	3	0	0	2	5	Vulnerable
83.	<i>Artemisia rutifolia</i> Steph ex Spreng.	2	1	0	2	5	Vulnerable
84.	<i>Artemisia laciniata</i> Willd.	1	1	0	2	4	Endangered
85.	<i>Aster altiacus</i> Willd.	1	3	0	3	7	Vulnerable
86.	<i>Aster amellus</i> auct.	1	2	0	3	6	Vulnerable
87.	<i>Bidens tripartita</i> L.	0	3	0	3	6	Vulnerable
88.	<i>Brchyactis roylei</i> D. C. Wendelbow.	0	3	0	3	6	Vulnerable
89.	<i>Centaurea calcitrapa</i> L.	1	3	0	3	7	Vulnerable
90.	<i>Chondrilla graminea</i> M.Bieb.	2	1	0	3	6	Vulnerable
91.	<i>Chrysanthemum cinerariifolium</i> (Trev.) Vis.	1	2	3	3	9	Rare
92.	<i>Cirsium acaule</i> (L.) Scop.	1	3	0	3	7	Vulnerable
93.	<i>Cirsium argyacanthum</i> D.C.	1	3	0	3	7	Vulnerable
94.	<i>Cichorium intybus</i> L.	3	0	0	3	6	Vulnerable
95.	<i>Cnicus benedictus</i> L.	2	2	0	3	7	Vulnerable
96.	<i>Conyza bonariensis</i> (L.) Conquist.	2	3	0	3	8	Vulnerable
97.	<i>Conyza canadensis</i> (L.) Conquist	2	3	0	3	8	Vulnerable
98.	<i>Conyza japonica</i> Less.	1	3	0	3	7	Vulnerable
99.	<i>Conyza stricta</i> Willd.	0	3	0	3	6	Vulnerable
100.	<i>Cosmos bipinnatus</i> Cav.	0	3	0	3	6	Vulnerable
101.	<i>Cousinia matfeldii</i> Bornm.	2	2	0	3	7	Vulnerable
102.	<i>Crepis sancta</i> (L.) Bab.	1	3	0	3	7	Vulnerable
103.	<i>Crepis thomsonii</i> Bab.	1	3	0	3	7	Vulnerable
104.	<i>Echinops echinatus</i> Roxb.	2	1	0	3	6	Vulnerable
105.	<i>Erigeron acer</i> subsp. <i>acer</i> L.	1	3	0	3	7	Vulnerable
106.	<i>Erigeron alpinus</i> L.	1	3	0	3	7	Vulnerable
107.	<i>Erigeron canadensis</i> L.Cronq.	0	3	0	3	6	Vulnerable
108.	<i>Erigeron acris</i> L.	0	3	0	3	6	Vulnerable
109.	<i>Filago germanica</i> L.	1	3	0	3	7	Vulnerable
110.	<i>Gnaphalium luteo-album</i> L.	2	1	0	3	6	Vulnerable
111.	<i>Gnaphalium thomsonii</i>	1	3	0	3	7	Vulnerable

	Hkf.						
112.	<i>Inula obtusifolia</i> Kerner.	2	2	0	3	7	Vulnerable
113.	<i>Lactuca clarkei</i> Hook.f.	1	3	0	2	6	Vulnerable
114.	<i>Lactuca orientalis</i> (Boiss.) Boiss.	1	3	0	2	6	Vulnerable
115.	<i>Lactuca serriola</i> L.	2	3	0	3	8	Vulnerable
116.	<i>Lactuca tatarica</i> (L.) C.A.Mey.	1	3	0	3	7	Vulnerable
117.	<i>Lactuca undulata</i> Ladb.	1	3	0	3	7	Vulnerable
118.	<i>Lactuca viminea</i> (L.) F.W.Schmid.	1	3	0	2	6	Vulnerable
119.	<i>Launaea polyclada</i> (Boiss.) Burkill.	0	3	0	3	6	Vulnerable
120.	<i>Launaea procumbens</i> Roxb.	1	3	0	3	7	Vulnerable
121.	<i>Matricaria chamomila</i> L.	2	1	3	3	9	Rare
122.	<i>Matricaria disciformis</i> (C.A.M.) DC.	1	1	3	3	8	Vulnerable
123.	<i>Matricaria praecox</i> DC.	0	3	0	3	6	Vulnerable
124.	<i>Myriactis wallichii</i> Less.	1	3	0	3	7	Vulnerable
125.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	2	3	0	3	8	Vulnerable
126.	<i>Senecio dubius</i> Ladeb.	1	3	0	3	7	Vulnerable
127.	<i>Solidago virgaurea</i> L.	1	3	0	3	7	Vulnerable
128.	<i>Sonchus arvensis</i> Boiss.	2	2	0	3	7	Vulnerable
129.	<i>Sonchus asper</i> (L.) Hill.	2	2	0	3	7	Vulnerable
130.	<i>Sonchus maritimus</i> L.	1	3	0	3	7	Vulnerable
131.	<i>Sonchus oleraceus</i> L.	1	3	0	3	7	Vulnerable
132.	<i>Taraxacum dealbatum</i> Haud & Mazz.	0	3	0	3	6	Vulnerable
133.	<i>Taraxacum officinale</i> Weber.	3	2	0	3	8	Vulnerable
134.	<i>Tricholepsis tibetica</i> H. & T.	2	3	0	3	8	Vulnerable
135.	<i>Tussilago farfara</i> L.	2	1	0	3	6	Vulnerable
136.	<i>Xanthium strumarium</i> L.	3	2	0	3	8	Vulnerable
21. Family Berberidaceae							
137.	<i>Berberis arthobotrys</i> Benth ex Aitch.	1	1	0	1	3	Endangered
138.	<i>Berberis lycium</i> Royle.	3	0	0	1	4	Endangered
139.	<i>Berberis pseudoumbellata</i> subsp. <i>gilgitica</i> Parker.	1	1	0	1	3	Endangered
22. Family Betulaceae							
140.	<i>Betula utilis</i> D. Don.	3	0	0	0	3	Endangered
23. Family Boraginaceae							
141.	<i>Arnebia euchroma</i> (Royle ex Benth) Johnst.	2	3	0	3	8	Vulnerable
142.	<i>Arnebia hispidissima</i> (Lehm.) DC.	2	2	0	3	7	Vulnerable

198.	<i>Euphorbia falcata</i> L.	1	3	0	3	7	Vulnerable
199.	<i>Euphorbia osyridea</i> Boiss.	0	3	0	3	6	Vulnerable
200.	<i>Euphorbia peplus</i> L.	1	3	0	3	7	Vulnerable
201.	<i>Euphorbia wallichii</i> Hk.	0	3	0	3	6	Vulnerable
37. Family Fumariaceae							
202.	<i>Corydalis govaniana</i> Wall ex Trend.	1	2	0	3	6	Vulnerable
203.	<i>Fumaria indica</i> (Hauskn.) L.	1	2	0	3	6	Vulnerable
38. Family Gentianaceae							
204.	<i>Centaurium meyeri</i> (Bunge.) Druce.	2	3	0	3	8	Vulnerable
205.	<i>Gentiana kurroo</i> Royle.	1	3	0	3	7	Vulnerable
206.	<i>Jeshkea oligosperma</i> L.	0	3	0	3	6	Vulnerable
207.	<i>Swertia speciosa</i> D. Don.	2	3	0	3	8	Vulnerable
39. Family Geraniaceae							
208.	<i>Geranium pretense</i> L.	2	3	0	3	8	Vulnerable
209.	<i>Geranium rotundifolium</i> L.	0	3	0	3	6	Vulnerable
210.	<i>Geranium wallichinum</i> D. Don ex Sweet.	2	3	0	3	8	Vulnerable
40. Family Hippuridaceae							
211.	<i>Hippuris vulgaris</i> L.	2	1	0	2	5	Vulnerable
41. Family Lamiaceae							
212.	<i>Alujga rhomboidea</i> Benth. Ikonn. Gal.	0	3	0	3	6	Vulnerable
213.	<i>Drachcephalum nutans</i> L.	1	3	0	3	7	Vulnerable
214.	<i>Lamium amplexicaule</i> L.	1	3	0	3	7	Vulnerable
215.	<i>Marrubium vulgare</i> L.	2	2	0	2	6	Vulnerable
216.	<i>Mentha longifolia</i> (L.) Huds.	3	1	0	4	8	Vulnerable
217.	<i>Mentha royleana</i> Benth.	1	3	0	3	7	Vulnerable
218.	<i>Nepeta cataria</i> L.	3	2	0	3	8	Vulnerable
219.	<i>Nepeta glutinosa</i> Benth.	1	3	0	3	7	Vulnerable
220.	<i>Nepeta kokanica</i> Regel.	0	3	0	3	6	Vulnerable
221.	<i>Nepeta lavigata</i> (D. Don.) Hand. Mazz.	2	1	0	3	6	Vulnerable
222.	<i>Nepeta paulsenii</i> Briq.	3	1	0	3	7	Vulnerable
223.	<i>Nepeta podostachys</i> Benth.	1	3	0	3	7	Vulnerable
224.	<i>Nepeta priostachya</i> Benth.	0	3	0	4	7	Vulnerable
225.	<i>Nepeta raphanorhiza</i> Benth.	2	2	0	3	7	Vulnerable
226.	<i>Otostegia limbata</i> (Bth.) Boiss.	2	2	0	3	7	Vulnerable
227.	<i>Salvia aegyptiaca</i> L.	1	3	0	3	7	Vulnerable
228.	<i>Salvia nubicola</i> Wall ex Sweet.	2	3	0	3	8	Vulnerable
229.	<i>Salvia rhytidea</i> Benth.	1	1	0	3	5	Vulnerable
230.	<i>Thymus linearis</i> subsp.	1	3	0	3	7	Vulnerable

	<i>hedgeri</i> Jales.						
231.	<i>Thymus serpyllum</i> L.	2	1	0	3	6	Vulnerable
232.	<i>Zizyphora clinopodioides</i> Lam.	1	2	0	3	6	Vulnerable
42. Family Lentibulariaceae							
233.	<i>Utricularia australis</i> R. Br.	0	3	0	0	3	Endangered
43. Family Malvaceae							
234.	<i>Abutilon bidentatum</i> Hochst ex A. Rich.	0	3	0	3	6	Vulnerable
235.	<i>Alcea rosea</i> (L.) Cav.	2	2	0	3	7	Vulnerable
236.	<i>Malva neglecta</i> Wall.	2	2	0	3	7	Vulnerable
237.	<i>Malva parviflora</i> L.	1	3	0	3	7	Vulnerable
44. Family Oleaceae							
238.	<i>Fraxinus xanthoxyloides</i> Wall ex G. Don.	3	0	0	1	4	Endangered
45. Family Onagraceae							
239.	<i>Epilobium angustifolium</i> L.	2	1	0	3	6	Vulnerable
240.	<i>Epilobium cylindricum</i> D. Don.	1	3	0	3	7	Vulnerable
241.	<i>Epilobium hirsutum</i> L.	2	3	0	3	8	Vulnerable
46. Family Paeoniaceae							
242.	<i>Paeonia emodi</i> Wall ex G. Don.	0	1	0	1	2	Endangered
47. Family Papilionaceae							
243.	<i>Astragalus amberstianus</i> Royle ex Benth.	2	2	0	3	7	Vulnerable
244.	<i>Astragalus chlorostachys</i> L.	1	3	0	3	7	Vulnerable
245.	<i>Astragalus corrugatus</i> Bertol.	0	3	0	3	6	Vulnerable
246.	<i>Astragalus gilgitensis</i> Ali.	0	3	0	3	6	Vulnerable
247.	<i>Astragalus subumbellatus</i> Klotzsch.	0	3	0	3	6	Vulnerable
248.	<i>Astragalus psilocentros</i> Fisch.	3	1	0	2	6	Vulnerable
249.	<i>Astragalus cndolleanus</i> Royle ex Bth.	2	2	0	3	7	Vulnerable
250.	<i>Chesneya depressa</i> (Oliver.) Popov.	2	2	0	3	7	Vulnerable
251.	<i>Cicer macranthum</i> M. Popov.	2	1	0	3	6	Vulnerable
252.	<i>Colutea paulsenii</i> Feryh.	3	0	0	1	4	Endangered
253.	<i>Crotolaria prostrata</i> Roxb ex D. Don.	2	3	0	3	8	Vulnerable
254.	<i>Glycyrrhiza glabra</i> L.	3	0	0	3	6	Vulnerable
255.	<i>Lotus corniculatus</i> var. <i>tenifolius</i> L.	1	2	0	3	6	Vulnerable
256.	<i>Lotus corniculatus</i> var. <i>corniculatus</i> L.	2	2	0	3	7	Vulnerable

257.	<i>Lespedeza</i> Sp.	1	3	0	3	7	Vulnerable
258.	<i>Medicago lupulina</i> L.	1	2	0	3	6	Vulnerable
259.	<i>Melilotus officinale</i> (L.) Desr.	2	1	0	3	6	Vulnerable
260.	<i>Melilotus indica</i> (L.) All.	1	2	0	3	6	Vulnerable
261.	<i>Sophora mollis</i> (Royle.) Baker.	3	0	0	1	4	Endangered
262.	<i>Trifolium pratense</i> L.	1	3	0	3	7	Vulnerable
263.	<i>Trifolium repens</i> L.	2	3	0	3	8	Vulnerable
264.	<i>Vicia monantha</i> Retz.	0	3	0	3	6	Vulnerable
265.	<i>Vicia sativa</i> L.	2	2	0	3	7	Vulnerable
48. Family Parnassiaceae							
266.	<i>Parnassia nubicola</i> Planch ex Clarke.	2	2	0	3	7	Vulnerable
49. Family Plantaginaceae							
267.	<i>Plantago lanceolata</i> L.	3	2	0	3	8	Vulnerable
268.	<i>Plantago major</i> Aitch.	2	2	0	3	7	Vulnerable
50. Family Plumbaginaceae							
269.	<i>Acantholimon longiscapum</i> Bokhari.	2	1	0	0	3	Endangered
270.	<i>Psyllisotachys suworowii</i> (Regd.) Roshk.	1	1	0	3	5	Vulnerable
51. Family Polygonaceae							
271.	<i>Atraphaxis pyrifolia</i> Bunge.	2	1	0	1	4	Endangered
272.	<i>Atraphaxis spinosa</i> L.	2	1	0	2	5	Vulnerable
273.	<i>Oxyria digyna</i> (L.) Hill.	2	3	0	3	8	Vulnerable
274.	<i>Polygonum afghanicum</i> Meiss.	0	3	0	3	6	Vulnerable
275.	<i>Polygonum aviculare</i> L.	1	3	0	3	7	Vulnerable
276.	<i>Polygonum barbatum</i> L.	1	3	0	3	7	Vulnerable
277.	<i>Polygonum chinensis</i> L.	0	3	0	3	6	Vulnerable
278.	<i>Polygonum convolvulus</i> L.	0	3	0	3	6	Vulnerable
279.	<i>Polygonum dumetorum</i> L.	2	2	0	3	7	Vulnerable
280.	<i>Polygonum glabrum</i> Willd.	2	2	0	3	7	Vulnerable
281.	<i>Polygonum hydropiper</i> L.	1	3	0	3	7	Vulnerable
282.	<i>Polygonum nepalense</i> Meiss.	0	3	0	3	6	Vulnerable
283.	<i>Polygonum orientale</i> L.	0	3	0	3	6	Vulnerable
284.	<i>Polygonum persicaria</i> L.	3	1	0	3	7	Vulnerable
285.	<i>Rheum emodi</i> Wall.ex Meissn.	3	0	0	0	3	Endangered
286.	<i>Rumex longifolius</i> DC.	3	1	0	3	7	Vulnerable
52. Family Primulaceae							
287.	<i>Primula denticulata</i> Sm.	2	3	0	3	8	Vulnerable
53. Family Ranunculaceae							
288.	<i>Clematis graveolens</i> Lindl.	1	2	0	2	5	Vulnerable
289.	<i>Clematis grata</i> Wall.	2	1	0	2	5	Vulnerable

290.	<i>Clematis orientalis</i> L.	2	1	0	2	5	Vulnerable
291.	<i>Delphinium nordhagenii</i> Wendd. & B. W.	1	3	0	3	7	Vulnerable
292.	<i>Ranunculus arvensis</i> L.	2	3	0	3	8	Vulnerable
293.	<i>Ranunculus lobatus</i> Jacq. ex Cam.	1	3	0	3	7	Vulnerable
294.	<i>Ranunculus natans</i> C.A. Mey.	0	3	0	3	6	Vulnerable
295.	<i>Thalictrum alpinum</i> L.	1	3	0	3	7	Vulnerable
54. Family Resedaceae							
296.	<i>Reseda odorata</i> L.	1	3	0	3	7	Vulnerable
55. Family Rosaceae							
297.	<i>Argemone eupatoria</i> L.	1	3	0	3	7	Vulnerable
298.	<i>Cotoneaster microphylla</i> Wall. ex Lind.	1	1	0	2	4	Endangered
299.	<i>Cotoneaster nummularia</i> Fisch. & Mey.	2	1	0	2	5	Vulnerable
300.	<i>Crataegus songarica</i> C. Koch.	3	0	0	0	3	Endangered
301.	<i>Potentilla ornithopoda</i> var. <i>ornithopoda</i> Tausch.	0	3	0	3	6	Vulnerable
302.	<i>Potentilla pamirica</i> Wolf.	0	3	0	3	6	Vulnerable
303.	<i>Potentilla supina</i> L.	2	2	0	3	7	Vulnerable
304.	<i>Rosa webbiana</i> Wall. ex Royle.	3	0	0	2	5	Vulnerable
305.	<i>Rubus fruticosus</i> L.	2	1	0	2	5	Vulnerable
56. Family Rubiaceae							
306.	<i>Asperula oppositifolia</i> Ssp. <i>cabaulica</i> Ehrend.	2	3	0	3	8	Vulnerable
307.	<i>Asperula oppositifolia</i> Ssp. <i>pseudocynanchia</i> Ehrend.	1	3	0	3	7	Vulnerable
308.	<i>Galium aparine</i> L.	2	2	0	3	7	Vulnerable
309.	<i>Galium asperifolium</i> Wall.	1	3	0	3	7	Vulnerable
310.	<i>Galium tricornutum</i> Dandy.	1	3	0	3	7	Vulnerable
57. Family Salicaceae							
311.	<i>Salix acmophylla</i> Boiss.	2	0	0	1	3	Endangered
312.	<i>Salix coerriola</i> (Sm.) Rech.	1	0	0	1	2	Endangered
313.	<i>Salix wilhelmsiana</i> M.B.	1	0	0	1	2	Endangered
58. Family Saxifragaceae							
314.	<i>Bergenia ciliata</i> (Haw.) Sternb.	1	3	0	3	7	Vulnerable
315.	<i>Bergenia himalaica</i> Boiss.	1	3	0	3	7	Vulnerable
316.	<i>Ribes orientale</i> Desf.	2	0	0	1	3	Endangered
59. Family Scrophulariaceae							
317.	<i>Antirrhinum majus</i> L.	1	3	0	3	7	Vulnerable
318.	<i>Euphrasia aristulata</i> Perm.	1	3	0	3	7	Vulnerable
319.	<i>Linaria vulgaris</i> Mill.	0	3	0	3	6	Vulnerable

320.	<i>Scrophularia scoparia</i> Penn.	1	3	0	3	7	Vulnerable
321.	<i>Scrophularia stewartii</i> Penn.	2	2	0	3	7	Vulnerable
322.	<i>Verbascum erianthum</i> Benth.	0	3	0	3	6	Vulnerable
323.	<i>Verbascum thapsus</i> L.	2	3	0	2	7	Vulnerable
324.	<i>Veronica anagalis-aquatica</i> L.	1	3	0	3	7	Vulnerable
325.	<i>Veronica serpyllifolia</i> L.	2	3	0	3	8	Vulnerable
60. Family Solanaceae							
326.	<i>Datura stramonium</i> L.	3	3	0	3	9	Rare
327.	<i>Hyoscyamus niger</i> L.	1	3	0	3	7	Vulnerable
328.	<i>Hyoscyamus pusillus</i> L.	0	3	0	3	6	Vulnerable
329.	<i>Solanum nigrum</i> L.	2	2	0	3	7	Vulnerable
61. Family Tamaricaceae							
330.	<i>Myricaria elegans</i> Royle.	3	0	0	2	5	Vulnerable
331.	<i>Tamarix dioica</i> Rox ex Roth.	3	0	0	2	5	Vulnerable
62. Family Thymeliaceae							
332.	<i>Daphne oleoides</i> Schrend.	2	2	0	3	7	Vulnerable
333.	<i>Thymelaea passerina</i> (L.) Cosson & Germain.	1	3	0	3	7	Vulnerable
63. Family Utricaceae							
334.	<i>Pilea umbrosa</i> Wedd.	2	3	0	3	8	Vulnerable
64. Family Violaceae							
335.	<i>Viola serpens</i> Wall ex Roxb.	1	2	0	3	6	Vulnerable
65. Family Zygophyllaceae							
336.	<i>Peganum harmala</i> L.	1	1	0	3	5	Vulnerable
337.	<i>Tribulus terrestris</i> L.	2	3	0	3	8	Vulnerable

Keys :

1. Availability :- 0 - Uncommon or very rare, 1- Less common or rare, 2- Occasional. 3- Abundant.
2. Collection :- 0 – More than 1000 kg/year, 1-Consumed from 500-1000 kg/year, 2- Consumed from 200-500 kg/year, 3-Consumed from 100-200 kg/year.
3. Part used :- 0- Root, whole plant, 1- Bark, 2- Seeds,fruits 3- Flowers, 4- Gum, Latex.
4. Growth :- 4-Re-growth in a season, 3-Re-growth in one year, 2- Re-growth in two years, 1-Re-growth in three years, 0-Re-growth in more than three years.
5. Total score- 0-4: Endangered, 5-8: Vulnerable, 9-12: Rare, 12-14: Infrequent, 15-16: Dominant.

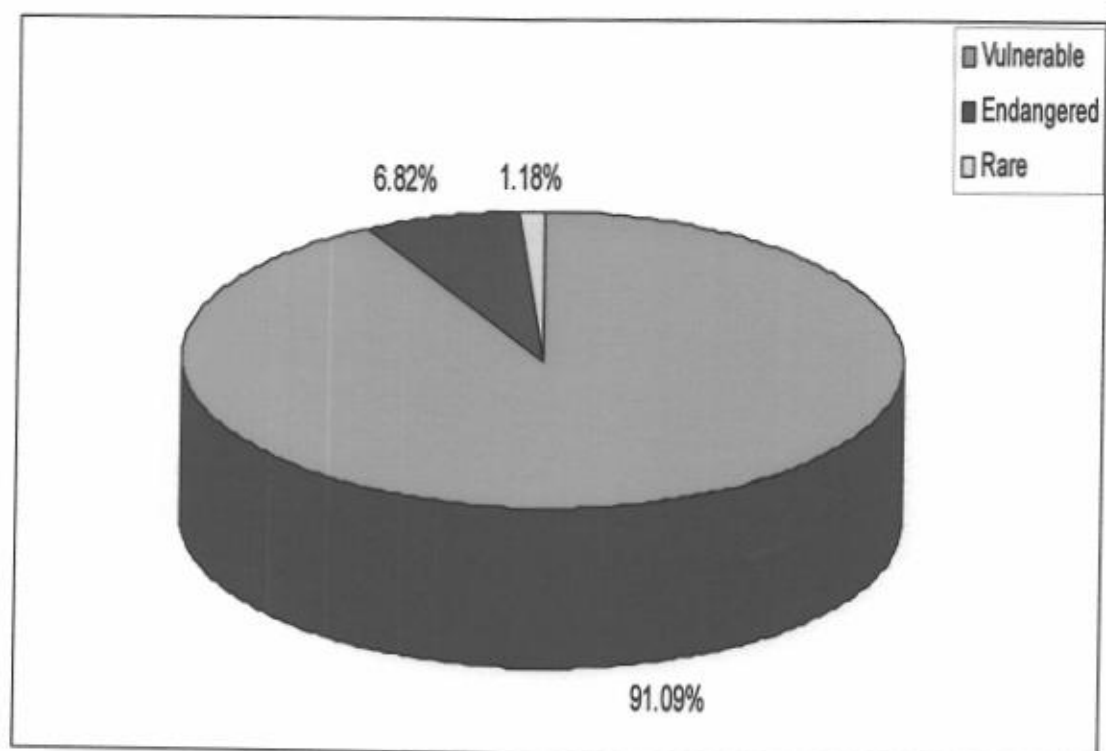


Fig. 33. No. of plant species with different conservation status found in Mastuj Valley, District Chitral, Pakistan.

Growth behavior, Sex ratio and Fruit output of *Juniperus excelsa*

Various parameters of growth performance of *Juniperus excelsa* are shown in Table 36. The population density showed that female plants had high density, followed by male plants and bisexual plants, respectively in the area (Table 36). The study showed that in Mastuj village average maximum height were that of bisexual plants 248cm, followed by female plants 169.5cm and male plants 112cm. In Dodorghaz gol maximum height 74.2cm was observed in female plants, followed by bisexual plants 49cm and male plants 41.2cm. In Ghuru gol bisexual plants had maximum height 84.2cm, followed by female plants 66.5cm and male plants 59cm (Table 37). The maximum average diameter of different sexes of *Juniperus excelsa* in Mastuj village were female plants 20cm, bisexual plants 17cm and male plants 13cm. In Dodorghaz gol bisexual plants had maximum diameter 16cm, followed by female plants 13cm and male plants 10cm. In Ghuru gol female plants had 10.5cm, bisexual plants 9cm and male plants had 7cm diameters. Maximum average fruit output per plant calculated in Dodorghaz gol was 23340, followed by 20646 in Mastuj village and 5568 in Ghuru gol. Number of fallen fruits were also high 347 m² in Dodorghaz gol, followed by 147 m² in Mastuj village and 55 m² in Ghuru gol. Maximum number of seedlings (16 m²) were recorded in Mastuj village, followed by (7 m²) in Ghuru gol and (5 m²) in Dodorghaz gol (Table 37). In Mastuj village the soils were sandy loam. In Ghuru gol the soils below the *Juniper* was sandy loam and loamy sand away from the *Juniper*. In Dodorghaz gol the soil below the *Juniper* was loamy sand and away from the *Juniperus* the soil was sandy loam (Table 38).

In Pakistan *Juniperus* forests are found in District Chitral, Gilgit, Kurum Agency, Kaghan Valley and in Balochistan Province between altitude of 1800 and 4200 meters. *Juniperus* survive in harsh climatic conditions with 200 to 400 mm average precipitation with the majority being in the form of snow in winter. They grow on very poor soils, steep and screed slopes and sometimes even on the crevices of bare rocks. *Juniper* forests are vanishing rapidly from the mountains of Chitral because of overexploitation for domestic use and in some areas for commercial purposes (Ali, 2003).

Table 36. Growth behaviour and Sex ratio of *Juniperus excelsa* in Mastuj Valley, District Chitral, Pakistan.

S.No.	Location	Mastuj	Dodorghaz gol	Ghuru gol	Parkusap gol	Parwak	Miragram- II
	Altitude	2300m- 2400m	2590m- 3300m.	2290m- 3100m.	2560m- 3010m.	2150m- 2220m.	2850m- 3000m.
	Habitat	Mesic	Dry	Stony & Dry	Dry	Mesic	Dry & Stony
1. Height (cm)							
1.	Male Plants	Max: 144 Min: 84 Av: 112	55 25 41.2	72 40 59	200 94 138	200 66 122.4	250 96 139.2
2.	Female Plants	Max: 280 Min: 114 Av. 169.5	100 52.5 74.2	116 30 66.5	300 150 234.5	400 96 171.4	120 36 73.8
3.	Bisexual Plants	Max: 480 Min: 96 Av. 248	55 43 49	96 72 84.2	250 120 166	200 39 121.8	120 60 97.2
2. Diameter (cm)							
1.	Male Plants	Max: 17 Min: 9 Av. 13	12 7 10	9 4 7	58 10 28.6	15 7 12.2	56 14 34
2.	Female Plants	Max: 28 Min: 12 Av. 20	15 9 13	15 7 10.5	66 28 39.4	39 14 24.5	36 2 17.2
3.	Bisexual Plants	Max: 18 Min: 16 Av. 17	18 14 16	10 8 9	60 15 34.8	42 6 25.6	48 9 25.8
3. Density (10 m²)							
1.	Male Plants	Max: 15 Min: 5 Av. 10	5 5 5	25 15 20	35 15 20	15 5 10	15 5 10
2.	Female Plants	Max: 25 Min: 15 Av. 20	25 15 20	35 15 25	85 75 80	35 15 25	25 15 20
3.	Bisexual Plants	Max: 5 Min: 5 Av. 5	5 5 5	5 5 5	25 5 15	15 5 10	15 5 10

Table 37. The Height (cm), Diameter (cm) and fruit output of Female *Juniperus excelsa* in Mastuj Valley, District Chitral, Pakistan.

S.No.	Localities	Height (cm)			Diameter (cm)			Fruit output/plant			No. of Fruits within Quadrat (1m ²)	No. of Seedlings within Quadrat (1m ²)
		Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.		
1.	Mastuj	280	114	169.5	28	12	20	72000	3000	20640	147	16
2.	Dodorghaz gol	100	52.5	74.2	15	9	13	85800	2160	23340	347	5
3.	Ghuru gol	116	30	66.5	15	7	10.5	25920	117	5568	55	7
4.	Parkusap gol	300	150	234.5	66	28	39.4	21600	1920	8078.8	1142	35
5.	Parwak	400	96	171.4	39	14	24.5	10290	336	2648.8	120	15
6.	Miragram-II	120	36	73.8	36	2	17.2	1120	36	504.7	75	9

Table 38. Physico-chemical analysis of soils below and away from *Juniperus excelsa*.

S.No	Sites	CaCO ₃ %	OM %	N %	P %	K %	pH	Ec $\times 10^3$	TSS %	Clay %	Silt %	Sand %	Textural class
1.	Mastuj village	5.75	2.82	0.141	22.02	95	7.4	0.23	0.073	13.6	32.0	54.4	Sandy
	<i>Juniper</i> soil												loam
	away <i>Juniper</i> soil	13.25	2.58	0.129	6.57	142	7.3	0.22	0.070	4.4	42.0	53.6	Sandy loam
2.	Dodorghaz gol	12.50	2.27	0.113	11.44	114	7.6	0.10	0.032	2.4	18.0	79.6	Loamy
	<i>Juniper</i> soil												sand
	away <i>Juniper</i> soil	12.75	2.20	0.110	13.15	95	8.2	0.12	0.038	10.4	26.0	63.6	Sandy loam
3.	Ghuru gol <i>Juniper</i>	6.00	2.89	0.144	31.17	142	8.1	0.14	0.045	11.6	20.0	68.4	Sandy
	soil												loam
	away <i>Juniper</i> soil	15.25	1.96	0.098	8.86	133	8.2	0.11	0.035	10.4	12.0	71.6	Loamy sand
4.	Parkusap gol	10.00	0.69	0.034	18.00	140	7.6	0.21	0.067	3.6	26.0	70.4	Loamy
	<i>Juniper</i> soil												sand
	away <i>Juniper</i> soil	10.50	0.89	0.044	14	120	7.4	0.60	0.192	1.6	22.0	76.4	Loamy sand
5.	Parwak <i>Juniper</i>	10.75	0.86	0.043	25	250	7.6	0.60	0.192	5.6	34.0	60.4	Sandy
	soil												loam
	away <i>Juniper</i> soil	9.50	0.69	0.034	21	200	7.7	0.13	0.041	5.6	26.0	68.4	Sandy loam
6	Miragram-II	12.75	0.82	0.041	20	180	7.6	0.23	0.074	1.6	34.0	64.4	Sandy
	<i>Juniper</i> soil												loam
	away <i>Juniper</i> soil	13.00	0.69	0.034	19	175	7.2	0.12	0.038	3.6	56.0	40.4	Silt loam

CONCLUSIONS AND RECOMMENDATIONS

The present research provides basic data on Mastuj Valley rangeland, which might be helpful for range ecologists in all their future research programmes meant for the improvement of this area.

1. The area is rich in endemic plant species, which are under severe biotic pressure in terms of heavy grazing and deforestation pressure. Moderate and rotational grazing system must be introduced and alternate fuel facilities should be provided to the local people.
2. Due to remoteness and insufficient health facilities the people mainly depend on medicinal plants to treat their various health problems. The local people should be trained to know the exact methodology of collection, cleaning, drying and storage of the crude drugs.
3. Sustainable use of plants should be encouraged.
4. To overcome the deficiency of mineral constituents in both soil and plants and ultimately in animals natural and chemical fertilizers must be applied.
5. Due to over exploitation of natural vegetation most of the plants are near to extinction. There is an urgent need to promote the ethics of conservation and improvement of vegetation for future generations.
6. Long term plans are needed to improve the existing condition of the rangelands by ecological management
7. Additional research is needed to explore the seed production, germination and growth patterns of fodder, fuel wood and medicinal plants for successful propagation and reintroduction.
8. The rangeland can be used as game reserve to generate income for its improvement.
9. Ecotourism is also promoted in this area. This will be an additional source of income.

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Appendix 1. Phytosociological Attributes of *Mentha-Hippophae-Trifolium* (MHT) Community at Sarghuz in Water course Site at an altitude of 2250m-2350m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Mentha longifolia</i> (L.) Huds.	6.0	9.0	60	8.05	8.14	8	24.19*
2.	<i>Hippophae rhamnoides</i> L.	5.0	10.0	40	6.71	9.04	5.33	21.08**
3.	<i>Trifolium repens</i> L.	6.5	5.5	30	8.72	4.97	4	17.69***
4.	<i>Equisetum ramosissimum</i> Desf.	4.0	4.0	40	5.36	3.61	5.33	14.3
5.	<i>Plantago major</i> Aitch.	3.5	5.5	30	4.69	4.97	4	13.66
6.	<i>Myricaria elegans</i> Royle.	4.0	6.0	20	5.36	5.42	2.66	13.44
7.	<i>Cnicus benedictus</i> L.	3.5	4.5	30	4.69	4.07	4	12.76
8.	<i>Salvia nubicola</i> Wall ex Sweet.	4.0	5.0	20	5.36	4.52	2.66	12.54
9.	<i>Taraxacum officinale</i> Weber.	2.0	5.0	40	2.68	4.52	5.33	12.53
10.	<i>Plantago lanceolata</i> L.	3.0	5.0	20	4.02	4.52	2.66	11.2
11.	<i>Tamarix dioica</i> Roxb ex Roth.	3.0	5.0	20	4.02	4.52	2.66	11.2
12.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	2.0	4.0	20	2.68	3.61	2.66	8.95
13.	<i>Rosa webbiana</i> Wall ex Royle.	1.0	4.0	20	1.34	3.61	2.66	7.61
14.	<i>Inula obtusifolia</i> Kerner.	1.5	1.5	30	2.01	1.35	4	7.36
15.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	1.5	1.5	30	2.01	1.35	4	7.36
16.	<i>Juncus articulata</i> L.	2.0	2.0	20	2.68	1.80	2.66	7.14
17.	<i>Cynodon dactylon</i> (L.) Pers.	2.5	2.5	10	3.35	2.26	1.33	6.94
18.	<i>Potamogeton</i> Sp.	2.5	2.5	10	3.35	2.26	1.33	6.94
19.	<i>Salix acmophylla</i> Boiss.	1.5	3.5	10	2.01	3.16	1.33	6.5
20.	<i>Epilobium hirsutum</i> L.	1.0	2.0	20	1.34	1.80	2.66	5.8
21.	<i>Lactuca serriola</i> L.	1.0	2.0	20	1.34	1.80	2.66	5.8
22.	<i>Verbascum thapsus</i> L.	1.0	2.0	20	1.34	1.80	2.66	5.8
23.	<i>Centaurea meyeri</i> (Bunge.) Druce.	1.5	2.5	10	2.01	2.26	1.33	5.6
24.	<i>Salix coerriola</i> (Sm.) Rich.	1.5	2.5	10	2.01	2.26	1.33	5.6
25.	<i>Nepeta cataria</i> L.	1.5	2.5	10	2.01	2.26	1.33	5.6
26.	<i>Elaeagnus angustifolia</i> L.	0.5	2.5	10	0.67	2.26	1.33	4.26
27.	<i>Sonchus asper</i> (L.) Hill.	0.5	1.5	10	0.67	1.35	1.33	3.35
28.	<i>Arnebia hispidissima</i> (Lehm.) DC.	0.5	0.5	10	0.67	0.45	1.33	2.45
29.	<i>Eragrostis minor</i> Host.	0.5	0.5	10	0.67	0.45	1.33	2.45
30.	<i>Capparis spinosa</i> L.	0.5	0.5	10	0.67	0.45	1.33	2.45
31.	<i>Clematis orientalis</i> L.	0.5	0.5	10	0.67	0.45	1.33	2.45
32.	<i>Crotolaria prostrata</i> Roxb ex D. Don.	0.5	0.5	10	0.67	0.45	1.33	2.45
33.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	0.67	0.45	1.33	2.45
34.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	0.67	0.45	1.33	2.45
35.	<i>Lotus corniculatus</i> L.	0.5	0.5	10	0.67	0.45	1.33	2.45
36.	<i>Melilotus officinale</i> (L.) Desr.	0.5	0.5	10	0.67	0.45	1.33	2.45
37.	<i>Nasturtium officinale</i> R. Br.	0.5	0.5	10	0.67	0.45	1.33	2.45
38.	<i>Primula denticulata</i> Sm.	0.5	0.5	10	0.67	0.45	1.33	2.45
39.	<i>Ranunculus lobatus</i> Jacq ex Cam.	0.5	0.5	10	0.67	0.45	1.33	2.45
40.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	0.5	0.5	10	0.67	0.45	1.33	2.45
41.	<i>Veronica anagallis-aquatica</i> L.	0.5	0.5	10	0.67	0.45	1.33	2.45
Total		74.5	110.5	750	99.86	99.79	99.85	299.5

Appendix 2. Phytosociological Attributes of *Mentha-Epilobium-Trifolium* (MET) Community at Malakandi in Water course Site at an altitude of 2300m-2400m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Mentha longifolia</i> (L.) Huds.	9.0	8.0	80	13.43	11.42	8.88	33.73*
2.	<i>Epilobium hirsutum</i> L.	4.5	4.5	70	6.71	6.42	7.77	20.9**
3.	<i>Trifolium repens</i> L.	4.0	4.0	60	5.97	5.71	6.66	18.34***
4.	<i>Primula denticulate</i> Sm.	5.0	4.0	40	7.46	5.71	4.44	17.61
5.	<i>Cnicus</i> Sp.	2.4	4.5	30	3.73	6.42	3.33	13.48
6.	<i>Equisetum ramossimum</i> Desf.	3.0	3.0	40	4.47	4.28	4.44	13.19
7.	<i>Triglochin palustris</i> L.	3.5	1.5	30	5.22	2.14	3.33	10.69
8.	<i>Salix coerriola</i> (Sm.) Rich.	1.5	3.5	30	2.23	5	3.33	10.56
9.	<i>Taraxacum officinale</i> Weber.	2.0	2.0	40	2.98	2.85	4.44	10.27
10.	<i>Nasturtium officinale</i> R.Br	2.0	2.0	20	2.98	2.85	2.22	8.05
11.	<i>Juncus articulata</i> L.	1.5	1.5	30	2.23	2.14	3.33	7.7
12.	<i>Lotus corniculatus</i> L.	1.5	1.5	30	2.23	2.14	3.33	7.7
13.	<i>Parnassia nubicola</i> Planch ex Clarke.	1.5	1.5	30	2.23	2.14	3.33	7.7
14.	<i>Plantago lanceolata</i> L.	2.5	1.5	10	3.73	2.14	1.11	6.98
15.	<i>Salix wilhelmsiana</i> M.B.	0.5	3.5	10	0.74	5	1.11	6.85
16.	<i>Myricaria elegans</i> Royle.	1.0	2.0	20	1.49	2.85	2.22	6.56
17.	<i>Salvia nubicola</i> Wall ex Sweet.	1.0	2.0	20	1.49	2.85	2.22	6.56
18.	<i>Cynodon dactylon</i> (L.) Pers.	1.5	1.5	10	2.23	2.14	1.11	5.48
19.	<i>Chara</i> Sp.	1.5	1.5	10	2.23	2.14	1.11	5.48
20.	<i>Geranium wallichinum</i> D.Don ex Sweet.	1.5	1.5	10	2.23	2.14	1.11	5.48
21.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	1.5	1.5	10	2.23	2.14	1.11	5.48
22.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	1.0	1.0	20	1.49	1.42	2.22	5.13
23.	<i>Cynoglossum lanceolatum</i> Forssk.	1.0	1.0	20	1.49	1.42	2.22	5.13
24.	<i>Hippophae rhamnoides</i> L.	1.0	1.0	20	1.49	1.42	2.22	5.13
25.	<i>Polygonum persicaria</i> L.	1.0	1.0	20	1.49	1.42	2.22	5.13
26.	<i>Rosa webbiana</i> Wall ex Royle	1.0	1.0	20	1.49	1.42	2.22	5.13
27.	<i>Cnicus benedictus</i> L.	1.5	0.5	10	2.23	0.71	1.11	4.05
28.	<i>Chenopodium album</i> L.	0.5	0.5	10	0.74	0.71	1.11	2.56
29.	<i>Amaranthus retroflexus</i> L.	0.5	0.5	10	0.74	0.71	1.11	2.56
30.	<i>Centaurium meyeri</i> (Bunge.) Druce.	0.5	0.5	10	0.74	0.71	1.11	2.56
31.	<i>Cepella bursa-pastoris</i> (L.) Medic.	0.5	0.5	10	0.74	0.71	1.11	2.56
32.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	0.74	0.71	1.11	2.56
33.	<i>Conyza bonariensis</i> (L.) Conquist	0.5	0.5	10	0.74	0.71	1.11	2.56
34.	<i>Dicanthium annulatum</i> Forssk. Stapf.	0.5	0.5	10	0.74	0.71	1.11	2.56
35.	<i>Eragrostis minor</i> Host.	0.5	0.5	10	0.74	0.71	1.11	2.56
36.	<i>Juncus himalensis</i> K.L. & Gracke.	0.5	0.5	10	0.74	0.71	1.11	2.56
37.	<i>Matricaria chamomila</i> L.	0.5	0.5	10	0.74	0.71	1.11	2.56
38.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	0.5	0.5	10	0.74	0.71	1.11	2.56
39.	<i>Plantago major</i> Aitch.	0.5	0.5	10	0.74	0.71	1.11	2.56
40.	<i>Ranunculus lobatus</i> Jacq ex Cam.	0.5	0.5	10	0.74	0.71	1.11	2.56
41.	<i>Scirpus planifolius</i> Grimm.	0.5	0.5	10	0.74	0.71	1.11	2.56
42.	<i>Sonchus asper</i> (L.) Hill.	0.5	0.5	10	0.74	0.71	1.11	2.56
43.	<i>Veronica anagallis-aquatica</i> L.	0.5	0.5	10	0.74	0.71	1.11	2.56
Total		67	70	900	99.76	99.79	99.9	299.45

Appendix 3. Phytosociological Attributes of *Mentha-Salix-Plantago* (MSP) Community at Mastuj village in Water course Site at an altitude of 2410m-2510m.

S.No.	Plant species	Densit y	Cover	Frequenc y	RD	RC	RF	IV
1.	<i>Mentha longifolia</i> (L.) Huds.	7.0	8.0	100	10.52	9.46	11.23	31.21 ^v
2.	<i>Salix acmophylla</i> Boiss.	5.0	11.0	40	7.51	13.01	4.49	25.01 ^{uv}
3.	<i>Plantago major</i> Aitch.	5.5	6.5	50	8.27	7.69	5.61	21.57 ^{uv}
4.	<i>Hippophae rhamnoides</i> L.	3.5	8.5	50	5.26	10.05	5.61	20.92
5.	<i>Trifolium repens</i> L.	4.5	4.5	50	6.76	5.32	5.61	17.69
6.	<i>Primula denticulata</i> Sm.	4.5	4.5	30	6.76	5.32	3.37	15.45
7.	<i>Cirsium</i> sp.	3.0	3.0	60	4.51	3.55	6.74	14.8
8.	<i>Rosa webbiana</i> Wall ex Royle	2.0	4.0	20	3.00	4.73	2.24	9.97
9.	<i>Taraxacum officinale</i> Weber.	2.0	2.0	40	3.00	2.36	4.49	9.85
10.	<i>Lotus corniculatus</i> L.	2.5	1.5	30	3.75	1.77	3.37	8.89
11.	<i>Cichorium intybus</i> L.	1.5	2.5	30	2.25	2.95	3.37	8.57
12.	<i>Calamagrostis pseudophragmites</i> Hall. f. Koeler.	1.5	1.5	30	2.25	1.77	3.37	7.39
13.	<i>Iris ensata</i> Thunb.	1.5	1.5	30	2.25	1.77	3.37	7.39
14.	<i>Medicago sativa</i> L.	2.0	2.0	20	3.00	2.36	2.24	7.6
15.	<i>Ferula</i> sp.	1.5	2.5	10	2.25	2.95	1.12	6.32
16.	<i>Tussilago farfara</i> L.	1.5	2.5	10	2.25	2.95	1.12	6.32
17.	<i>Myricaria elegans</i> Royle.	1.0	2.0	20	1.50	2.36	2.24	6.1
18.	<i>Dicanthium annulatum</i> Forssk. Stapf.	1.5	1.5	10	2.25	1.77	1.12	5.14
19.	<i>Juncus articulata</i> L.	1.5	1.5	10	2.25	1.77	1.12	5.14
20.	<i>Scirpus planifolius</i> Grimm.	1.5	1.5	10	2.25	1.77	1.12	5.14
21.	<i>Artemisia parviflora</i> Roxb.	1.0	1.0	20	1.50	1.18	2.24	4.92
22.	<i>Berberis lycium</i> Royle.	1.0	1.0	20	1.50	1.18	2.24	4.92
23.	<i>Epilobium hirsutum</i> L.	1.0	1.0	20	1.50	1.18	2.24	4.92
24.	<i>Melilotus officinale</i> (L.) Desr.	1.0	1.0	20	1.50	1.18	2.24	4.92
25.	<i>Alcea rosea</i> (L.) Cav.	0.5	0.5	10	0.75	0.59	1.12	2.46
26.	<i>Bromus gracillimus</i> Bunge.	0.5	0.5	10	0.75	0.59	1.12	2.46
27.	<i>Chenopodium album</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
28.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
29.	<i>Cnicus benedictus</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
30.	<i>Conyza canadensis</i> (L.) Conquist.	0.5	0.5	10	0.75	0.59	1.12	2.46
31.	<i>Cotoneaster affinis</i> var. <i>bacillaris</i> (Lindl.) Schneider.	0.5	0.5	10	0.75	0.59	1.12	2.46
32.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	0.75	0.59	1.12	2.46
33.	<i>Daucus carota</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
34.	<i>Lactuca serriola</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
35.	<i>Matricaria chamomila</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
36.	<i>Nepeta cataria</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
37.	<i>Plantago lanceolata</i> L.	0.5	0.5	10	0.75	0.59	1.12	2.46
38.	<i>Pteris</i> sp.	0.5	0.5	10	0.75	0.59	1.12	2.46
39.	<i>Sonchus asper</i> (L.) Hill.	0.5	0.5	10	0.75	0.59	1.12	2.46
40.	<i>Torilis arvensis</i> (Huds.) Link.	0.5	0.5	10	0.75	0.59	1.12	2.46
Total		66.5	84.5	890	99.84	99.84	99.83	299.51

Appendix 4. Phytosociological Attributes of *Juncus-Phragmites-Nasturtium* (JPN)
Community at Tooque in Water course Site at an altitude of 2250m- 2350m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Juncus articulata</i> L.	7.5	7.5	90	11.45	9.49	11.11	32.05*
2.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	7.0	8.0	60	10.68	10.12	7.40	28.2**
3.	<i>Nasturtium officinale</i> R.Br.	4.5	6.5	30	6.87	8.22	3.70	18.79***
4.	<i>Equisetum ramossimum</i> Desf.	4.0	3.5	30	6.10	4.43	3.70	14.23
5.	<i>Epilobium hirsutum</i> L.	2.5	2.5	50	3.81	3.16	6.17	13.14
6.	<i>Veronica anagalis-aquatica</i> L.	2.5	4.5	30	3.81	5.69	3.70	13.2
7.	<i>Mentha longifolia</i> (L.) Huds.	2.0	4.0	40	3.05	5.06	4.93	13.04
8.	<i>Triglochin palustris</i> L.	4.0	3.0	20	6.10	3.79	2.46	12.35
9.	<i>Chara</i> Sp.	2.5	2.5	30	3.81	3.16	3.70	10.67
10.	<i>Eragrostis poaeoides</i> P. Beauv.	2.0	2.0	40	3.05	2.53	4.93	10.51
11.	<i>Inula obtusifolia</i> Kerner.	2.0	2.0	40	3.05	2.53	4.93	10.51
12.	<i>Typha angustata</i> Borry & Chaub.	2.5	3.5	10	3.81	4.43	1.23	9.47
13.	<i>Utricularia australis</i> R.Br	2.5	3.5	10	3.81	4.43	1.23	9.47
14.	<i>Polygonum persicaria</i> L.	1.5	2.5	30	2.29	3.16	3.70	9.8
15.	<i>Tussilago farfara</i> L.	2.0	3.0	20	3.05	3.79	2.46	9.3
16.	<i>Juncus himalensis</i> K.L & Gracke.	1.5	1.5	30	2.29	1.89	3.70	7.88
17.	<i>Cyprus</i> Sp.	1.5	1.5	20	2.29	1.89	2.46	6.64
18.	<i>Hippuris vulgaris</i> L.	1.0	2.0	20	1.52	2.53	2.46	6.51
19.	<i>Plantago major</i> Aitch.	1.0	2.0	20	1.52	2.53	2.46	6.51
20.	<i>Schoenoplectus litoralis</i> (Schard.) Palla.	1.0	2.0	20	1.52	2.53	2.46	6.51
21.	<i>Cynodon dactylon</i> (L.) Pers.	1.5	1.5	10	2.29	1.89	1.23	5.41
22.	<i>Primula denticulata</i> Sm.	1.5	1.5	10	2.29	1.89	1.23	5.41
23.	<i>Epilobium angustifolium</i> L.	1.0	1.0	20	1.52	1.26	2.46	5.24
24.	<i>Parnassia nubicola</i> Planch ex Clarke.	1.0	1.0	20	1.52	1.26	2.46	5.24
25.	<i>Ranunculus lobatus</i> Jacq ex Cam.	1.0	1.0	20	1.52	1.26	2.46	5.24
26.	<i>Melilotus indica</i> (L.) All.	0.5	1.5	10	0.76	1.89	1.23	3.88
27.	<i>Bromus gracillimus</i> Bunge.	0.5	0.5	10	0.76	0.63	1.23	2.62
28.	<i>Centaurium meyeri</i> (Bunge.) Druce.	0.5	0.5	10	0.76	0.63	1.23	2.62
29.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	0.76	0.63	1.23	2.62
30.	<i>Lactuca tatarica</i> (L.) C.A. Mey.	0.5	0.5	10	0.76	0.63	1.23	2.62
31.	<i>Plantago lanceolata</i> L.	0.5	0.5	10	0.76	0.63	1.23	2.62
32.	<i>Potamogeton</i> Sp.	0.5	0.5	10	0.76	0.63	1.23	2.62
33.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	0.5	0.5	10	0.76	0.63	1.23	2.62
34.	<i>Sonchus asper</i> (L.) Hill.	0.5	0.5	10	0.76	0.63	1.23	2.62
Total		65.5	79	810	99.86	99.85	99.8	300.16

Appendix 5. Phytosociological Attributes of *Equisetum-Juncus-Phragmites* (EJP)
Community at Chinar in Water course Site at an altitude of 2220m- 2360m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Equisetum ramosissimum</i> Desf.	7.0	7.0	80	10.44	9.58	9.52	29.54*
2.	<i>Juncus articulata</i> L.	7.0	7.0	80	10.44	9.58	9.52	29.54**
3.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	4.0	8.0	80	5.97	10.95	9.52	26.44***
4.	<i>Mentha longifolia</i> (L.) Huds.	4.5	5.5	70	6.71	7.53	8.33	22.57
5.	<i>Chara</i> Sp.	6.0	6.0	40	8.95	8.21	4.76	21.92
6.	<i>Epilobium hirsutum</i> L.	4.5	3.5	50	6.71	4.79	5.95	17.45
7.	<i>Trifolium repens</i> L.	4.0	4.0	20	5.97	5.47	2.38	13.82
8.	<i>Nasturtium officinale</i> R.Br.	2.5	3.5	30	3.73	4.79	3.57	12.09
9.	<i>Plantago major</i> Aitch.	2.0	3.0	40	2.98	4.10	4.76	11.84
10.	<i>Triglochin palustris</i> L.	2.0	2.0	40	2.98	2.73	4.76	10.47
11.	<i>Carex diluta</i> M.Bieb.	3.0	2.0	20	4.47	2.73	2.38	9.58
12.	<i>Potamogeton</i> Sp.	2.5	2.5	10	3.73	3.42	1.19	8.34
13.	<i>Cyperus</i> Sp.	1.5	1.5	30	2.23	2.05	3.57	7.85
14.	<i>Inula obtusifolia</i> Kerner.	1.5	1.5	30	2.23	2.05	3.57	7.85
15.	<i>Taraxacum officinale</i> Weber.	1.5	1.5	30	2.23	2.05	3.57	7.85
16.	<i>Ranunculus lobatus</i> Jacq ex Cam.	2.5	1.5	10	3.73	2.05	1.19	6.97
17.	<i>Cnicus benedictus</i> L.	1.5	2.5	10	2.23	3.42	1.19	6.84
18.	<i>Tussilago farfara</i> L.	1.5	1.5	10	2.23	2.05	1.19	5.47
19.	<i>Lactuca serriola</i> L.	1.0	1.0	20	1.49	1.36	2.38	5.23
20.	<i>Plantago lanceolata</i> L.	1.0	1.0	20	1.49	1.36	2.38	5.23
21.	<i>Swertia speciosa</i> D.Don.	1.0	1.0	20	1.49	1.36	2.38	5.23
22.	<i>Utricularia australis</i> R.Br.	0.5	1.5	10	0.74	2.05	1.19	3.98
23.	<i>Centaurium meyeri</i> (Bunge.) Druce.	0.5	0.5	10	0.74	0.68	1.19	2.61
24.	<i>Cichorium intybus</i> L.	0.5	0.5	10	0.74	0.68	1.19	2.61
25.	<i>Epilobium angustifolium</i> L.	0.5	0.5	10	0.74	0.68	1.19	2.61
26.	<i>Eragrostis minor</i> Host.	0.5	0.5	10	0.74	0.68	1.19	2.61
27.	<i>Lotus corniculatus</i> L.	0.5	0.5	10	0.74	0.68	1.19	2.61
28.	<i>Matricaria chamomila</i> L.	0.5	0.5	10	0.74	0.68	1.19	2.61
29.	<i>Torilis arvensis</i> (Huds.) Link.	0.5	0.5	10	0.74	0.68	1.19	2.61
30.	<i>Trifolium</i> Sp.	0.5	0.5	10	0.74	0.68	1.19	2.61
31.	<i>Veronica anagalis-aquatica</i> L.	0.5	0.5	10	0.74	0.68	1.19	2.61
Total		67	73	840	99.83	99.8	99.96	299.59

Appendix 6. Phytosociological Attributes of *Rheum-Artemisia-Ephedra* (RAE) Community at Sarghuz on Dry site at an altitude of 2250m-2500m.

S.No.	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Rheum emodi</i> Wall ex Meissn.	5.0	10.0	40	9.43	11.11	6.66	27.2*
2.	<i>Artemisia maritima</i> L.	6.0	8.0	40	11.32	8.88	6.66	26.86**
3.	<i>Ephedra gerardiana</i> L.	4.0	7.0	40	7.54	7.77	6.66	21.97***
4.	<i>Verbascum thapsus</i> L.	2.0	5.0	40	3.77	5.55	6.66	15.98
5.	<i>Tamarix dioica</i> Roxb ex Roth.	3.0	4.0	20	5.66	4.44	3.33	13.43
6.	<i>Artemisia brevifolia</i> Wall ex DC.	2.5	2.5	30	4.71	2.77	5	12.48
7.	<i>Astragalus psilocentros</i> Fisch.	3.0	3.0	20	5.66	3.33	3.33	12.32
8.	<i>Rosa webbiana</i> Wall ex Royle.	2.0	4.0	20	3.77	4.44	3.33	11.54
9.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden	2.0	3.0	20	3.77	3.33	3.33	10.43
10.	<i>Nepeta paulsenii</i> Briq.	2.0	3.0	20	3.77	3.33	3.33	10.43
11.	<i>Glycyrrhiza glabra</i> L.	2.5	3.5	10	4.71	3.88	1.66	10.25
12.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	2.5	3.5	10	4.71	3.88	1.66	10.25
13.	<i>Juniperus excelsa</i> M.Bieb.	1.0	4.0	20	1.88	4.44	3.33	9.65
14.	<i>Cynanchum acutum</i> L.	1.5	1.5	30	2.83	1.66	5	9.49
15.	<i>Chenopodium botrys</i> L.	2.0	2.0	20	3.77	2.22	3.33	9.32
16.	<i>Marrubium vulgare</i> L.	1.0	3.0	20	1.88	3.33	3.33	8.54
17.	<i>Artemisia scoparia</i> Waldst & Kit.	1.0	2.0	20	1.88	2.22	3.33	7.43
18.	<i>Colutea paulsenii</i> Feryh.	1.5	1.5	10	2.83	1.66	1.66	6.15
19.	<i>Berberis lycium</i> Royle.	0.5	2.5	10	0.94	2.77	1.66	5.37
20.	<i>Capparis spinosa</i> L.	0.5	2.5	10	0.94	2.77	1.66	5.37
21.	<i>Sophora mollis</i> (Royle.) Baker.	0.5	2.5	10	0.94	2.77	1.66	5.37
22.	<i>Cicer macranthum</i> M. Popov.	0.5	1.5	10	0.94	1.66	1.66	4.26
23.	<i>Dichanthium annulatum</i> Forssk. Stapf.	0.5	1.5	10	0.94	1.66	1.66	4.26
24.	<i>Echinops echinatus</i> Roxb.	0.5	1.5	10	0.94	1.66	1.66	4.26
25.	<i>Metthiola flavida</i> Boiss.	0.5	1.5	10	0.94	1.66	1.66	4.26
26.	<i>Pistacia integerrhima</i> (L.) Stewart ex Brand.	0.5	1.5	10	0.94	1.66	1.66	4.26
27.	<i>Conyza bonariensis</i> (L.) Conquist.	0.5	0.5	10	0.94	0.55	1.66	3.15
28.	<i>Kochia prostrata</i> (L.) Schard.	0.5	0.5	10	0.94	0.55	1.66	3.15
29.	<i>Artemisia</i> Sp.	0.5	0.5	10	0.94	0.55	1.66	3.15
30.	<i>Clematis orientalis</i> L.	0.5	0.5	10	0.94	0.55	1.66	3.15
31.	<i>Cnicus benedictus</i> L.	0.5	0.5	10	0.94	0.55	1.66	3.15
32.	<i>Cnicus</i> Sp.	0.5	0.5	10	0.94	0.55	1.66	3.15
33.	<i>Gnaphalum luteo-album</i> L.	0.5	0.5	10	0.94	0.55	1.66	3.15
34.	<i>Lactuca serriola</i> L.	0.5	0.5	10	0.94	0.55	1.66	3.15
35.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	0.5	0.5	10	0.94	0.55	1.66	3.15
Total		53	90	600	99.87	99.8	99.81	299.48

Appendix 7. Phytosociological Attributes of *Sophora-Salvia-Hippophae* (SSH)
Community at Malakandi on Dry site at an altitude of 2290m-2410m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Sophora mollis</i> (Royle.) Baker.	5.5	8.5	50	9.16	11.40	5.37	25.93*
2.	<i>Salvia nubicola</i> Wall ex Sweet.	4.0	4.0	40	6.66	5.36	4.30	16.32**
3.	<i>Hippophae rhamnoides</i> L.	2.5	4.5	30	4.16	6.04	3.22	13.42***
4.	<i>Artemisia scoparia</i> Waldst & Kit.	3.0	3.0	40	5	4.02	4.30	13.32
5.	<i>Kochia prostrata</i> (L.) Schard.	3.0	3.0	40	5	4.02	4.30	13.32
6.	<i>Cnicus benedictus</i> L.	3.0	4.0	20	5	5.36	2.15	12.51
7.	<i>Cynodon dactylon</i> (L) Pers.	2.0	2.0	40	3.33	2.68	4.30	10.31
8.	<i>Mentha longifolia</i> (L.) Huds.	1.5	2.5	30	2.5	3.35	3.22	9.07
9.	<i>Echinops echinatus</i> Roxb.	1.5	1.5	30	2.5	2.01	3.22	7.73
10.	<i>Elaeagnus angustifolia</i> L.	1.5	1.5	20	2.5	2.01	2.15	6.66
11.	<i>Chenopodium botrys</i> L.	1.0	2.0	20	1.66	2.68	2.15	6.49
12.	<i>Rosa webbiana</i> Wall ex Royle.	1.0	2.0	20	1.66	2.68	2.15	6.49
13.	<i>Tamarix dioica</i> Roxb ex Roth.	1.0	2.0	20	1.66	2.68	2.15	6.49
14.	<i>Plantago major</i> Aitch.	1.5	2.5	10	2.5	2.68	1.07	6.25
15.	<i>Nepeta lavigata</i> (D.Don.) Hand. Mazz.	1.5	1.5	10	2.5	2.01	1.07	5.58
16.	<i>Verbascum thapsus</i> L.	1.5	1.5	10	2.5	2.01	1.07	5.58
17.	<i>Arisaema jacquemontii</i> Blume.	1.0	1.0	20	1.66	1.34	2.15	5.15
18.	<i>Chenopodium album</i> L.	1.0	1.0	20	1.66	1.34	2.15	5.15
19.	<i>Cirsium acaule</i> (L.) Scop.	1.0	1.0	20	1.66	1.34	2.15	5.15
20.	<i>Dichanthium annulatum</i> Forssk. Stapf.	1.0	1.0	20	1.66	1.34	2.15	5.15
21.	<i>Epilobium hirsutum</i> L.	1.0	1.0	20	1.66	1.34	2.15	5.15
22.	<i>Myricaria elegans</i> Royle.	1.0	1.0	20	1.66	1.34	2.15	5.15
23.	<i>Tagetes erecta</i> L.	1.0	1.0	20	1.66	1.34	2.15	5.15
24.	<i>Taraxacum officinale</i> Weber.	1.0	1.0	20	1.66	1.34	2.15	5.15
25.	<i>Berberis lycium</i> Royle.	0.5	1.5	10	0.83	2.01	1.07	3.91
26.	<i>Capparis spinosa</i> L.	0.5	1.5	10	0.83	2.01	1.07	3.91
27.	<i>Ferula jeschkeana</i> Vatke.	0.5	1.5	10	0.83	2.01	1.07	3.91
28.	<i>Tribulus terrestris</i> L.	0.5	1.5	10	0.83	2.01	1.07	3.91
29.	<i>Artemisia brevifolia</i> Wall ex DC.	0.5	0.5	10	0.83	0.67	1.07	2.57
30.	<i>Artemisia parviflora</i> Roxb.	0.5	0.5	10	0.83	0.67	1.07	2.57
31.	<i>Artemisia maritima</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
32.	<i>Tussilago farfara</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57

33.	<i>Cicer macranthum</i> M. Popov.	0.5	0.5	10	0.83	0.67	1.07	2.57
34.	<i>Cotoneaster microphylla</i> Wall ex Lind.	0.5	0.5	10	0.83	0.67	1.07	2.57
35.	<i>Cousinia mattfeldii</i> Bornm.	0.5	0.5	10	0.83	0.67	1.07	2.57
36.	<i>Crataegus songarica</i> C. Koch.	0.5	0.5	10	0.83	0.67	1.07	2.57
37.	<i>Crotolaria prostrata</i> Roxb ex D.Don.	0.5	0.5	10	0.83	0.67	1.07	2.57
38.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
39.	<i>Euphorbia peplus</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
40.	<i>Gnaphalium luteo-album</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
41.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss	0.5	0.5	10	0.83	0.67	1.07	2.57
42.	<i>Juniperus excelsa</i> M.Bieb.	0.5	0.5	10	0.83	0.67	1.07	2.57
43.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	0.5	0.5	10	0.83	0.67	1.07	2.57
44.	<i>Lactuca serriola</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
45.	<i>Lactuca viminea</i> (L.) Schmid.	0.5	0.5	10	0.83	0.67	1.07	2.57
46.	<i>Malva neglecta</i> Wall.	0.5	0.5	10	0.83	0.67	1.07	2.57
47.	<i>Marrubium vulgare</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
48.	<i>Matricaria disciformis</i> (Cam.) DC.	0.5	0.5	10	0.83	0.67	1.07	2.57
49.	<i>Matthiola flavida</i> Boiss.	0.5	0.5	10	0.83	0.67	1.07	2.57
50.	<i>Nepeta paulsenii</i> Briq.	0.5	0.5	10	0.83	0.67	1.07	2.57
51.	<i>Nepeta raphanorhiza</i> Benth.	0.5	0.5	10	0.83	0.67	1.07	2.57
52.	<i>Otostegia limbata</i> (Bth.) Boiss.	0.5	0.5	10	0.83	0.67	1.07	2.57
53.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	0.5	0.5	10	0.83	0.67	1.07	2.57
54.	<i>Nepeta</i> Sp.	0.5	0.5	10	0.83	0.67	1.07	2.57
55.	<i>Rheum emodi</i> Wall ex Meissn.	0.5	0.5	10	0.83	0.67	1.07	2.57
56.	<i>Solanum nigrum</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
57.	<i>Salix acmophylla</i> Boiss.	0.5	0.5	10	0.83	0.67	1.07	2.57
58.	<i>Trifolium repens</i> L.	0.5	0.5	10	0.83	0.67	1.07	2.57
Total		60	74.5	930	99.79	99.85	99.77	299.41

Appendix 8. Phytosociological Attributes of *Sophora-Capparis-Saccharum* (SCS) Community at Mastuj village on Dry site at an altitude of 2320m-2420m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Sophora mollis</i> (Royle.) Baker.	6.5	11.5	70	11.71	15.43	9.09	36.23*
2.	<i>Capparis spinosa</i> L.	2.0	6.0	40	3.60	8.05	5.19	16.84**
3.	<i>Saccharum spontaneum</i> L.	3.0	4.0	40	5.40	5.36	5.19	15.95***
4.	<i>Artemisia scoparia</i> Waldst & Kit.	3.0	3.0	40	5.40	4.02	5.19	14.61
5.	<i>Verbascum thapsus</i> L.	3.0	3.0	40	5.40	4.02	5.19	14.61
6.	<i>Artemisia brevifolia</i> Wall ex DC.	2.5	2.5	50	4.50	3.35	6.49	14.34
7.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	3.0	5.0	20	5.40	6.71	2.59	14.7
8.	<i>Echinops echinatus</i> Roxb.	2.0	2.0	40	3.60	2.68	5.19	11.47
9.	<i>Rosa webbiana</i> Wall ex Royle.	1.5	2.5	30	2.70	3.35	3.89	9.94
10.	<i>Conyza</i> Sp.	2.5	2.5	10	4.50	3.35	1.29	9.14
11.	<i>Chenopodium botrys</i> L.	2.0	2.0	20	3.60	2.68	2.59	8.87
12.	<i>Ephedra gerardiana</i> L.	2.0	2.0	20	3.60	2.68	2.59	8.87
13.	<i>Anaphalia gracilis</i> Hud & Mazz.	1.5	1.5	30	2.70	2.01	3.89	8.6
14.	<i>Lactuca serriola</i> L.	1.5	1.5	30	2.70	2.01	3.89	8.6
15.	<i>Chenopodium album</i> L.	1.5	1.5	10	2.70	2.01	1.29	6
16.	<i>Chondrilla graminea</i> M.Bieb.	1.5	1.5	10	2.70	2.01	1.29	6
17.	<i>Lactuca viminea</i> (L.) Schmid.	1.5	1.5	10	2.70	2.01	1.29	6
18.	<i>Lotus corniculatus</i> L.	1.5	1.5	10	2.70	2.01	1.29	6
19.	<i>Marrubium vulgare</i> L.	1.5	1.5	10	2.70	2.01	1.29	6
20.	<i>Cotoneaster microphylla</i> Wall ex Lind.	0.5	2.5	10	0.90	3.35	1.29	5.54
21.	<i>Juniperus excelsa</i> M.Bieb.	0.5	2.5	10	0.90	3.35	1.29	5.14
22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.5	1.5	10	0.90	2.01	1.29	4.2
23.	<i>Tamarix dioica</i> Roxb ex Roth.	0.5	1.5	10	0.90	2.01	1.29	4.2
24.	<i>Acantholimon longiscapum</i> Bokhari.	0.5	0.5	10	0.90	0.67	1.29	2.86
25.	<i>Ailanthus altissima</i> (Mill.) Swingle.	0.5	0.5	10	0.90	0.67	1.29	2.86
26.	<i>Amaranthus retroflexus</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
27.	<i>Artemisia maritima</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
28.	<i>Artemisia parviflora</i> Roxb.	0.5	0.5	10	0.90	0.67	1.29	2.86
29.	<i>Astragalus ambersianus</i> Royle ex Benth.	0.5	0.5	10	0.90	0.67	1.29	2.86
30.	<i>Atraphaxis spinosa</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
31.	<i>Berberis lycium</i> Royle.	0.5	0.5	10	0.90	0.67	1.29	2.86
32.	<i>Clematis orientalis</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
33.	<i>Conyza canadensis</i> (L.) Conquist.	0.5	0.5	10	0.90	0.67	1.29	2.86
34.	<i>Cynanchum acutum</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
35.	<i>Dichanthium annulatum</i> Forssk. Stapf.	0.5	0.5	10	0.90	0.67	1.29	2.86
36.	<i>Elaeagnus angustifolia</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
37.	<i>Gnaphalium luteo-album</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
38.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	0.5	0.5	10	0.90	0.67	1.29	2.86
39.	<i>Mentha longifolia</i> (L.) Huds.	0.5	0.5	10	0.90	0.67	1.29	2.86
40.	<i>Nepeta cataria</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
41.	<i>Rubus fruticosus</i> L.	0.5	0.5	10	0.90	0.67	1.29	2.86
42.	<i>Scrophularia stewartii</i> Penn.	0.5	0.5	10	0.90	0.67	1.29	2.86
43.	Grass sp 1.	0.5	0.5	10	0.90	0.67	1.29	2.86
Total		55.5	74.5	770	99.91	99.88	99.67	299.45

Appendix 9. Phytosociological Attributes of *Hippophae-Cnicus-Myricaria* (HCM) Community at Tooque on Dry site at an altitude of 2200m-2400m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Hippophae rhamnoides</i> L.	2.0	6.0	40	4.49	8.39	4.70	17.58*
2.	<i>Cnicus benedictus</i> L.	2.0	4.0	40	4.49	5.59	4.70	14.78**
3.	<i>Myricaria elegans</i> Royle.	2.0	4.0	40	4.49	5.59	4.70	14.78***
4.	<i>Rosa webbiana</i> Wall ex Royle.	1.5	5.5	30	3.37	7.69	3.52	14.58
5.	<i>Chondrilla graminea</i> M.Bieb.	2.5	3.5	30	5.61	4.89	3.52	14.02
6.	<i>Elaeagnus angustifolia</i> L.	1.5	4.5	30	3.37	6.29	3.52	13.18
7.	<i>Equisetum ramosissimum</i> Desf.	2.0	3.0	40	4.49	4.19	4.70	13.38
8.	<i>Artemisia brevifolia</i> Wall ex DC.	1.5	2.5	30	3.37	3.49	3.52	10.38
9.	<i>Glycyrrhiza glabra</i> L.	1.5	2.5	30	3.37	3.49	3.52	10.38
10.	<i>Plantago lanceolata</i> L.	1.5	2.5	30	3.37	3.49	3.52	10.38
11.	<i>Populus alba</i> L.	1.5	3.5	10	3.37	4.89	1.17	9.43
12.	<i>Mentha longifolia</i> (L.) Huds.	1.5	1.5	30	3.37	2.09	3.52	8.98
13.	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	1.5	1.5	30	3.37	2.09	3.52	8.98
14.	<i>Arnebia hispidissima</i> (Lehm.) DC.	1.0	1.0	20	2.24	1.39	2.35	5.98
15.	<i>Artemisia scoparia</i> Waldst & Kit.	1.0	1.0	20	2.24	1.39	2.35	5.98
16.	<i>Cichorium intybus</i> L.	1.0	1.0	20	2.24	1.39	2.35	5.98
17.	<i>Clematis orientalis</i> L.	1.0	1.0	20	2.24	1.39	2.35	5.98
18.	<i>Cnicus</i> Sp.	1.0	1.0	20	2.24	1.39	2.35	5.98
19.	<i>Inula obtusifolia</i> Kerner.	1.0	1.0	20	2.24	1.39	2.35	5.98
20.	<i>Taraxacum officinale</i> Weber.	1.0	1.0	20	2.24	1.39	2.35	5.98
21.	<i>Trachomitum venetum</i> (L.) Woodson.	1.0	1.0	20	2.24	1.39	2.35	5.98
22.	<i>Salix coerriola</i> (Sm.) Rech.	0.5	2.5	10	1.12	3.49	1.17	5.78
23.	<i>Colutea paulsenii</i> Feryh.	0.5	1.5	10	1.12	2.09	1.17	4.38
24.	<i>Lactuca tatarica</i> (L.) C.A. Mey.	0.5	1.5	10	1.12	2.09	1.17	4.38
25.	<i>Tamarix dioica</i> Roxb ex Roth.	0.5	1.5	10	1.12	2.09	1.17	4.38
26.	<i>Anaphalis gracilis</i> Haud & Mazz.	0.5	0.5	10	1.12	0.69	1.17	2.98
27.	<i>Artemisia parviflora</i> Roxb.	0.5	0.5	10	1.12	0.69	1.17	2.98
28.	<i>Astragalus psilocentros</i> Fisch.	0.5	0.5	10	1.12	0.69	1.17	2.98
29.	<i>Capparis spinosa</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
30.	<i>Chesneya depressa</i> (Oliver.) Popov.	0.5	0.5	10	1.12	0.69	1.17	2.98
31.	<i>Crotolaria prostrata</i> Roxb ex D.Don.	0.5	0.5	10	1.12	0.69	1.17	2.98
32.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	1.12	0.69	1.17	2.98
33.	<i>Cynanchum acutum</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
34.	<i>Cynodon dactylon</i> (L.) Pers.	0.5	0.5	10	1.12	0.69	1.17	2.98
35.	Compositae Sp.	0.5	0.5	10	1.12	0.69	1.17	2.98
36.	<i>Dichanthium annulatum</i> Forssk. Stapf.	0.5	0.5	10	1.12	0.69	1.17	2.98
37.	<i>Echinops echinatus</i> Roxb.	0.5	0.5	10	1.12	0.69	1.17	2.98
38.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
39.	<i>Epilobium hirsutum</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
40.	<i>Iris ensata</i> Thunb.	0.5	0.5	10	1.12	0.69	1.17	2.98
41.	<i>Juncus articulata</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
42.	<i>Lotus corniculatus</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
43.	<i>Plantago major</i> Aitch.	0.5	0.5	10	1.12	0.69	1.17	2.98
44.	<i>Polygonum persicaria</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
45.	<i>Saccharum spontaneum</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
46.	<i>Sonchus asper</i> (L.) Hill.	0.5	0.5	10	1.12	0.69	1.17	2.98
47.	<i>Triglochin palustris</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
48.	Grass sp 1.	0.5	0.5	10	1.12	0.69	1.17	2.98
49.	<i>Tribulus terrestris</i> L.	0.5	0.5	10	1.12	0.69	1.17	2.98
Total		44.5	71.5	850	99.81	99.61	99.69	299.11

Appendix 10. Phytosociological Attributes of *Elaeagnus-Salix-Hippophae* (ESH) Community at Chinar on Dry site at an altitude of 2260m-2350m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Elaeagnus angustifolia</i> L.	3.0	7.0	60	4.41	7.86	6.06	18.33 [*]
2.	<i>Salix acmophylla</i> Boiss.	4.0	7.0	40	5.88	7.86	4.04	17.78 ^{***}
3.	<i>Hippophae rhamnoides</i> L.	3.0	6.0	60	4.41	6.74	6.06	17.21 ^{***}
4.	<i>Myricaria elegans</i> Royle.	4.0	7.0	20	5.88	7.86	2.02	15.76
5.	<i>Clematis orientalis</i> L.	2.5	4.5	50	3.67	5.05	5.05	13.77
6.	<i>Plantago lanceolata</i> L.	4.0	3.0	20	5.88	3.37	2.02	11.27
7.	<i>Tamarix dioica</i> Roxb ex Roth.	2.0	4.0	20	2.94	4.49	2.02	9.45
8.	<i>Calamogrostris pseudophragmites</i>	2.0	2.0	40	2.94	2.24	4.04	9.22
9.	<i>Artemisia maritima</i> L.	3.0	3.0	20	4.41	3.37	2.02	9.8
10.	<i>Artemisia scoparia</i> Waldst & Kit.	3.0	3.0	20	4.41	3.37	2.02	9.8
11.	<i>Setaria glauca</i> (Retz.) Trin ex Steud.	2.5	1.5	30	3.67	1.68	3.03	8.38
12.	<i>Medicago sativa</i> L.	2.0	3.0	20	2.94	3.37	2.02	8.33
13.	<i>Cichorium intybus</i> L.	1.5	1.5	30	2.20	1.68	3.03	6.91
14.	<i>Sonchus asper</i> (L.) Hill.	1.5	1.5	30	2.20	1.68	3.03	6.91
15.	Grass sp 2.	1.5	1.5	30	2.20	1.68	3.03	6.91
16.	<i>Sophora mollis</i> (Royle.) Baker.	1.0	3.0	20	1.47	3.37	2.02	6.86
17.	<i>Eragrostis minor</i> Host.	2.0	1.0	20	2.94	1.12	2.02	6.08
18.	<i>Capparis spinosa</i> L.	1.0	2.0	20	1.47	2.24	2.02	5.73
19.	<i>Rosa webbiana</i> Wall ex Royle.	1.0	2.0	20	1.47	2.24	2.02	5.73
20.	<i>Artemisia</i> Sp.	1.5	1.5	10	2.20	1.68	1.01	4.89
21.	<i>Saccharum spontaneum</i> L.	1.0	2.0	10	1.47	2.24	1.01	4.72
22.	<i>Artemisia parviflora</i> Roxb.	1.0	1.0	20	1.47	1.12	2.02	4.61
23.	<i>Chenopodium botrys</i> L.	1.0	1.0	20	1.47	1.12	2.02	4.61
24.	<i>Cnicus benedictus</i> L.	1.0	1.0	20	1.47	1.12	2.02	4.61
25.	<i>Cynoglossum lanceolatum</i> Royle.	1.0	1.0	20	1.47	1.12	2.02	4.61
26.	<i>Iris ensata</i> Thunb.	1.0	1.0	20	1.47	1.12	2.02	4.61
27.	<i>Lotus corniculatus</i> L.	1.0	1.0	20	1.47	1.12	2.02	4.61
28.	<i>Plantago major</i> Aitch.	1.0	1.0	20	1.47	1.12	2.02	4.61
29.	<i>Trifolium repens</i> L.	1.5	0.5	10	2.20	0.56	1.01	3.77
30.	<i>Melilotus officinale</i> (L.) Desr.	0.5	1.5	10	0.73	1.68	10.1	3.42
31.	<i>Salix coerriola</i> (Sm.) Rech.	0.5	1.5	10	0.73	1.68	1.01	3.42
32.	<i>Abutilon bidentatum</i> Hochst ex A.Rich.	0.5	0.5	10	0.73	0.56	1.01	2.3
33.	<i>Artemisia brevifolia</i> Wall ex DC.	0.5	0.5	10	0.73	0.56	1.01	2.3
34.	<i>Astragalus ambersianus</i> Royle ex Benth.	0.5	0.5	10	0.73	0.56	1.01	2.3
35.	<i>Bromus gracillimus</i> Bunge.	0.5	0.5	10	0.73	0.56	1.01	2.3
36.	<i>Chondrilla graminea</i> M.Bieb.	0.5	0.5	10	0.73	0.56	1.01	2.3
37.	<i>Crotolaria prostrata</i> Roxb ex D.Don.	0.5	0.5	10	0.73	0.56	1.01	2.3
38.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	0.73	0.56	1.01	2.3
39.	<i>Cynanchum acutum</i> L.	0.5	0.5	10	0.73	0.56	1.01	2.3
40.	<i>Datura stramonium</i> L.	0.5	0.5	10	0.73	0.56	1.01	2.3

41.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.73	0.56	1.01	2.3
42.	<i>Equisetum ramossimum</i> Desf.	0.5	0.5	10	0.73	0.56	1.01	2.3
43.	<i>Geranium wallichianum</i> D.Don ex Sweet.	0.5	0.5	10	0.73	0.56	1.01	2.3
44.	<i>Matthiola flavida</i> Boiss.	0.5	0.5	10	0.73	0.56	1.01	2.3
45.	<i>Mentha longifolia</i> (L.) Huds.	0.5	0.5	10	0.73	0.56	1.01	2.3
46.	Sp. M	0.5	0.5	10	0.73	0.56	1.01	2.3
47.	<i>Nepeta cateria</i> L.	0.5	0.5	10	0.73	0.56	1.01	2.3
48.	<i>Populus nigra</i> L.	0.5	0.5	10	0.73	0.56	1.01	2.3
49.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	0.5	0.5	10	0.73	0.56	1.01	2.3
50.	<i>Pteris</i> sp.	0.5	0.5	10	0.73	0.56	1.01	2.3
51.	<i>Taraxacum officinale</i> Weber.	0.5	0.5	10	0.73	0.56	1.01	2.3
52.	<i>Torilis arvensis</i> (Huds.) Link.	0.5	0.5	10	0.73	0.56	1.01	2.3
53.	<i>Trifolium</i> Sp.	0.5	0.5	10	0.73	0.56	1.01	2.3
54.	<i>Tussilago farfara</i> L.	0.5	0.5	10	0.73	0.56	1.01	2.3
Total		68	89	990	99.8	99.83	99.99	299.62

Appendix 11. Phytosociological Attributes of *Sophora-Rheum-Haloxylon* (SRH)
Community at Mastuj along Foothill between altitude of 2325m- 2425m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Sophora mollis</i> (Royle.) Baker.	10.0	10.0	100	18.01	15.26	12.98	46.25*
2.	<i>Rheum emodi</i> Wall ex Meissn.	4.5	9.5	70	8.10	14.50	9.09	31.69**
3.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss	6.5	7.5	50	11.71	11.45	6.49	29.65***
4.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	4.0	5.0	60	7.20	7.63	7.79	22.62
5.	<i>Chenopodium botrys</i> L.	3.5	3.5	70	6.30	5.34	9.09	20.73
6.	<i>Hippophae rhamnoides</i> L.	3.5	3.5	70	6.30	5.34	9.09	20.73
7.	<i>Capparis spinosa</i> L.	3.0	5.0	20	5.40	7.63	2.59	15.62
8.	<i>Artemisia brevifolia</i> Wall ex DC.	3.0	3.0	40	5.40	4.58	5.19	15.17
9.	<i>Nepeta paulsenii</i> Briq.	2.5	2.5	30	4.50	3.81	3.89	12.2
10.	<i>Polygonum</i> Sp.	2.0	2.0	40	3.60	3.05	5.19	11.84
11.	<i>Rosa webbiana</i> Wall ex Royle.	2.0	3.0	20	3.60	4.58	2.59	10.77
12.	<i>Cuscuta reflexa</i> Roxb.	2.0	2.0	20	3.60	3.05	2.59	9.24
13.	<i>Astragalus ambersianus</i> Royle ex Benth.	1.5	1.5	30	2.70	2.29	3.89	8.88
14.	<i>Chenopodium album</i> L.	1.0	1.0	20	1.80	1.52	2.59	5.91
15.	<i>Otostegia limbata</i> (Bth.) Boiss.	1.0	1.0	20	1.80	1.52	2.59	5.91
16.	<i>Juniperus excelsa</i> M.B.	1.0	1.0	20	1.80	1.52	2.59	5.91
17.	<i>Nepeta</i> Sp.	0.5	0.5	10	0.90	0.76	1.29	2.95
18.	Grass sp 2.	0.5	0.5	10	0.90	0.76	1.29	2.95
19.	<i>Artemisia scoparia</i> Waldst & Kit.	0.5	0.5	10	0.90	0.76	1.29	2.95
20.	<i>Artemisia</i> Sp.	0.5	0.5	10	0.90	0.76	1.29	2.95
21.	<i>Astragalus psilocentros</i> Fisch.	0.5	0.5	10	0.90	0.76	1.29	2.95
22.	<i>Echinops echinatus</i> Roxb.	0.5	0.5	10	0.90	0.76	1.29	2.95
23.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.90	0.76	1.29	2.95
24.	<i>Marubium vulgare</i> L.	0.5	0.5	10	0.90	0.76	1.29	2.95
25.	<i>Verbascum thapsus</i> L.	0.5	0.5	10	0.90	0.76	1.29	2.95
Total		55.5	65.5	770	99.92	99.91	99.84	299.67

Appendix 12. Phytosociological Attributes of *Artemisia-Sophora-Ephedra* (ASE)
Community at Mastuj along Mid hill between altitude of 2440m- 2620m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia scoparia</i> Waldst & Kit.	6.0	7.0	100	17.64	16.27	18.51	52.42*
2.	<i>Sophora mollis</i> (Royle.) Baker.	5.0	9.0	60	14.70	20.93	11.11	46.74**
3.	<i>Ephedra gerardiana</i> L.	5.0	5.0	80	14.70	11.62	14.81	41.13***
4.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	4.0	4.0	60	11.76	9.30	11.11	32.17
5.	<i>Bromus gracillimus</i> Bunge.	3.0	3.0	40	8.82	6.97	7.40	23.19
6.	<i>Echinops echinatus</i> Roxb.	2.5	3.5	30	7.35	8.13	5.55	21.03
7.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	2.0	2.0	40	5.88	4.65	7.40	17.93
8.	<i>Ferula</i> Sp.	1.5	2.5	30	4.41	5.81	5.55	15.77
9.	<i>Rheum emodi</i> Wall ex Meissn.	1.5	2.5	30	4.41	5.81	5.55	15.77
10.	<i>Capparis spinosa</i> L.	1.0	1.0	20	2.94	2.32	3.70	8.96
11.	<i>Colutea paulsenii</i> Feryh.	0.5	1.5	10	1.47	3.48	1.85	6.8
12.	<i>Astragalus amberstianus</i> Royle ex Benth.	0.5	0.5	10	1.47	1.16	1.85	4.46
13.	<i>Cotoneaster nummularia</i> Fisch & Mey.	0.5	0.5	10	1.47	1.16	1.85	4.46
14.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	1.47	1.16	1.85	4.46
15.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	1.47	1.16	1.85	4.46
Total		34	43	540	99.96	99.93	99.94	299.75

Appendix 13. Phytosociological Attributes of *Artemisia-Matricaria-Juniperus* (AMJ) Community at Mastuj along Top hill between altitude of 2725m-3000m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia maritima</i> L.	7.0	8.0	100	10.60	10.81	9.61	31.02*
2.	<i>Matricaria disciformis</i> (C.A.M.) DC.	6.5	8.5	90	9.84	11.48	8.65	29.97**
3.	<i>Juniperus excelsa</i> M.Bieb.	5.5	9.5	50	8.33	12.83	4.80	25.96***
4.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	70	6.81	6.08	6.73	19.62
5.	<i>Trachyspermum ammi</i> (L.) Spargue.	3.5	3.5	70	5.30	4.72	6.73	16.75
6.	<i>Cicer macranthum</i> M. Popov	4.0	4.0	40	6.06	5.40	3.84	15.3
7.	<i>Aristida cynantha</i> Nees & Steud.	3.0	3.0	60	4.54	4.05	5.76	14.35
8.	<i>Nepeta paulsenii</i> L.	3.0	3.0	60	4.54	4.05	5.76	14.35
9.	<i>Ribes orientale</i> Desf.	3.0	3.0	40	4.54	4.05	3.84	12.43
10.	<i>Astragalus amberstianus</i> Royle ex Benth.	2.5	2.5	50	3.78	3.37	4.80	11.95
11.	S. Papilionaceae	2.0	3.0	40	3.03	4.05	3.84	10.92
12.	<i>Ephedra gerardiana</i> L.	2.0	2.0	40	3.03	2.70	3.84	9.57
13.	<i>Gnaphalium luteo-album</i> L.	2.0	2.0	40	3.03	2.70	3.84	9.57
14.	<i>Acantholimon longiscapum</i> Bokhari.	2.0	2.0	20	3.03	2.70	1.92	7.65
15.	<i>Asperula oppositifolia</i> Ehrend.	1.5	1.5	30	2.27	2.02	2.88	7.17
16.	<i>Epilobium angustifolium</i> L.	1.5	1.5	10	2.27	2.02	0.96	5.25
17.	<i>Oxyria digyna</i> (L.) Hill.	1.5	1.5	10	2.27	2.02	0.96	5.25
18.	<i>Allium carolinianum</i> DC.	1.0	1.0	20	1.51	1.35	1.92	4.78
19.	<i>Astragalus psilocentros</i> Fisch.	1.0	1.0	20	1.51	1.35	1.92	4.78
20.	<i>Cuscuta reflexa</i> Roxb.	1.0	1.0	20	1.51	1.35	1.92	4.78
21.	<i>Scrophularia stewartii</i> Penn.	1.0	1.0	20	1.51	1.35	1.92	4.78
22.	<i>Trachyspermum</i> sp.	1.0	1.0	20	1.51	1.35	1.92	4.78
23.	Asteraceae-1	1.0	1.0	20	1.51	1.35	1.92	4.78
24.	<i>Matricaria</i> Sp.	1.0	1.0	20	1.51	1.35	1.92	4.78
25.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	0.75	0.67	0.96	2.38
26.	<i>Codonopsis clematidia</i> (Schrenk.) Clarke.	0.5	0.5	10	0.75	0.67	0.96	2.38
27.	<i>Colutea paulsenii</i> L.	0.5	0.5	10	0.75	0.67	0.96	2.38
28.	<i>Cotoneaster nummularia</i> Fisch & Mey.	0.5	0.5	10	0.75	0.67	0.96	2.38
29.	<i>Euphorbia falcata</i> L.	0.5	0.5	10	0.75	0.67	0.96	2.38
30.	<i>Salix acmophylla</i> Boiss.	0.5	0.5	10	0.75	0.67	0.96	2.38
31.	Grass sp 2.	0.5	0.5	10	0.75	0.67	0.96	2.38
32.	<i>Taraxacum</i> Sp.	0.5	0.5	10	0.75	0.67	0.96	2.38
Total		66	74	1040	99.84	99.86	99.88	299.58

Appendix 14. Phytosociological Attributes of *Betula-Ribes-Rosa* (BRR) Community at Mastuj along Timberline between altitude of 3010m – 3300m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Betula utilis</i> D.Don.	5.0	10.0	60	14.70	25.64	11.76	52.1*
2.	<i>Ribes orientale</i> Desf.	4.0	4.0	60	11.76	10.25	11.76	33.77**
3.	<i>Rosa webbiana</i> Wall ex Royle.	2.5	2.5	50	7.35	6.41	9.80	3.56***
4.	<i>Cicer macranthum</i> M. Popov.	2.5	2.5	30	7.35	6.41	5.88	19.64
5.	<i>Rheum emodi</i> Wall ex Meissn.	2.5	2.5	30	7.35	6.41	5.88	19.64
6.	<i>Aristida cynantha</i> Nees & Steud.	2.0	2.0	40	5.88	5.12	7.84	18.84
7.	<i>Nepeta paulsenii</i> Briq.	1.5	1.5	30	4.41	3.84	5.88	14.13
8.	<i>Swertia speciosa</i> D.Don.	1.5	1.5	30	4.41	3.84	5.88	14.13
9.	Asteraceae l.	1.5	1.5	30	4.41	3.84	5.88	14.13
10.	<i>Hippophae rhamnoides</i> L.	2.0	2.0	10	5.88	5.12	1.96	12.96
11.	<i>Pteris</i> sp.	1.5	1.5	10	4.41	3.84	1.96	10.21
12.	<i>Sedum ewersii</i> Ledeb.	1.5	1.5	10	4.41	3.84	1.96	10.21
13.	<i>Codonopsis clematidia</i> (Schrenk.) Clarke.	1.0	1.0	20	2.94	2.56	3.92	9.42
14.	<i>Sonchus asper</i> (L.) Hill.	1.0	1.0	20	2.94	2.56	3.92	9.42
15.	<i>Astragalus amberstianus</i> Royle ex Benth.	0.5	0.5	10	1.47	1.28	1.96	4.71
16.	<i>Berberis lycium</i> Royle.	0.5	0.5	10	1.47	1.28	1.96	4.71
17.	<i>Mentha longifolia</i> (L.) Huds.	0.5	0.5	10	1.47	1.28	1.96	4.71
18.	<i>Parnassia nubicola</i> Planch ex Clarke.	0.5	0.5	10	1.47	1.28	1.96	4.71
19.	<i>Scrophularia stewartii</i> Penn.	0.5	0.5	10	1.47	1.28	1.96	4.71
20.	<i>Sonchus</i> Sp.	0.5	0.5	10	1.47	1.28	1.96	4.71
21.	<i>Nepeta</i> Sp.	0.5	0.5	10	1.47	1.28	1.96	4.71
22.	<i>Matricaria disciformis</i> (C.A.M.) DC.	0.5	0.5	10	1.47	1.28	1.96	4.71
Total		34	39	510	99.96	99.92	99.96	299.84

Appendix 15. Phytosociological Attributes of *Salvia-Berberis-Rosa* (SBR) Community at Miragram-I along Foothill between altitude of 2230m – 2525m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Salvia nubicola</i>	7.0	7.0	100	15.21	14.28	12.82	42.31*
2.	<i>Berberis lycium</i> Royle.	6.0	7.0	100	13.04	14.28	12.82	40.14**
3.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	90	9.78	9.18	11.53	30.49***
4.	<i>Echinops echinatus</i> Roxb.	3.5	3.5	70	7.60	7.14	8.97	23.71
5.	<i>Gnaphalium luteo-album</i> L.	3.5	3.5	50	7.60	7.14	6.41	21.15
6.	<i>Eragrostis minor</i> Host.	3.0	3.0	60	6.52	6.12	7.69	20.33
7.	<i>Fraxinus xanthoxloides</i> Wall ex G.Don.	2.5	3.5	30	5.43	7.14	3.84	16.41
8.	<i>Artemisia maritima</i> L.	2.0	2.0	40	4.34	4.08	5.15	13.54
9.	<i>Nepeta paulsenii</i> Briq.	2.0	2.0	20	4.34	4.08	2.56	10.98
10.	<i>Verbascum thapsus</i> L.	1.5	1.5	30	3.26	3.06	3.84	10.16
11.	<i>Salix acmophylla</i> Boiss.	1.5	1.5	10	3.26	3.06	1.28	7.6
12.	<i>Epilobium hirsutum</i> L.	1.0	1.0	20	2.17	2.04	2.56	6.77
13.	<i>Matricaria disciformis</i> (C.A.M.) DC.	1.0	1.0	20	2.17	2.04	2.56	6.77
14.	<i>Ribes orientale</i> Desf.	1.0	1.0	20	2.17	2.04	2.56	6.77
15.	<i>Sedum</i> Sp.	1.0	1.0	20	2.17	2.04	2.56	6.77
16.	<i>Juniperus excelsa</i> M.Bieb.	0.5	1.5	10	1.08	3.06	1.28	5.42
17.	<i>Aristida cynantha</i> Nees & Steud.	0.5	0.5	10	1.08	1.02	1.28	3.38
18.	<i>Astragalus amberstianus</i> Royle ex Benth.	0.5	0.5	10	1.08	1.02	1.28	3.38
19.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	1.08	1.02	1.28	3.38
20.	<i>Cotoneaster nummularia</i> Fisch & Mey.	0.5	0.5	10	1.08	1.02	1.28	3.38
21.	<i>Equisetum ramosissimum</i> Desf.	0.5	0.5	10	1.08	1.02	1.28	3.38
22.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	0.5	0.5	10	1.08	1.02	1.28	3.38
23.	<i>Marrubium vulgare</i> L.	0.5	0.5	10	1.08	1.02	1.28	3.38
24.	<i>Nepeta raphanorrhiza</i> Benth.	0.5	0.5	10	1.08	1.02	1.28	3.38
25.	<i>Pteris</i> sp.	0.5	0.5	10	1.08	1.02	1.28	3.38
Total		46	49	780	99.86	99.96	99.92	299.74

Appendix 16. Phytosociological Attributes of *Sophora-Astragalus-Berberis* (SAB) Community at Miragram-I along Mid hill between altitude of 2320m – 2550m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Sophora mollis</i> (Royle.) Baker.	8.0	8.0	100	21.62	21.05	15.62	58.29*
2.	<i>Astragalus psilocentros</i> Fisch.	5.5	5.5	90	14.86	14.47	14.06	43.39**
3.	<i>Berberis lycium</i> Royle.	3.0	3.0	60	8.10	7.89	9.37	25.36***
4.	<i>Echinops echinatus</i> Roxb.	3.0	3.0	60	8.10	7.89	9.37	25.36
5.	<i>Astragalus ambersianus</i> Royle ex Benth.	2.5	2.5	50	6.75	6.57	7.81	21.13
6.	<i>Marrubium vulgare</i> L.	2.5	2.5	50	6.75	6.57	7.81	21.13
7.	<i>Rosa webbiana</i> Wall ex Royle.	2.5	2.5	50	6.75	6.57	7.81	21.13
8.	<i>Cotoneaster nummularia</i> Fisch & Mey.	2.0	2.0	40	5.40	5.26	3.12	16.91
9.	<i>Verbascum thapsus</i> L.	2.0	2.0	40	5.40	5.26	6.25	16.91
10.	<i>Juniperus excelsa</i> M.Bieb.	1.5	2.5	30	4.05	6.57	4.68	15.3
11.	<i>Nepeta paulesenii</i> Briq.	2.0	2.0	20	5.40	5.26	3.12	13.78
12.	<i>Artemisia maritima</i> L.	1.0	1.0	20	2.70	2.63	3.12	8.45
13.	<i>Ribes orientale</i> Desf.	1.0	1.0	20	2.70	2.63	3.12	8.45
14.	<i>Cuscuta approximata</i> Bab.	0.5	0.5	10	1.35	1.31	1.56	4.22
Total		37	38	640	99.93	99.93	99.95	299.81

Appendix 17. Phytosociological Attributes of *Gnaphalum-Nepeta-Matricaria* (GNM) Community at Miragram-I along Top hill between altitude of 2640m – 935m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Gnaphalum luteo-album</i> L.	7.0	7.0	100	17.07	16.27	14.70	48.04*
2.	<i>Nepeta paulsenii</i> Briq.	5.0	5.0	80	12.19	11.62	11.76	35.57**
3.	<i>Matricaria disciformis</i> (C.A.M.) DC.	5.0	5.0	60	12.19	11.62	8.82	2.63***
4.	<i>Rosa webbiana</i> Wall ex Royle.	3.0	3.0	60	7.31	6.97	8.82	23.1
5.	<i>Cicer</i> Sp.	2.5	2.5	50	6.09	5.81	7.35	19.25
6.	<i>Juniperus excelsa</i> M.Bieb.	1.5	3.5	30	3.65	8.13	4.41	16.19
7.	<i>Acantholimon longiscapum</i> Bokhari.	2.0	2.0	30	4.87	4.65	4.41	13.93
8.	<i>Cleome ariana</i> Hedge & Lamond.	2.0	2.0	30	4.87	4.65	4.41	13.93
9.	<i>Cicer macranthum</i> M. Popov.	1.5	1.5	30	3.65	3.48	4.41	11.54
10.	<i>Ribes orientale</i> Desf.	1.5	1.5	30	3.65	3.48	4.41	11.54
11.	<i>Rheum emodi</i> Wall ex Meissn.	1.5	1.5	30	3.65	3.48	4.41	11.54
12.	Asteraceae 2.	1.5	1.5	30	3.65	3.48	4.41	11.54
13.	<i>Nepeta</i> Sp.	1.5	1.5	10	3.65	3.48	1.47	8.6
14.	<i>Trachyspermum ammi</i> (L.) Spargue.	1.0	1.0	20	2.43	2.32	2.94	7.69
15.	Grass 1.	1.0	1.0	20	2.43	2.32	2.94	7.69
16.	<i>Echinops echinatus</i> Roxb.	0.5	0.5	10	1.21	1.16	1.47	3.84
17.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	1.21	1.16	1.47	3.84
18.	<i>Potentilla supina</i> L.	0.5	0.5	10	1.21	1.16	1.47	3.84
19.	<i>Trifolium</i> Sp.	0.5	0.5	10	1.21	1.16	1.47	3.84
20.	<i>Polygonum</i> Sp.	0.5	0.5	10	1.21	1.16	1.47	3.84
21.	Lamiaceae 1.	0.5	0.5	10	1.21	1.16	1.47	3.84
22.	<i>Cynoglossum</i> Sp.	0.5	0.5	10	1.21	1.16	1.47	3.84
Total		41	43	680	99.82	99.88	99.96	299.66

Appendix 18. Phytosociological Attributes of *Epilobium-Rheum-Matricaria* (ERM)
Community at Miragram-I along Timberline between altitude of 2935m-
3100m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Epilobium angustifolium</i> L.	8.5	8.5	90	23.28	22.07	16.36	61.71*
2.	<i>Rheum emodi</i> Wall ex Meissn.	4.5	5.5	70	12.32	14.28	12.72	39.32**
3.	<i>Matricaria disciformis</i> (C.A.M.) DC.	3.0	3.0	60	8.21	7.79	10.90	26.9***
4.	<i>Swertia</i> Sp.	3.5	3.5	30	9.58	9.09	5.45	24.12
5.	<i>Eragrastris minor</i> Host.	2.5	2.5	50	6.84	6.49	9.09	22.42
6.	<i>Oxyria digyna</i> (L.) Hill.	2.0	2.0	40	5.47	5.19	7.27	17.93
7.	<i>Berberis lycium</i> Royle.	2.0	3.0	20	5.47	7.79	3.63	16.89
8.	<i>Chondrilla graminea</i> M.Bieb.	2.0	2.0	20	5.47	5.19	3.63	14.29
9.	<i>Pteris</i> sp.	1.0	1.0	20	2.73	2.59	3.63	8.95
10.	<i>Scrophularia stewartii</i> Penn.	1.0	1.0	20	2.73	2.59	3.63	8.95
11.	<i>Cicer macranthum</i> M. Popov.	0.5	0.5	10	1.36	1.29	1.81	4.46
12.	<i>Conyza canadensis</i> (L.) Conquist.	0.5	0.5	10	1.36	1.29	1.81	4.46
13.	<i>Epilobium hirsutum</i> L.	0.5	0.5	10	1.36	1.29	1.81	4.46
14.	<i>Eragrastris nigra</i> Nees ex Steud.	0.5	0.5	10	1.36	1.29	1.81	4.46
15.	<i>Nepeta paulsenii</i> Briq.	0.5	0.5	10	1.36	1.29	1.81	4.46
16.	<i>Ribes orientale</i> Desf.	0.5	0.5	10	1.36	1.29	1.81	4.46
17.	<i>Salix acmophylla</i> Boiss.	0.5	0.5	10	1.36	1.29	1.81	4.46
18.	<i>Sedum ewersii</i> Ledeb.	0.5	0.5	10	1.36	1.29	1.81	4.46
19.	<i>Pteris</i> Sp.	0.5	0.5	10	1.36	1.29	1.81	4.46
20.	<i>Cynoglossum</i> Sp..	0.5	0.5	10	1.36	1.29	1.81	4.46
21.	<i>Medicago lupulina</i> L.	0.5	0.5	10	1.36	1.29	1.81	4.46
22.	<i>Potentilla supina</i> L.	0.5	0.5	10	1.36	1.29	1.81	4.46
23.	Grass 1.	0.5	0.5	10	1.36	1.29	1.81	4.46
Total		36.5	38.5	550	99.78	99.84	99.84	299.46

Appendix 19. Phytosociological Attributes of *Rosa-Artemisia-Berberis* (RAB)
Community at Miragram-II along Foothill between altitude of 2400m – 2710m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Rosa webbiana</i> Wall ex Royle.	5.5	5.5	70	17.18	16.17	13.46	46.81*
2.	<i>Artemisia brevifolia</i> Wall & DC.	4.5	4.5	90	14.06	13.23	17.30	44.59**
3.	<i>Berberis lycium</i> Royle.	3.5	3.5	50	10.93	10.29	9.61	30.83***
4.	<i>Ephedra gerardiana</i> L.	3.5	3.5	50	10.93	10.29	9.61	30.83
5.	<i>Juniperus excelsa</i> M.Bieb.	2.0	4.0	40	6.25	11.76	7.69	25.7
6.	<i>Colutea paulsenii</i> Feryh.	2.5	2.5	30	7.81	7.35	5.76	20.92
7.	<i>Echinops echinatus</i> Roxb.	2.5	2.5	30	7.81	7.35	5.76	20.92
8.	<i>Gnaphalium luteo-album</i> L.	2.0	2.0	40	6.25	5.88	7.69	19.82
9.	<i>Astragalus psilocentros</i> Fisch.	1.5	1.5	30	4.68	4.41	5.76	14.85
10.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden	1.5	1.5	30	4.68	4.41	5.76	14.85
11.	<i>Artemisia scoparia</i> Waldst & Kit.	1.0	1.0	20	3.12	2.94	3.84	9.9
12.	<i>Clematis orientalis</i> L.	1.0	1.0	20	3.12	2.94	3.84	9.9
13.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	1.56	1.47	1.92	4.95
14.	<i>Pteris</i> Sp.	0.5	0.5	10	1.56	1.47	1.92	4.95
Total		32	34	520	99.94	99.96	99.92	299.82

Appendix 20. Phytosociological Attributes of *Ephedra-Matricaria-Acantholimon* (EMA) Community at Miragram-II along Mid hill between altitude of 2720m – 2860m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Ephedra gerardiana</i> L.	9.0	9.0	100	22.78	21.17	14.92	58.87*
2.	<i>Matricaria disciformis</i> (C.A.M.) DC.	7.0	8.0	100	17.72	18.82	14.92	51.46**
3.	<i>Acantholimon longiscapum</i> Bokhari.	5.0	7.0	100	12.65	16.47	14.92	44.04***
4.	<i>Artemisia brevifolia</i> Wall ex DC.	3.5	3.5	70	8.86	8.23	10.44	27.53
5.	<i>Codonopsis clematidia</i> (Schrenk.) Clarke.	3.5	3.5	70	8.86	8.23	10.44	27.53
6.	<i>Astragalus psilocentros</i> Fisch.	3.0	3.0	60	7.59	7.05	8.95	23.59
7.	<i>Gnaphalium luteo-album</i> L.	2.0	2.0	40	5.06	4.70	5.97	15.73
8.	<i>Berberis lycium</i> Royle.	1.5	1.5	30	3.79	3.52	4.47	11.78
9.	<i>Rosa webbiana</i> Wall ex Royle.	1.5	1.5	30	3.79	3.52	4.47	11.78
10.	<i>Aristida cynantha</i> Nees & Steud.	1.0	1.0	20	2.53	2.35	2.98	7.86
11.	<i>Nepeta paulsenii</i> Briq.	1.0	1.0	20	2.53	2.35	2.98	7.86
12.	<i>Colutea paulsenii</i> Feryh.	0.5	0.5	10	1.26	1.17	1.49	3.92
13.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	1.26	1.17	1.49	3.92
14.	<i>Ribes orientale</i> Desf.	0.5	0.5	10	1.26	1.17	1.49	3.92
Total		39.5	42.5	670	99.94	99.92	99.93	299.79

Appendix 21. Phytosociological Attributes of *Ephedra-Juniper-Rosa* (EJR) Community at Miragram-II along Top hill between altitude of 2870m – 2950m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Ephedra gerardiana</i> L.	8.5	8.5	90	17.52	16.83	11.11	45.46*
2.	<i>Juniperus excelsa</i> M.Bieb.	7.5	9.5	90	15.46	18.81	11.11	45.38**
3.	<i>Rosa webbiana</i> Wall ex Royle.	5.5	5.5	90	11.34	10.89	11.11	33.34***
4.	<i>Artemisia maritima</i> L.	4.0	4.0	80	8.24	7.92	9.87	26.03
5.	<i>Gnaphalium luteo-album</i> L.	3.0	3.0	60	6.18	5.94	7.40	19.52
6.	<i>Codonopsis clematidia</i> (Schrenk.) Clarke.	2.5	2.5	50	5.15	4.95	6.17	16.27
7.	<i>Matricaria disciformis</i> (C.A.M.) DC.	2.5	2.5	50	5.15	4.95	6.17	16.27
8.	<i>Ribes orientale</i> Desf.	2.5	2.5	50	5.15	4.95	6.17	16.27
9.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden	2.0	2.0	40	4.12	3.96	4.93	13.01
10.	<i>Aristida cynantha</i> Nees & Steud.	2.0	2.0	40	4.12	3.96	4.93	13.01
11.	<i>Astragalus psilocentros</i> Fisch.	2.0	2.0	40	4.12	3.96	4.93	13.01
12.	Compositae Sp.	1.5	1.5	30	3.09	2.97	3.70	9.76
13.	<i>Berberis lycium</i> Royle.	1.5	1.5	30	3.09	2.97	3.70	9.76
14.	<i>Cleome ariana</i> Hedge & Lamond.	1.5	1.5	30	3.09	2.97	3.70	9.76
15.	<i>Cotoneaster nummularia</i> Fisch & Mey.	1.5	1.5	30	3.09	2.97	3.70	9.76
16.	<i>Ferula jaeschkeana</i> Vatke.	0.5	0.5	10	1.03	0.99	1.23	3.25
Total		48.5	50.5	810	99.94	99.99	99.93	299.86

Appendix 22. Phytosociological Attributes of *Betula-Salix-Rosa* (BSR) Community at Miragram- II along Timberline between altitude of 2980m – 3100m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Betula utilis</i> D.Don.	7.5	8.5	90	22.38	23.28	18.36	64.02*
2.	<i>Salix acmophylla</i> Boiss.	5.0	5.0	80	14.92	13.69	16.32	44.93**
3.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	70	13.43	12.32	14.28	40.03***
4.	<i>Rumex longifolius</i> DC.	3.0	4.0	20	8.95	10.95	4.08	23.98
5.	<i>Epilobium hirsutum</i> L.	2.5	2.5	30	7.46	6.84	6.12	20.42
6.	<i>Polygonum</i> Sp.	2.0	2.0	40	5.97	5.47	8.16	19.6
7.	<i>Juniperus excelsa</i> M.Bieb.	1.5	2.5	30	4.47	6.84	6.12	17.43
8.	<i>Eragrastris nigra</i> Nees ex Steud.	2.0	2.0	20	5.97	5.47	4.08	15.52
9.	<i>Aristida cynantha</i> Nees & Steud..	1.5	1.5	30	4.47	4.10	6.12	14.69
10.	<i>Swertia speciosa</i> D.Don.	1.5	1.5	30	4.47	4.10	6.12	14.69
11.	<i>Capparis spinosa</i> L.	0.5	0.5	10	1.49	1.36	2.04	4.89
12.	<i>Conyza canadensis</i> (L.) Conquist.	0.5	0.5	10	1.49	1.36	2.04	4.89
13.	<i>Hippophae rhamnoides</i> L.	0.5	0.5	10	1.49	1.36	2.04	4.89
14.	<i>Sedum ewersii</i> Ledeb.	0.5	0.5	10	1.49	1.36	2.04	4.89
15.	<i>Lactuca</i> Sp.	0.5	0.5	10	1.49	1.36	2.04	4.89
Total		33.5	36.5	490	99.94	99.86	99.96	299.76

Appendix 23. Phytosociological Attributes of *Chenopodium-Haloxylon-Echinops* (CHE) Community at Ghuru along Foothill between altitude of 2200m - 2300m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Chenopodium botrys</i> L.	7.5	9.5	90	17.64	16.52	13.04	47.2*
2.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	6.0	9.0	80	14.11	15.65	11.59	41.35**
3.	<i>Echinops echinatus</i> Roxb.	3.0	4.0	60	7.05	6.95	8.69	22.69***
4.	<i>Capparis spinosa</i> L.	2.5	3.5	50	5.88	6.08	7.24	19.2
5.	<i>Sophora mollis</i> (Royle.) Baker.	2.0	4.0	20	4.70	6.95	2.89	14.54
6.	<i>Artemisia scoparia</i> Waldst & Kit.	1.5	2.5	30	3.52	4.34	4.34	12.2
7.	<i>Artemisia brevifolia</i> Wall ex DC.	1.5	2.5	30	3.52	4.34	4.34	12.2
8.	<i>Chenopodium</i> Sp.	2.0	2.0	20	4.70	3.47	2.89	11.06
9.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	1.5	1.5	30	3.52	2.60	4.34	10.46
10.	<i>Peganum harmala</i> L.	1.5	1.5	30	3.52	2.60	4.34	10.46
11.	<i>Saccharum spontaneum</i> L.	1.0	2.0	20	2.35	3.47	2.89	8.71
12.	<i>Cynodon dactylon</i> (L.) Pers.	1.5	1.5	10	3.52	2.60	1.44	7.56
13.	<i>Chenopodium album</i> L.	1.0	1.0	20	2.35	1.73	2.89	6.97
14.	<i>Cynoglossum lanceolatum</i> Forssk.	1.0	1.0	20	2.35	1.73	2.89	6.97
15.	<i>Sonchus</i> Sp.	1.0	1.0	20	2.35	1.73	2.89	6.97
16.	Grass 1.	1.0	1.0	20	2.35	1.73	2.89	6.97
17.	Sp. Labiatae	1.0	1.0	20	2.35	1.73	2.89	6.97
18.	<i>Rheum emodi</i> Wall ex Meissn.	0.5	2.5	10	1.17	4.34	1.44	6.95
19.	<i>Pteris</i> sp.	0.5	1.5	10	1.17	2.60	1.44	5.21
20.	<i>Aristida cynantha</i> Nees & Steud.	0.5	0.5	10	1.17	0.86	1.44	3.47
21.	<i>Bromus</i> Sp.	0.5	0.5	10	1.17	0.86	1.44	3.47
22.	<i>Cleome ariana</i> Hedge & Lamond.	0.5	0.5	10	1.17	0.86	1.44	3.47
23.	<i>Cnicus benedictus</i> L.	0.5	0.5	10	1.17	0.86	1.44	3.47
24.	<i>Cynanchum acutum</i> L.	0.5	0.5	10	1.17	0.86	1.44	3.47
25.	<i>Cynoglossum wallichii</i> G.Don.	0.5	0.5	10	1.17	0.86	1.44	3.47
26.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	1.17	0.86	1.44	3.47
27.	<i>Rosa webbiana</i> Wall ex Royle.	0.5	0.5	10	1.17	0.86	1.44	3.47
28.	<i>Verbascum thapsus</i> L.	0.5	0.5	10	1.17	0.86	1.44	3.47
29.	<i>Ferula</i> Sp.	0.5	0.5	10	1.17	0.86	1.44	3.47
Total		42.5	57.5	690	99.82	99.76	99.76	299.34

Appendix 24. Phytosociological Attributes of *Rosa-Ephedra-Artemisia* (REA)
Community at Ghuru along Mid hill between altitude of 2480m – 3000m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Rosa webbiana</i> Wall ex Royle.	7.0	10.0	60	12.06	12.82	7.79	32.67*
2.	<i>Ephedra gerardiana</i> L.	7.5	9.5	50	12.93	12.17	6.49	31.59**
3.	<i>Artemisia brevifolia</i> Wall ex DC.	5.0	6.0	60	8.62	7.69	7.79	24.1***
4.	<i>Nepeta paulsenii</i> Briq.	4.0	4.0	70	6.89	5.12	9.09	21.1
5.	<i>Juniperus excelsa</i> M.Bieb.	1.5	7.5	30	2.58	9.61	3.89	16.08
6.	Papilionaceae 1.	3.0	5.0	20	5.17	6.41	2.59	14.17
7.	<i>Ferula jaeschkeana</i> Vatke.	3.5	4.5	10	6.03	5.76	1.29	13.08
8.	<i>Chenopodium botrys</i> L.	2.5	2.5	30	4.31	3.20	3.89	11.4
9.	<i>Acantholimon longiscapum</i> Bokhari.	2.0	3.0	20	3.44	3.84	2.59	9.87
10.	Asteraceae 2.	2.0	2.0	20	3.44	2.56	2.59	8.59
11.	<i>Cotoneaster nummularia</i> Fisch & Mey.	1.5	1.5	30	2.58	1.92	3.89	8.39
12.	<i>Verbascum thapsus</i> L.	1.5	1.5	30	2.58	1.92	3.89	8.39
13.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	1.0	2.0	20	1.72	2.56	2.59	6.87
14.	<i>Astragalus amberstianus</i> Royle ex Benth.	1.0	1.0	20	1.72	1.28	2.59	5.59
15.	<i>Echinops echinatus</i> Roxb.	1.0	1.0	20	1.72	1.28	2.59	5.59
16.	Grass 1.	1.0	1.0	20	1.72	1.28	2.59	5.59
17.	<i>Astragalus</i> Sp.	1.0	1.0	20	1.72	1.28	2.59	5.59
18.	<i>Cicer</i> Sp.	1.0	1.0	20	1.72	1.28	2.59	5.59
19.	<i>Berberis lycium</i> Royle.	0.5	1.5	10	0.86	1.92	1.29	4.07
20.	<i>Otostegia limbata</i> (Bth.) Boiss.	0.5	1.5	10	0.86	1.92	1.29	4.07
21.	<i>Rheum emodi</i> Wall ex Meissn.	0.5	1.5	10	0.86	1.92	1.29	4.07
22.	<i>Astragalus cndolleamus</i> Royle ex Bth.	0.5	0.5	10	0.86	0.64	1.29	2.79
23.	<i>Aristida cynantha</i> Nees & Steud.	0.5	0.5	10	0.86	0.64	1.29	2.79
24.	<i>Asperula oppositifolia</i> Ehrend.	0.5	0.5	10	0.86	0.64	1.29	2.79
25.	<i>Astragalus psilocentros</i> Fisch.	0.5	0.5	10	0.86	0.64	1.29	2.79
26.	<i>Chenopodium album</i> L.	0.5	0.5	10	0.86	0.64	1.29	2.79
27.	<i>Cicer macranthum</i> M. Popov.	0.5	0.5	10	0.86	0.64	1.29	2.79
28.	<i>Cuscuta reflexa</i> Roxb.	0.5	0.5	10	0.86	0.64	1.29	2.79
29.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	0.86	0.64	1.29	2.79
30.	<i>Eragrastris nigra</i> Nees ex Steud.	0.5	0.5	10	0.86	0.64	1.29	2.79
31.	<i>Fumaria indica</i> (Hausskn.) L.	0.5	0.5	10	0.86	0.64	1.29	2.79
32.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	0.5	0.5	10	0.86	0.64	1.29	2.79
33.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	0.5	0.5	10	0.86	0.64	1.29	2.79
34.	<i>Medicago lupulina</i> L.	0.5	0.5	10	0.86	0.64	1.29	2.79
35.	<i>Nepeta raphanorrhiza</i> Benth.	0.5	0.5	10	0.86	0.64	1.29	2.79
36.	<i>Ribes orientale</i> Desf.	0.5	0.5	10	0.86	0.64	1.29	2.79
37.	<i>Chesneya depressa</i> (Oliver.) Popov.	0.5	0.5	10	0.86	0.64	1.29	2.79
38.	<i>Carum</i> Sp.	0.5	0.5	10	0.86	0.64	1.29	2.79
39.	<i>Gnaphalum</i> Sp.	0.5	0.5	10	0.86	0.64	1.29	2.79
40.	Asteraceae 1.	0.5	0.5	10	0.86	0.64	1.29	2.79
41.	<i>Thymus</i> Sp.	0.5	0.5	10	0.86	0.64	1.29	2.79
Total		58	78	770	99.87	99.26	99.7	299.47

Appendix 25. Phytosociological Attributes of *Polygonum-Ephedra-Rheum* (PER) Community at Ghuru along Top hill between altitude of 3010m – 3500m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Polygonum glabrum</i> Willd.	7.0	9.5	60	11.02	12.5	6.89	30.41*
2.	<i>Ephedra gerardiana</i> L.	6.5	7.5	70	10.23	9.86	8.04	28.13**
3.	<i>Rheum emodi</i> Wall ex Meissn	5.0	6.0	40	7.87	7.89	4.59	20.35***
4.	<i>Codonopsis clematidia</i> (Schrenk.) Clarke.	3.5	3.5	60	5.51	4.60	6.89	17
5.	<i>Aristida cynantha</i> Nees & Steud.	2.5	2.5	50	3.93	3.28	5.74	12.95
6.	<i>Ribes orientale</i> Desf.	2.0	3.0	40	3.14	3.94	4.59	11.67
7.	<i>Cicer macranthum</i> M. Popov.	2.5	2.5	30	3.93	3.28	3.44	10.65
8.	<i>Artemisia brevifolia</i> Wall ex DC.	2.0	2.0	40	3.14	2.63	4.59	10.36
9.	<i>Scrophularia stewartii</i> Penn.	2.0	2.0	40	3.14	2.63	4.59	10.36
10.	<i>Taraxacum officinale</i> Weber.	2.5	3.5	10	3.93	4.60	1.14	9.67
11.	<i>Thalictrum alpinum</i> L.	2.0	3.0	20	3.14	3.94	2.29	9.37
12.	<i>Juniperus excelsa</i> M.Bieb.	1.0	4.0	20	1.57	5.26	2.29	9.12
13.	<i>Acantholimon longiscapum</i> Bokhari.	1.5	2.5	30	2.36	3.28	3.44	9.08
14.	<i>Euphorbia</i> Sp.	2.0	2.0	20	3.14	2.63	2.29	8.06
15.	<i>Gallium</i> Sp.	1.5	1.5	30	2.36	1.97	3.44	7.77
16.	<i>Nepeta paulsenii</i> Briq.	1.5	1.5	30	2.36	1.97	3.44	7.77
17.	<i>Rosa webbiana</i> Wall ex Royle.	1.0	2.0	20	1.57	2.63	2.29	6.49
18.	<i>Bromus gracillimus</i> Bunge.	1.5	1.5	10	2.36	1.97	1.14	5.47
19.	<i>Cnicus</i> sp.	1.5	1.5	10	2.36	1.97	1.14	5.47
20.	<i>Lactuca viminea</i> (L.) Schmid.	1.0	1.0	20	1.57	1.31	2.29	5.17
21.	<i>Nepeta raphanorrhiza</i> Benth.	1.5	1.5	10	2.36	1.97	1.14	5.47
22.	<i>Otostegia limbata</i> (Bth.) Boiss.	1.5	1.5	10	2.36	1.97	1.14	5.47
23.	<i>Psilostachys suworowii</i> (Regd.) Roshk.	1.0	1.0	20	1.57	1.31	2.29	5.17
24.	<i>Argimonia</i> Sp.	1.0	1.0	20	1.57	1.31	2.29	5.17
25.	Grass 2.	1.0	1.0	20	1.57	1.31	2.29	5.17
26.	<i>Crepis</i> Sp.	1.0	1.0	20	1.57	1.31	2.29	5.17
27.	<i>Cotoneaster nummularia</i> Fisch & Mey.	1.0	1.0	10	1.57	1.31	1.14	4.02
28.	<i>Atraphaxis pyrifolia</i> Bunge.	0.5	0.5	10	0.78	0.65	1.14	2.57
29.	<i>Matricaria disciformis</i> (C.A.M.) DC.	0.5	0.5	10	0.78	0.65	1.14	2.57
30.	<i>Pteris</i> sp.	0.5	0.5	10	0.78	0.65	1.14	2.57
31.	<i>Ribes</i> Sp.	0.5	0.5	10	0.78	0.65	1.14	2.57
32.	<i>Trachyspermum ammi</i> (L.) Spargue.	0.5	0.5	10	0.78	0.65	1.14	2.57
33.	<i>Trifolium</i> Sp.	0.5	0.5	10	0.78	0.65	1.14	2.57
34.	<i>Cicer</i> Sp.	0.5	0.5	10	0.78	0.65	1.14	2.57
35.	Sp. Brassicaceae	0.5	0.5	10	0.78	0.65	1.14	2.57
36.	<i>Cynoglossum</i> Sp.	0.5	0.5	10	0.78	0.65	1.14	2.57
37.	<i>Eragrostis nigra</i> Nees ex Steud.	0.5	0.5	10	0.78	0.65	1.14	2.57
38.	<i>Asperul</i> Sp.	0.5	0.5	10	0.78	0.65	1.14	2.57
Total		63.5	76	870	100.05	99.78	99.67	299.23

Appendix 26. Phytosociological Attributes of *Cicer-Aristida-Tricholepsis* (CAT)
Community at Ghuru along Timberline between altitude of 3520m – 3900m.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Cicer macranthum</i> M. Popov.	9.5	9.5	90	16.37	16.10	13.23	45.7*
2.	<i>Aristida cynantha</i> Nees & Steud.	9.5	9.5	70	16.37	16.10	10.29	42.76**
3.	<i>Tricholepsis tibetica</i> H & T.	7.0	7.0	60	12.06	11.86	8.82	32.74***
4.	<i>Acantholimon longiscapum</i> Bokhari.	4.5	4.5	70	7.75	7.62	10.29	25.66
5.	<i>Trachyspermum ammi</i> (L.) Spargue.	4.0	4.0	60	6.89	6.77	8.82	22.48
6.	<i>Nepeta paulsenii</i> Briq.	3.0	3.0	60	5.17	5.08	8.82	19.07
7.	<i>Acantholimon</i> Sp.1	4.0	3.0	40	6.89	5.08	5.88	17.85
8.	<i>Acantholimon</i> Sp.2	3.0	4.0	20	5.17	6.77	2.94	14.88
9.	<i>Rosa webbiana</i> Wall ex Royle.	3.0	4.0	20	5.17	6.77	2.94	14.88
10.	<i>Matricaria disciformis</i> (C.A.M.) DC.	2.0	2.0	40	3.44	3.38	5.88	12.7
11.	<i>Asperula oppositifolia</i> Ehrend.	1.5	1.5	10	2.58	2.54	1.47	6.59
12.	<i>Astragalus amberstianus</i> Royle ex Benth.	1.0	1.0	20	1.72	1.69	2.94	6.35
13.	<i>Euphorbia falcata</i> L.	1.0	1.0	20	1.72	1.69	2.94	6.35
14.	<i>Oxyria digyna</i> (L.) Hill.	1.0	1.0	20	1.72	1.69	2.94	6.35
15.	<i>Pteris</i> sp.	1.0	1.0	20	1.72	1.69	2.94	6.35
16.	<i>Berberis lycium</i> Royle.	0.5	0.5	10	0.86	0.84	1.47	3.17
17.	<i>Psilostachya suworowii</i> (Regd) Roshk.	0.5	0.5	10	0.86	0.84	1.47	3.17
18.	<i>Rheum emodi</i> Wall ex Meissn.	0.5	0.5	10	0.86	0.84	1.47	3.17
19.	<i>Scrophularia stewartii</i> Penn.	0.5	0.5	10	0.86	0.84	1.47	3.17
20.	<i>Taraxacum</i> Sp.	0.5	0.5	10	0.86	0.84	1.47	3.17
21.	<i>Thalictrum alpinum</i> L.	0.5	0.5	10	0.86	0.84	1.47	3.17
Total		58	59	680	99.9	99.87	99.96	299.73

Appendix 27. Phytosociological Attributes of *Capparis-Atraphaxis-Fraxinus* (CAF) Community at Chumarkhan Pass along Foothill between altitude of 2380m-2480m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Capparis spinosa</i> L.	6.0	6.0	100	11.76	10.90	11.11	33.77*
2.	<i>Atraphaxis spinosa</i> L.	5.0	5.0	100	9.80	9.09	11.11	30**
3.	<i>Fraxinus xanthoxyloides</i> Wall ex G.Don.	4.5	6.5	70	8.82	11.81	7.7	28.4***
4.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	90	8.82	8.18	10	27
5.	<i>Artemisia brevifolia</i> Wall ex DC.	4.5	4.5	50	8.82	8.18	5.55	22.55
6.	<i>Juniperus excelsa</i> M.Bieb.	3.0	5.0	60	5.88	9.09	6.66	21.63
7.	<i>Pulicaria gnaphalodes</i> (Vent.) Boiss.	4.0	4.0	40	7.84	7.27	4.44	19.55
8.	<i>Astragalus psilocentros</i> Fisch.	3.0	3.0	60	5.88	5.45	6.66	17.99
9.	<i>Colutea paulsenii</i> Feryh.	2.0	2.0	40	3.92	3.63	4.44	11.99
10.	<i>Echinops echinatus</i> Roxb.	2.0	2.0	40	3.92	3.63	4.44	11.99
11.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	2.0	2.0	40	3.92	3.63	4.44	11.99
12.	<i>Chondrilla graminea</i> M.Bieb.	1.5	1.5	30	2.94	2.72	3.33	8.99
13.	<i>Cotoneaster nummularia</i> Fisch & Mey.	1.5	1.5	30	2.94	2.72	3.33	8.99
14.	<i>Berberis lycium</i> Royle.	1.0	1.0	20	1.96	1.81	2.22	5.99
15.	<i>Chenopodium botrys</i> L.	1.0	1.0	20	1.96	1.81	2.22	5.99
16.	<i>Dichanthium annulatum</i> Forssk. Stapf.	1.0	1.0	20	1.96	1.81	2.22	5.99
17.	<i>Ephedra gerardiana</i> L.	1.0	1.0	20	1.96	1.81	2.22	5.99
18.	<i>Karcheninnikovia ceratoides</i> (L.) Guelden.	1.0	1.0	20	1.96	1.81	2.22	5.99
19.	<i>Kochia prostrata</i> (L.) Schard.	1.0	1.0	20	1.96	1.81	2.22	5.99
20.	<i>Chenopodium album</i> L.	0.5	0.5	10	0.98	0.90	1.11	2.99
21.	<i>Nepeta lavigata</i> (D.Don.) Hand. Mazz.	0.5	0.5	10	0.98	0.90	1.11	2.99
22.	<i>Peganum harmala</i> L.	0.5	0.5	10	0.98	0.90	1.11	2.99
Total		51	55	900	99.96	99.86	99.93	299.75

Appendix 28. Phytosociological Attributes of *Atraphaxis-Cotoneaster-Capparis* (ACC) Community at Chumarkhan Pass along Mid hill between altitude of 2540m-2660m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Atraphaxis spinosa</i> L.	8.0	8.0	100	19.51	19.04	14.70	53.25*
2.	<i>Cotoneaster nummularia</i> Fisch & Mey.	5.0	5.0	80	12.19	11.90	11.76	35.85**
3.	<i>Capparis spinosa</i> L.	4.0	4.0	80	9.75	9.52	11.76	31.03***
4.	<i>Ephedra gerardiana</i> L.	3.5	3.5	50	8.53	8.33	7.35	24.21
5.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	3.0	3.0	60	7.31	7.14	8.82	23.27
6.	<i>Juniperus excelsa</i> M.Bieb.	2.0	3.0	40	4.87	7.14	5.88	17.89
7.	<i>Colutea paulsenii</i> Feryh.	2.5	2.5	30	6.09	5.95	4.41	16.45
8.	<i>Artemisia brevifolia</i> Wall ex DC.	2.0	2.0	40	4.87	4.76	5.88	15.51
9.	<i>Clematis orientalis</i> L.	2.0	2.0	40	4.87	4.76	5.88	15.51
10.	<i>Echinops echinatus</i> Roxb.	2.0	2.0	20	4.87	4.76	2.94	12.57
11.	<i>Astragalus psilocentros</i> Fisch.	1.5	1.5	30	3.65	3.57	4.41	11.63
12.	<i>Peganum harmala</i> L.	0.5	0.5	10	1.21	1.19	1.47	3.87
13.	<i>Arnebia hispidissima</i> (Lehm.) DC.	1.0	1.0	20	2.43	2.38	2.94	7.75
14.	<i>Cuscuta approximata</i> Bab.	1.0	1.0	20	2.43	2.38	2.94	7.75
15.	<i>Rosa webbiana</i> Wall ex Royle.	1.0	1.0	20	2.43	2.38	2.94	7.75
16.	<i>Atraphaxis pyrifolia</i> Bunge.	0.5	0.5	10	1.21	1.19	1.47	3.87
17.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	1.21	1.19	1.47	3.87
18.	<i>Gnaphalium luteo- album</i> L.	0.5	0.5	10	1.21	1.19	1.47	3.87
19.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	0.5	0.5	10	1.21	1.19	1.47	3.87
Total		41	42	680	99.85	99.96	99.96	299.77

Appendix 29. Phytosociological Attributes of *Cotoneaster-Artemisia-Juniperus* (CAJ) Community at Chumarkhan Pass along Top hill between altitude of 2720m-3000m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Cotoneaster nummularia</i> Fisch & Mey.	5.0	6.0	100	14.28	15	14.70	43.98*
2.	<i>Artemisia brevifolia</i> Wall ex DC.	5.0	5.0	100	14.28	12.5	14.70	41.48**
3.	<i>Juniperus excelsa</i> M. Bieb.	4.0	7.0	80	11.42	17.5	11.76	40.68***
4.	<i>Ephedra gerardiana</i> L.	4.0	4.0	80	11.42	10	11.76	33.18
5.	<i>Ribes orientale</i> Desf.	4.0	4.0	80	11.42	10	11.76	33.18
6.	<i>Rosa webbiana</i> Wall ex Royle.	3.5	3.5	70	10	8.75	10.29	29.04
7.	<i>Acantholimon longiscapum</i> Bokhari.	2.5	3.5	50	7.14	8.75	7.35	23.24
8.	<i>Berberis lycium</i> Royle.	3.0	3.0	40	8.57	7.5	5.88	21.95
9.	<i>Atraphaxis pyrifolia</i> Bunge.	1.0	1.0	20	2.85	2.5	2.94	8.29
10.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	1.0	1.0	20	2.85	2.5	2.94	8.29
11.	Grass sp.	1.0	1.0	20	2.85	2.5	2.94	8.29
12.	<i>Cicer macranthum</i> M. Popov.	0.5	0.5	10	1.42	1.25	1.47	4.14
13.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	1.42	1.25	1.47	4.14
Total		35	40	680	99.92	100	99.96	299.88

Appendix 30. Phytosociological Attributes of *Betula-Juniperus-Acantholimon* (BJA) Community at Chumarkhan Pass along Timberline between altitude of 3100m-3500m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Betula utilis</i> D.Don.	5.5	9.5	90	12.5	17.27	10.97	40.74*
2.	<i>Juniperus excelsa</i> M.Bieb.	4.5	7.5	90	10.22	13.63	10.97	34.82**
3.	<i>Acantholimon longiscapum</i> Bokhari.	4.5	6.5	90	10.22	11.81	10.97	33***
4.	<i>Artemisia brevifolia</i> Wall ex DC.	4.0	4.0	80	9.09	7.27	9.75	26.11
5.	<i>Rosa webbiana</i> Wall ex Royle.	4.0	4.0	80	9.09	7.27	9.75	26.11
6.	<i>Ribes orientalis</i> Desf.	3.0	3.0	60	6.81	5.45	7.31	19.57
7.	<i>Atraphaxis pyrifolia</i> Bunge.	2.5	2.5	50	5.68	4.54	6.09	16.31
8.	<i>Cotoneaster nummularia</i> Fisch & Mey.	2.5	2.5	50	5.68	4.54	6.09	16.31
9.	<i>Ephedra gerardiana</i> L.	2.5	2.5	50	5.68	4.54	6.09	16.31
10.	<i>Berberis lycium</i> Royle.	2.0	2.0	40	4.54	3.63	4.87	13.04
11.	<i>Asperula oppositifolia</i> Ehrend.	2.0	2.0	20	4.54	3.63	2.43	10.6
12.	<i>Potentilla supina</i> L.	2.0	2.0	20	4.54	3.63	2.43	10.6
13.	<i>Hippophae rhamnoides</i> L.	1.0	2.0	20	2.27	3.63	2.43	8.33
14.	<i>Salix acmophylla</i> Boiss.	1.0	2.0	20	2.27	3.63	2.43	8.33
15.	<i>Myricaria elegans</i> Royle.	1.0	1.0	20	2.27	1.81	2.43	6.51
16.	<i>Tricholepsis tibetica</i> H & T.	1.0	1.0	20	2.27	1.81	2.43	6.51
17.	<i>Pteris</i> sp.	0.5	0.5	10	1.13	0.90	1.21	3.24
18.	<i>Salix</i> sp.	0.5	0.5	10	1.13	0.90	1.21	3.24
Total		44	55	820	99.93	99.89	99.86	299.68

Appendix 31. Phytosociological Attributes of *Artemisia-Sophora-Haloxylon* (ASH) Community at Reshun along Foothill between altitude of 1800m-1910m.

S.No	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia brevifolia</i> Wall ex DC.	8.5	9.5	90	14.78	14.96	13.43	43.17*
2.	<i>Sophora mollis</i> (Royle.) Baker.	8.0	9.0	80	13.91	14.17	11.94	40.02**
3.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss	9.0	9.0	60	15.65	14.17	8.95	38.77***
4.	<i>Capparis spinosa</i> L.	3.5	4.5	50	6.08	7.08	7.46	20.62
5.	<i>Saccharum spontaneum</i> L.	3.0	4.0	40	5.21	6.29	5.97	17.47
6.	<i>Echinops echinatus</i> Roxb.	3.5	3.5	30	6.08	5.51	4.47	16.06
7.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	3.0	3.0	40	5.21	4.72	5.97	15.9
8.	<i>Pistacia khinjuk</i> Stock.	3.0	3.0	20	5.21	4.72	2.98	12.91
9.	<i>Polygonum glabrum</i> L.	3.0	3.0	20	5.21	4.72	2.98	12.91
10.	<i>Artemisia scoparia</i> Waldst & Kit.	2.0	2.0	40	3.47	3.14	5.97	12.58
11.	<i>Verbascum thapsus</i> L.	1.5	1.5	30	2.60	2.36	4.47	9.43
12.	<i>Clematis orientalis</i> L.	2.0	2.0	20	3.47	3.14	2.98	9.59
13.	<i>Cotoneaster nummularia</i> Fisch & Mey.	0.5	1.5	10	0.86	2.36	1.49	4.71
14.	<i>Rosa webbiana</i> Wall ex Royle.	0.5	1.5	10	0.86	2.36	1.49	4.71
15.	<i>Adiantum venustum</i> D.Don.	0.5	0.5	10	0.86	0.78	1.49	3.13
16.	<i>Astragalus psilocentros</i> Fisch.	0.5	0.5	10	0.86	0.78	1.49	3.13
17.	<i>Atriplex crassifolia</i> C.A.May.	0.5	0.5	10	0.86	0.78	1.49	3.13
18.	<i>Berberis lycium</i> Royle.	0.5	0.5	10	0.86	0.78	1.49	3.13
19.	<i>Cuscuta approximata</i> Bab.	0.5	0.5	10	0.86	0.78	1.49	3.13
20.	<i>Dichanthium annulatum</i> Forssk. Stapf.	0.5	0.5	10	0.86	0.78	1.49	3.13
21.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.86	0.78	1.49	3.13
22.	<i>Fraxinus xanthoxyloides</i> Wall ex G.Don.	0.5	0.5	10	0.86	0.78	1.49	3.13
23.	<i>Lactuca serriola</i> L.	0.5	0.5	10	0.86	0.78	1.49	3.13
24.	<i>Lepidium</i> Sp.	0.5	0.5	10	0.86	0.78	1.49	3.13
25.	<i>Marrubium vulgare</i> L.	0.5	0.5	10	0.86	0.78	1.49	3.13
26.	<i>Salix acmophylla</i> Boiss.	0.5	0.5	10	0.86	0.78	1.49	3.13
27.	<i>Trachyspermum ammi</i> (L.) Spargue.	0.5	0.5	10	0.86	0.78	1.49	3.13
Total		57.5	63.5	670	99.78	99.84	99.92	299.54

Appendix 32. Phytosociological Attributes of *Artemisia-Echinops-Saccharum* (AES) Community at Koragh along Foothill between altitude of 1880m-2100m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia scoparia</i> Waldst & Kit.	5.5	6.5	90	12.08	13.13	13.04	38.25*
2.	<i>Echinops echinatus</i> Roxb.	5.5	5.5	90	12.08	11.11	13.04	36.23**
3.	<i>Saccharum spontaneum</i> L.	5.5	6.5	50	12.08	13.13	7.24	32.45***
4.	<i>Sophora mollis</i> (Royle.) Baker.	3.5	4.5	50	7.69	9.09	7.24	24.02
5.	<i>Artemisia brevifolia</i> Wall ex DC.	3.5	3.5	50	7.69	7.07	7.24	22
6.	<i>Capparis spinosa</i> L.	3.5	3.5	50	7.69	7.07	7.24	22
7.	<i>Verbascum thapsus</i> L.	3.0	3.0	60	6.59	6.06	8.69	21.34
8.	<i>Cotoneaster nummularia</i> Fisch & Mey.	2.5	2.5	50	5.49	5.05	7.24	17.78
9.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	3.0	3.0	20	6.59	6.06	2.89	15.54
10.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	1.5	1.5	30	3.29	3.03	4.34	10.66
11.	<i>Lactuca serriola</i> L.	1.5	1.5	10	3.29	3.03	1.44	7.76
12.	<i>Astragalus psilocentros</i> Fisch.	1.0	1.0	20	2.19	2.02	2.89	7.1
13.	<i>Chenopodium botrys</i> L.	1.0	1.0	20	2.19	2.02	2.89	7.1
14.	<i>Acantholimon longiscapum</i> Bokhari.	0.5	0.5	10	1.09	1.01	1.44	3.54
15.	<i>Marrubium vulgare</i> L.	1.0	1.0	20	2.19	2.02	2.89	7.1
16.	<i>Rosa webbiana</i> Wall ex Royle.	0.5	1.5	10	1.09	3.03	1.44	5.56
17.	<i>Cleome ariana</i> Hedge & Lamond.	0.5	0.5	10	1.09	1.01	1.44	3.54
18.	<i>Conyza Canadensis</i> (L.) Conquist.	0.5	0.5	10	1.09	1.01	1.44	3.54
19.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	0.5	0.5	10	1.09	1.01	1.44	3.54
20.	<i>Nepeta raphanorrhiza</i> Benth.	0.5	0.5	10	1.09	1.01	1.44	3.54
21.	<i>Polygonum glabrum</i> Willd.	0.5	0.5	10	1.09	1.01	1.44	3.54
22.	<i>Rheum emodi</i> Wall ex Meissn.	0.5	0.5	10	1.09	1.01	1.44	3.54
Total		45.5	49.5	690	99.85	99.99	99.83	299.67

Appendix 33. Phytosociological Attributes of *Sophora-Cotoneaster-Fraxinus* (SCF) Community at Booni along Foothill between altitude of 2140m-2220m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Sophora mollis</i> (Royle.) Baker.	6.0	7.0	100	11.32	11.66	12.82	35.8*
2.	<i>Cotoneaster nummularia</i> Fisch & Mey.	5.0	6.0	80	9.43	10	10.25	29.68**
3.	<i>Fraxinus xanthoxyloides</i> Wall ex G.Don.	3.5	5.5	50	6.60	9.16	6.41	22.17***
4.	<i>Hippophae rhamnoides</i> L.	4.5	4.5	50	8.49	7.5	6.41	22.4
5.	<i>Artemisia brevifolia</i> Wall ex DC.	3.0	3.0	40	5.66	5	5.12	15.78
6.	<i>Saccharum spontaneum</i> L.	2.0	3.0	40	3.77	5	5.12	13.89
7.	<i>Atraphaxis pyrifolia</i> Bunge.	2.5	2.5	30	4.71	4.16	3.84	12.71
8.	<i>Nepeta paulsenii</i> Briq.	2.5	2.5	30	4.71	4.16	3.84	12.71
9.	<i>Rosa webbiana</i> Wall ex Royle.	2.5	2.5	30	4.71	4.16	3.84	12.71
10.	<i>Conyza canadensis</i> (L.) Conquist.	2.0	2.0	40	3.77	3.33	5.12	12.22
11.	<i>Scrophularia stewartii</i> Penn.	2.0	2.0	40	3.77	3.33	5.12	12.22
12.	<i>Astragalus psilocentros</i> Fisch.	1.5	2.5	30	2.83	4.16	3.84	10.83
13.	<i>Nepeta lavigata</i> (D.Don) Hand.Mazz.	1.5	1.5	30	2.83	2.5	3.84	9.17
14.	<i>Berberis lycium</i> Royle.	2.0	2.0	20	3.77	3.33	2.56	9.66
15.	<i>Cuscuta approximata</i> Bab.	2.0	2.0	20	3.77	3.33	2.56	9.66
16.	<i>Ephedra gerardiana</i> L.	2.0	2.0	20	3.77	3.33	2.56	9.66
17.	<i>Clematis orientalis</i> L.	1.0	2.0	20	1.88	3.33	2.56	7.77
18.	<i>Artemisia scoparia</i> Waldst & Kit.	1.0	1.0	20	1.88	1.66	2.56	6.1
19.	<i>Juniperus excelsa</i> M.Bieb.	1.5	1.5	10	2.83	2.5	1.28	6.61
20.	<i>Lactuca viminea</i> (L.) F.W. Schmid	1.5	1.5	10	2.83	2.5	1.28	6.61
21.	<i>Marrubium vulgare</i> L.	1.0	1.0	20	1.88	1.66	2.56	6.1
22.	<i>Verbascum thapsus</i> L.	1.0	1.0	20	1.88	1.66	2.56	6.1
23.	<i>Capparis spinosa</i> L.	0.5	0.5	10	0.94	0.83	1.28	3.05
24.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	0.94	0.83	1.28	3.05
25.	<i>Echinops echinatus</i> Roxb.	0.5	0.5	10	0.94	0.83	1.28	3.05
Total		53	60	780	99.91	99.91	99.89	299.71

Appendix 34. Phytosociological Attributes of *Juniperus-Sophora-Artemisia* (JSA) Community at Parwak along Foothill between altitude of 2240m-2335m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Juniperus excelsa</i> M.Bieb.	6.5	8.5	90	16.25	18.88	14.06	49.19*
2.	<i>Sophora mollis</i> (Royle.) Baker.	6.5	7.5	90	16.25	16.16	14.06	46.97**
3.	<i>Artemisia brevifolia</i> Wall ex DC.	5.5	5.5	90	13.75	12.22	14.06	40.03***
4.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss	3.5	3.5	70	8.75	7.77	10.93	27.45
5.	<i>Echinops echinatus</i> Roxb.	3.0	3.0	60	7.5	6.66	9.37	23.53
6.	<i>Cotoneaster nummularia</i> Fisch & Mey.	2.5	2.5	50	6.25	5.55	7.81	19.61
7.	<i>Rosa webbiana</i> Wall ex Royle.	1.5	2.5	30	3.75	5.55	7.81	13.98
8.	<i>Saccharum spontaneum</i> L.	2.0	2.0	20	5	4.44	3.12	12.56
9.	<i>Capparis spinosa</i> L.	1.5	1.5	30	3.75	3.33	4.68	11.76
10.	<i>Berberis lycium</i> Royle.	1.5	2.5	10	3.75	5.55	1.56	10.86
11.	<i>Artemisia scoparia</i> Waldst & Kit.	1.5	1.5	10	3.75	3.33	1.56	8.64
12.	<i>Astragalus psilocentros</i> Fisch.	1.0	1.0	20	2.5	2.22	3.12	7.84
13.	<i>Verbascum thapsus</i> L.	1.0	1.0	20	2.5	2.22	3.12	7.84
14.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	0.5	0.5	10	1.25	1.11	1.56	3.92
15.	<i>Chenopodium botrys</i> L.	0.5	0.5	10	1.25	1.11	1.56	3.92
16.	<i>Clematis orientalis</i> L.	0.5	0.5	10	1.25	1.11	1.56	3.92
17.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	1.25	1.11	1.56	3.92
18.	<i>Rheum emodi</i> Wall ex Meissn.	0.5	0.5	10	1.25	1.11	1.56	3.92
Total		40	45	640	100	99.93	99.93	299.86

Appendix 35. Phytosociological Attributes of *Acantholimon-Ephedra-Ribes* (AER) Community at Shandur Pass along Mid hill between altitude of 3640m-3910m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Acantholimon longiscapum</i> Bokhari.	5.0	6.0	100	15.38	16.43	17.54	49.53*
2.	<i>Ephedra gerardiana</i> L.	4.0	5.0	60	12.30	13.69	10.52	36.51**
3.	<i>Ribes orientale</i> Desf.	4.0	4.0	60	12.30	10.95	10.52	33.77***
4.	<i>Artemisia brevifolia</i> Wall ex DC.	2.5	3.5	50	7.69	9.58	8.77	26.04
5.	<i>Swertia speciosa</i> D.Don.	2.5	2.5	50	7.69	6.84	8.77	23.3
6.	<i>Arenaria serpyllifolia</i> L.	2.0	2.0	40	6.15	5.47	7.01	18.63
7.	<i>Cicer macranthum</i> M. Popov.	2.0	2.0	40	6.15	5.47	7.01	18.63
8.	<i>Potentilla supina</i> L.	2.0	2.0	40	6.15	5.47	7.01	18.63
9.	<i>Rosa webbiana</i> Wall ex Royle.	2.0	3.0	20	6.15	8.21	3.50	17.86
10.	<i>Primula</i> sp.	1.5	1.5	10	4.61	4.10	1.75	10.46
11.	<i>Astragalus amberstianus</i> Royle ex Benth.	1.0	1.0	20	3.07	2.73	3.50	9.3
12.	<i>Cotoneaster microphylla</i> Wall ex Lind.	1.0	1.0	20	3.07	2.73	3.50	9.3
13.	<i>Taraxacum officinale</i> Weber.	0.5	0.5	10	1.53	1.36	1.75	4.64
14.	<i>Pteris</i> sp.	0.5	0.5	10	1.53	1.36	1.75	4.64
15.	<i>Primula denticulata</i> Sm.	0.5	0.5	10	1.53	1.36	1.75	4.64
16.	<i>Thalictrum alpinum</i> L.	0.5	0.5	10	1.53	1.36	1.75	4.64
17.	<i>Trachomitum Venetum</i> (L.) Woodson.	0.5	0.5	10	1.53	1.36	1.75	4.64
18.	<i>Ranunculus lobatus</i> Jacq ex Cam.	0.5	0.5	10	1.53	1.36	1.75	4.64
Total		32.5	36.5	570	99.89	99.83	99.9	299.8

Appendix 36. Phytosociological Attributes of *Artemisia-Rosa-Sophora* (ARS)
Community at Chuing along Foothill between altitude of 2300m-2400m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia brevifolia</i> Wall ex DC.	5.0	5.0	100	12.98	12.04	13.33	38.35*
2.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	90	11.68	10.84	12	34.52**
3.	<i>Sophora mollis</i> (Royle.) Baker.	4.5	4.5	70	11.68	10.84	9.33	31.85***
4.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss	4.0	4.0	80	10.38	9.63	10.66	30.67
5.	<i>Capparis spinosa</i> L.	2.5	2.5	50	6.49	6.02	6.66	19.17
6.	<i>Cotoneaster nummularia</i> Fisch & Mey.	2.5	2.5	50	6.49	6.02	6.66	19.17
7.	<i>Ephedra gerardiana</i> L.	2.5	2.5	50	6.49	6.02	6.66	19.17
8.	<i>Juniperus excelsa</i> M.Bieb.	1.0	3.0	20	2.59	7.22	2.66	12.47
9.	<i>Artemisia scoparia</i> Waldst & Kit.	1.5	1.5	30	3.89	3.61	4	11.5
10.	<i>Cuscuta approximata</i> Bab.	1.5	1.5	30	3.89	3.61	4	11.5
11.	<i>Chenopodium botrys</i> L.	1.0	1.0	20	2.59	2.40	2.66	7.65
12.	<i>Echinops echinatus</i> Roxb.	1.0	1.0	20	2.59	2.40	2.66	7.65
13.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	1.0	1.0	20	2.59	2.40	2.66	7.65
14.	<i>Astragalus psilocentros</i> Fisch.	1.0	1.0	20	2.59	2.40	2.66	7.65
15.	<i>Berberis lycium</i> Royle.	0.5	1.5	10	1.29	3.61	1.33	6.23
16.	<i>Astragalus amberstianus</i> Royle ex Benth.	0.5	0.5	10	1.29	1.20	1.33	3.82
17.	<i>Colutea paulsenii</i> Feryh.	0.5	0.5	10	1.29	1.20	1.33	3.82
18.	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	0.5	10	1.29	1.20	1.33	3.82
19.	<i>Gnaphalium luteo-album</i> L.	0.5	0.5	10	1.29	1.20	1.33	3.82
20.	<i>Kochia prostrata</i> (L.) Schard.	0.5	0.5	10	1.29	1.20	1.33	3.82
21.	<i>Lactuca viminea</i> (L.) f.w. Schmid.	0.5	0.5	10	1.29	1.20	1.33	3.82
22.	<i>Otostegia limbata</i> (Bth.) Boiss.	0.5	0.5	10	1.29	1.20	1.33	3.82
23.	<i>Pteris</i> sp.	0.5	0.5	10	1.29	1.20	1.33	3.82
24.	<i>Verbascum thapsus</i> L.	0.5	0.5	10	1.29	1.20	1.33	3.82
Total		38.5	41.5	750	99.82	99.86	99.9	299.58

Appendix 37. Phytosociological Attributes of *Artemisia-Haloxylon-Atraphaxis* (AHA) Community at Chapali along Foothill between altitude of 2160m-2300m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia brevifolia</i> Wall ex DC.	8.0	8.0	100	22.22	20.51	16.66	59.39*
2.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	4.5	4.5	70	12.5	11.53	11.66	35.69**
3.	<i>Atraphaxis spinosa</i> L.	4.0	4.0	60	11.11	10.25	10	31.36***
4.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	3.5	3.5	70	9.72	8.97	11.66	30.35
5.	<i>Ephedra gerardiana</i> L.	3.0	3.0	60	8.33	7.69	10	26.02
6.	<i>Rosa webbiana</i> Wall ex Royle.	2.5	2.5	30	6.94	6.41	5	18.35
7.	<i>Colutea paulsenii</i> Feryh.	1.5	2.5	30	4.16	6.41	5	15.57
8.	<i>Fraxinus xanthoxyloides</i> Wall ex G.Don.	1.5	2.5	30	4.16	6.41	5	15.57
9.	<i>Capparis spinosa</i> L.	1.5	1.5	30	4.16	3.84	5	13
10.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	1.0	1.0	20	2.77	2.56	3.33	8.66
11.	<i>Clematis orientalis</i> L.	1.0	1.0	20	2.77	2.56	3.33	8.66
12.	<i>Nepeta lavigata</i> (D.Don.) Hand. Mazz.	1.0	1.0	20	2.77	2.56	3.33	8.66
13.	<i>Juniperus excelsa</i> M.Bieb.	0.5	1.5	10	1.38	3.84	1.66	6.88
14.	<i>Artemisia scoparia</i> Waldst & Kit.	0.5	0.5	10	1.38	1.28	1.66	4.32
15.	<i>Astragalus psilocentros</i> Fisch.	0.5	0.5	10	1.38	1.28	1.66	4.32
16.	<i>Sophora mollis</i> (Royle.) Baker.	0.5	0.5	10	1.38	1.28	1.66	4.32
17.	<i>Nepeta raphanorrhiza</i> Benth.	0.5	0.5	10	1.38	1.28	1.66	4.32
18.	<i>Pilea umbrosa</i> Wedd.	0.5	0.5	10	1.38	1.28	1.66	4.32
Total		36	39	600	99.89	99.94	99.93	299.76

Appendix 38. Phytosociological Attributes of *Artemisia-Rosa-Berberis* (ARB) community at Brep along Foothill between altitude of 2280m-2420m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia brevifolia</i> Wall ex DC.	6.0	6.0	100	17.91	14.81	16.39	49.11*
2.	<i>Rosa webbiana</i> Wall ex Royle.	5.0	6.0	100	14.92	14.81	16.39	46.12**
3.	<i>Berberis lycium</i> Royle.	2.5	3.5	50	7.46	8.64	8.19	24.29***
4.	<i>Echinops echinatus</i> Roxb.	2.0	2.0	40	5.97	4.93	6.55	17.45
5.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	2.0	2.0	20	5.97	4.93	3.27	14.17
6.	<i>Capparis spinosa</i> L.	1.5	1.5	30	4.47	3.70	4.91	13.08
7.	<i>Chenopodium botrys</i> L.	1.5	1.5	30	4.47	3.70	4.91	13.08
8.	<i>Cotoneaster nummularia</i> Fisch & Mey.	1.5	1.5	30	4.47	3.70	4.91	13.08
9.	<i>Gnaphalium luteo-album</i> L.	1.5	1.5	30	4.47	3.70	4.91	13.08
10.	<i>Fraxinus xanthoxyloides</i> Wall ex G.Don.	1.0	2.0	20	2.98	2.46	3.27	11.18
11.	<i>Sophora mollis</i> (Royle.) Baker.	1.0	2.0	20	2.98	2.46	3.27	11.18
12.	<i>Saccharum spontaneum</i> L.	1.5	1.5	10	4.47	3.70	1.63	9.8
13.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	1.0	1.0	20	2.98	2.46	3.27	8.71
14.	<i>Astragalus psilocentros</i> Fisch.	1.0	1.0	20	2.98	2.46	3.27	8.71
15.	<i>Verbascum thapsus</i> L.	1.0	1.0	20	2.98	2.46	3.27	8.71
16.	<i>Atraphaxis pyrifolia</i> Bunge.	0.5	1.5	10	1.49	3.70	1.63	6.82
17.	<i>Juniperus excelsa</i> M.Bieb.	0.5	1.5	10	1.49	3.70	1.63	6.82
18.	<i>Ribes orientale</i> Desf.	0.5	1.5	10	1.49	3.70	1.63	6.82
19.	<i>Clematis orientalis</i> L.	0.5	0.5	10	1.49	1.23	1.63	4.35
20.	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	1.49	1.23	1.63	4.35
21.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	0.5	0.5	10	1.49	1.23	1.63	4.35
22.	<i>Salvia nubicola</i> Wall ex Sweet.	0.5	0.5	10	1.49	1.23	1.63	4.35
Total		33.5	40.5	610	99.91	99.88	99.82	299.61

Appendix 39. Phytosociological Attributes of *Artemisia-Haloxylon-Ephedra* (AHE) Community at Bang along Mid hill between altitude of 2340m-2615m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Artemisia brevifolia</i> Wall ex DC.	6.0	6.0	100	19.67	17.39	18.86	55.92*
2.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss	4.0	4.0	80	13.11	11.59	15.09	39.79**
3.	<i>Ephedra gerardiana</i> L.	3.5	3.5	50	11.47	10.14	9.43	31.04***
4.	<i>Cotoneaster nummularia</i> Fisch & Mey.	3.5	3.5	30	11.47	10.14	5.66	27.27
5.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	2.5	2.5	50	8.19	7.24	9.43	24.86
6.	<i>Rosa webbiana</i> Wall ex Royle.	2.0	3.0	40	6.55	8.69	7.54	22.78
7.	<i>Juniperus excelsa</i> M.Bieb.	1.5	3.5	30	4.91	10.14	5.66	20.71
8.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	1.5	1.5	30	3.27	2.89	3.77	14.91
9.	<i>Atraphaxis spinosa</i> L.	1.0	1.0	20	3.27	2.89	3.77	9.93
10.	<i>Sophora mollis</i> (Royle.) Baker.	1.0	1.0	20	3.27	2.89	3.77	9.93
11.	<i>Berberis lycium</i> Royle.	0.5	1.5	10	1.63	4.34	1.88	7.85
12.	<i>Atraphaxis pyrifolia</i> Bunge.	0.5	0.5	10	1.63	1.44	1.88	4.95
13.	<i>Astragalus psilocentros</i> Fisch.	0.5	0.5	10	1.63	1.44	1.88	4.95
14.	<i>Capparis spinosa</i> L.	0.5	0.5	10	1.63	1.44	1.88	4.95
15.	<i>Clematis orientalis</i> L.	0.5	0.5	10	1.63	1.44	1.88	4.95
16.	<i>Colutea paulsenii</i> Feryh.	0.5	0.5	10	1.63	1.44	1.88	4.95
17.	<i>Cuscuta approximata</i> Bab.	0.5	0.5	10	1.63	1.44	1.88	4.95
18.	<i>Equisetum ramossum</i> Desf.	0.5	0.5	10	1.63	1.44	1.88	4.95
Total		30.5	34.5	530	99.86	99.87	99.91	299.64

Appendix 40. Phytosociological Attributes of *Juniperus-Artemisia-Cotoneaster* (JAC) Community at Power along Foothill between altitude of 2460m-2660m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Juniperus excelsa</i> M.Bieb.	6.0	7.0	100	14.11	16.09	14.49	44.69*
2.	<i>Artemisia brevifolia</i> Wall ex DC.	5.0	5.0	100	11.76	11.49	14.49	37.74**
3.	<i>Cotoneaster nummularia</i> Fisch & Mey.	5.0	5.0	80	11.76	11.49	11.59	34.84***
4.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	90	10.58	10.34	13.04	33.96
5.	<i>Ephedra gerardiana</i> L.	4.0	4.0	40	9.41	9.19	5.79	24.39
6.	<i>Astragalus psilocentros</i> Fisch.	3.0	3.0	40	7.05	6.89	5.79	19.73
7.	<i>Colutea paulsenii</i> Feryh.	3.0	3.0	40	7.05	6.89	5.79	19.73
8.	<i>Berberis lycium</i> Royle.	2.5	2.5	50	5.88	5.74	7.24	18.86
9.	<i>Atraphaxis pyrifolia</i> Bunge.	2.5	2.5	30	5.88	5.74	4.34	15.96
10.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	2.5	2.5	30	5.88	5.74	4.34	15.96
11.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	1.0	1.0	20	2.35	2.29	2.89	7.53
12.	<i>Potentilla supina</i> L.	1.0	1.0	20	2.35	2.29	2.89	7.53
13.	<i>Acantholimon longiscapum</i> Bokhari.	0.5	0.5	10	1.17	1.14	1.44	3.75
14.	<i>Ribes orientale</i> Desf.	1.0	1.0	20	2.35	2.29	2.89	7.53
15.	<i>Scrophularia stewartii</i> Penn.	0.5	0.5	10	1.17	1.14	1.44	3.75
16.	<i>Verbascum thapsus</i> L.	0.5	0.5	10	1.17	1.14	1.44	3.75
Total		42.5	43.5	690	99.92	99.89	99.89	299.7

Appendix 41. Phytosociological Attributes of *Ephedra-Artemisia-Juniperus* (EAJ) Community at Wasum along foothill between altitude of 2520m-2600m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Ephedra gerardiana</i> L.	6.0	6.0	100	13.79	12.90	12.98	39.67*
2.	<i>Artemisia brevifolia</i> Wall ex DC.	5.0	5.0	100	11.49	10.75	12.98	35.22**
3.	<i>Juniperus excelsa</i> M.Bieb.	4.5	5.5	90	10.34	11.82	11.68	33.84***
4.	<i>Colutea paulsenii</i> Feryh.	5.0	6.0	60	11.49	12.90	7.79	32.18
5.	<i>Atraphaxis pyrifolia</i> Bunge.	4.0	4.0	60	9.19	8.60	7.79	25.58
6.	<i>Cotoneaster nummularia</i> Fisch & Mey.	3.5	3.5	70	8.04	7.52	9.09	24.65
7.	<i>Rosa webbiana</i> Wall ex Royle.	3.5	3.5	70	8.04	7.52	9.09	24.65
8.	<i>Berberis lycium</i> Royle.	2.5	2.5	50	5.74	5.37	6.49	17.6
9.	<i>Acantholimon longiscapum</i> Bokhari.	2.0	3.0	40	4.59	6.45	5.19	16.23
10.	<i>Astragalus psilocentros</i> Fisch.	1.5	1.5	30	3.44	3.22	3.89	10.55
11.	<i>Ribes orientale</i> Desf.	1.5	1.5	10	3.44	3.22	1.29	7.95
12.	<i>Astragalus amberstianus</i> Royle ex Benth.	1.0	1.0	20	2.29	2.15	2.59	7.03
13.	<i>Clematis orientalis</i> L.	1.0	1.0	20	2.29	2.15	2.59	7.03
14.	<i>Artemisia scoparia</i> Waldst & Kit.	0.5	0.5	10	1.14	1.07	1.29	3.5
15.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	0.5	0.5	10	1.14	1.07	1.29	3.5
16.	<i>Lactuca viminea</i> (L.) F.W. Schmid.	0.5	0.5	10	1.14	1.07	1.29	3.5
17.	<i>Otostegia limbata</i> (Bth.) Boiss.	0.5	0.5	10	1.14	1.07	1.29	3.5
18.	<i>Cuscuta approximata</i> Bab.	0.5	0.5	10	1.14	1.07	1.29	3.5
Total		43.5	46.5	770	99.87	99.92	99.89	299.68

Appendix 42. Phytosociological Attributes of *Cotoneaster-Berberis-Artemisia* (CBA) Community at Ghazin along Foothill between altitude of 2580m-2800m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Cotoneaster nummularia</i> Fisch & Mey.	6.5	6.5	90	16.66	15.47	13.63	45.76*
2.	<i>Berberis lycium</i> Royle.	7.0	7.0	60	17.94	16.66	9.09	43.69**
3.	<i>Artemisia brevifolia</i> Wall ex DC.	5.0	5.0	100	12.82	11.90	15.15	39.87***
4.	<i>Rosa webbiana</i> Wall ex Royle.	4.5	4.5	90	11.53	10.71	13.63	35.87
5.	<i>Juniperus excelsa</i> M.Bieb.	3.0	4.0	60	7.69	9.52	9.09	26.3
6.	<i>Ribes orientale</i> Desf.	2.5	2.5	50	6.41	5.95	7.57	19.93
7.	<i>Ephedra gerardiana</i> L.	2.0	2.0	40	5.12	4.76	6.06	15.94
8.	<i>Gnaphalium luteo-album</i> L.	2.0	2.0	40	5.12	4.76	6.06	15.94
9.	<i>Atraphaxis pyrifolia</i> Bunge.	1.5	2.5	30	3.84	5.95	4.54	14.33
10.	<i>Kracheninnikovia ceratoides</i> (L.) Guelden.	1.5	1.5	30	3.84	3.57	4.54	11.95
11.	<i>Colutea paulsenii</i> Feryh.	1.0	2.0	20	2.56	4.76	3.03	10.35
12.	<i>Asperula oppositifolia</i> Ehrend.	0.5	0.5	10	1.28	1.19	1.51	3.98
13.	<i>Echinops echinatus</i> Roxb.	0.5	0.5	10	1.28	1.19	1.51	3.98
14.	<i>Verbascum thapsus</i> L.	0.5	0.5	10	1.28	1.19	1.51	3.98
15.	<i>Clematis orientalis</i> L.	0.5	0.5	10	1.28	1.19	1.51	3.98
16.	Grass 1.	0.5	0.5	10	1.28	1.19	1.51	3.98
Total		39	42	660	99.93	99.96	99.94	299.83

Appendix 43. Phytosociological Attributes of *Ephedra-Juniperus-Artemisia* (EJA) Community at Baroghill Pass along Foothill between altitude of 3060m-3100m.

S.No	Plant species	Density	Cover	Frequency	RD	RC	RF	IV
1.	<i>Ephedra gerardiana</i> L.	5.5	5.5	90	16.17	15.27	15	46.44*
2.	<i>Juniperus excelsa</i> M.Bieb.	4.5	6.5	90	13.23	18.05	15	46.28**
3.	<i>Artemisia brevifolia</i> Wall ex DC.	4.0	4.0	80	11.76	11.11	13.33	36.2***
4.	<i>Atraphaxis pyrifolia</i> Bunge.	3.5	3.5	50	10.29	9.72	8.33	28.34
5.	<i>Ribes orientale</i> Desf.	4.0	4.0	60	11.76	11.11	10	32.87
6.	<i>Rosa webbiana</i> Wall ex Royle.	4.0	4.0	60	11.76	11.11	10	32.87
7.	<i>Hippophae rhamnoides</i> L.	2.5	2.5	50	7.35	6.94	8.33	22.62
8.	<i>Berberis lycium</i> Royle.	1.5	1.5	30	4.41	4.16	5	13.57
9.	<i>Cicer macranthum</i> M. Popov.	1.0	1.0	20	2.94	2.77	3.33	9.04
10.	<i>Gnaphalium luteo-album</i> L.	1.0	1.0	20	2.94	2.77	3.33	9.04
11.	<i>Salix acmophylla</i> Boiss.	1.0	1.0	20	2.94	2.77	3.33	9.04
12.	<i>Artemisia scoparia</i> Waldst & Kit.	0.5	0.5	10	1.47	1.38	1.66	4.51
13.	<i>Clematis grata</i> Wall.	0.5	0.5	10	1.47	1.38	1.66	4.51
14.	<i>Calamogrostris pseudophragmites</i> Hall. f. Koeler.	0.5	0.5	10	1.47	1.38	1.66	4.51
Total		34	36	600	99.96	99.92	99.96	299.84