

Assessment of floristic diversity in the mountain ecosystem of Marghazar Valley, Hindukush Range, Swat, Pakistan

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Abstract. Khan MN, Ali S, Razak SA, Zaman A, Iqbal M, Shah SN. 2022. Assessment of floristic diversity in the mountain ecosystem of Marghazar Valley, Hindukush Range, Swat, Pakistan. *Biodiversitas* 23: 1000-1013. Marghazar Valley, a part of the Hindukush Range, is an area with a rich diversity of plant resources. Geo-climatically and ecologically, this valley is characterized by a moist temperate and subtropical zone with a Sino-Japanese type of vegetation. A comprehensive survey was carried out from April 2019-June 2020 to explore the biodiversity and ecological aspects of plants in Marghazar Valley, Swat District, Khyber Pakhtunkhwa, Pakistan. The study recorded a total number of 307 taxa (161 herbs, 45 shrubs, 46 trees, 37 grasses, 10 climbers, 2 shrubby herbs, 1 subshrub, 1 tree-like herb, 1 hollow tufted tree, 1 climbing shrub, 1 parasitic herb and 1 woody climber) belong to 94 families and 236 genera that consisted of Pteridophytes (14 species, 9 genera, 7 families), Gymnosperms (5 species, 4 genera, 2 families) and Angiosperms (288 species, 223 genera and 85 families). Families with the highest number of species were Poaceae (38 species) and Asteraceae (29 species), followed by Rosaceae (22 species), Brassicaceae (13 species) and Lamiaceae (11 species), while the rest of the families had less than 11 species. Dicots were the group with the largest number of genera (75.24 %), followed by Monocots (18.56 %), Pteridophytes (4.54 %) and Gymnosperms (1.62 %). *Cousinia bupthalmoides* was recorded from the area for the first time and are a novel addition to the flora of Swat. Phenology of vegetation revealed that 173 taxa (56.35%) recorded as perennial followed by 134 taxa as annual plants (43.50%). Bio-spectrum classes were represented by 126 species as therophytes (40.90%) and 122 species as microphylls (39.61%) in life form and leaf size respectively, while 2 species i.e *Cuscuta reflexa* and *Equisetum arvense* are aphyllous which possesses no leaves.

Keywords: *Cousinia*, floristic checklist, Hindukush range, Marghazar valley, phenology

INTRODUCTION

The Hindukush mountainous region of Swat Valley, Pakistan, is one of the most picturesque places on the subcontinent and is frequently referred to as Pakistan's "little Switzerland." The valley is located near the summits of three huge mountains: the Hindukush, the Himalayas, and the Karakorum, and as a result, it has diverse and unique fauna and vegetation. Swat is located at the northwest junction of Pakistan (Hamayun et al. 2006). Mount Elum, located between Swat and Buner, is the valley's highest point, rising 1780 meters above sea level (asl). This valley is characterized by the vegetation of the most temperate and subtropical zones, with snowfall and heavy rain while the weather is so severe that it has a pleasant summer all year (Yousufzai et al. 2010). The picturesque Marghazar Valley has emerged as a major tourist destination in Swat Valley with thousands of tourists visiting it every year. Besides the remarkable locations, greenery, and serene environment, the valley that is

positioned around 12 km from Mingora City is also known for walnut cultivation.

Mountain ecosystems offer a diverse range of products and resources to humans, both to those who live in the mountains and those who do not (MA, 2005). For example, more than half of the human population depends on freshwater collected, preserved, and filtered in mountainous areas. Mountainous areas are hotspots for biodiversity. Besides, mountains are of global importance as major tourism and leisure destinations. Mountains are valuable resources for rapid global development (Schroter et al. 2005). Changes in land management policies, infrastructure construction, unhealthy tourism, forest fragmentation, and global climate change are the main threats to mountain ecosystems (Grêt-Regamey et al. 2012). Traditional conservation approaches became some extent of contention, and therefore the principle of ecosystem services (ESS) has risen to prominence (Naidoo et al. 2008), including the importance of preserving mountain habitats.

Phytodiversity is the variety of plant species in a geographical area (Gifford 1989). The importance of plant diversity is widely recognized at the moment, and it has been properly described as "life insurance for our changing environment." It is also acknowledged as critical in ensuring our nutritional security in the face of an aging population. Wildlife diversity may decline as a result of decreased vegetation (Njeri et al. 2017). Natural diversity is defined as the inconsistency between current living organisms, including terrestrial, marine, and other submarine environments, and the environmental developments of which they are a part; this includes variation within species, between species, and between environments (Ertu 2006). It contains all of the biosphere's vegetation, making the ecosystem flawless (Dar and Farooq 1997). Flora documentation is commonly acknowledged as essential over the world since it plays an important part in preserving the region's national assets (Amber et al. 2019). The documentation of local flora, combined with an explanation of a place, is critical since it can provide specific species of the native area, mounting season, species rigidity, any new species identified in the region, and the influence of climatic settings (Ali 2008). It has been found that about 308,312 species of vascular plants are currently being described and accepted, in which 295,383 are Angiosperms (74,273 are Monocots and 210,008 are Eudicots), Gymnosperms 1079, Ferns 10,560 and remaining 1,290 species of Lycopods (Maarten et al. 2016). The leading vascular plant family is Orchidaceae having 736 genera and 28,000 species and Asteraceae having 1,623 genera and 24,700 species throughout the world (Chase et al. 2015).

The floristic element of plants has long been recognized, but the concept of growth forms emerged after Humboldt by classifying vegetation based on physiognomic characteristics (Mack 2003). This is a representation of the harmony that exists between plants and their surroundings (Ewald 2003). Floristic analysis of any given location aids in determining plant wealth and potential values (Shaheen et al. 2016). A floristic inventory not only identifies and describes local and regional species, but also provides evidence of plant phenology, the invasion of new species, and vegetative stress (Ali 2008; Saand et al. 2019). Plant biodiversity conservation necessitates stable and solid quantitative and qualitative botanical data archives that are organized (Clubbe et al. 2010). The biological scale is the proportion ratio of plant species' life form adaption in any place. The life form scale denotes an area's microclimate (Danin and Orshan 1990; Hussain et al. 2014). The floristic checklists of a certain region are the primary source of botanical materials for that region (Safidkon et al. 2003). After floristic arrangement studies, the understanding of living forms is the second most important component of vegetation explanation (Cain 1950). Plant adaptation to specific environmental settings describes life forms, which is an indicator of micro and macroclimate (Shimwell 1971). Raunkiaer (1934) stated that flora are also categorized on the source of life form and leaf sizes spectrum and this has been unusually helpful

for relationship plotting of vegetation. The leaf size information represents the flora's physical processes (Oosting 1956; Rahman et al. 2019). Biotic activities, for example, are the primary causes of changes in the phytoclimatic spectrum in a specific floristic zone.

The first challenge in developing a checklist of vascular plants in mountainous places such as Marghazar Valley was deciding what area to cover. We have examined a lot of published literature about Swat District, Pakistan, and a lot of work has been done on occasion. However, the current valley is still unexplored and no written work is currently available. Therefore, this study aimed to provide a complete list of flora of Marghazar Valley, Swat District, Khyber Pakhtunkhwa, Pakistan through a comprehensive survey to collect information regarding the plant wealth, identification, description of local and regional species and its potential values (Ali 2008; Shaheen et al. 2016; Saand et al. 2019).

MATERIALS AND METHODS

Site details

The Swat has always remained self-sufficient in its natural and agricultural resources (Khan et al. 2017). Marghazar Valley lies in Hindu Kush Himalaya (HKH) region of Swat District, Pakistan, having 34°34' to 35°55' N latitudes and 72°08' to 72°50' E longitudes. It is confined on the North by district Chitral, East by district Kohistan, South by district Malakand, and West by district Dir (Anonymous 1998), as shown in Fig 1. Marghazar Valley. The area has an altitude about 2,000 meters above sea level, average relative humidity around 60%, and annual rainfall of 1004 mm. With this climatic condition, Marghazar Valley is a lush green part of Hindukush Range. It is comprised of five main villages named Spal Bandai, Kukrai, Marghazar, Sher Athraf and Islampur. The valley is surrounded by green mountains. It covers an area of 8220 km² of land (Ahmad et al. 2015) (Fig 2).

Data collection and observations

Different field surveys were carried out in both blooming and flowering seasons during April 2019-June 2020 in Marghazar Valley, Hindukush Range, Swat areas (Pakistan). Study trips were arranged to five different valley villages, including Spal Bandai, Kukrai, Marghazar, Sher Athraf and Islampur to collect different plant species. The field survey included observations and field walks. The valley was divided into five main sites and each site was surveyed two times for collection, observation, documentation and exploration. Major threats and factors were examined during field survey like habitat loss, over-collection of plants, overgrazing, soil erosion, over browsing, over-harvesting, land sliding, snow sliding, excessive rain, unpleasant weather, overexploitation, land use, agriculture expansion, natural disaster and other anthropogenic activities.

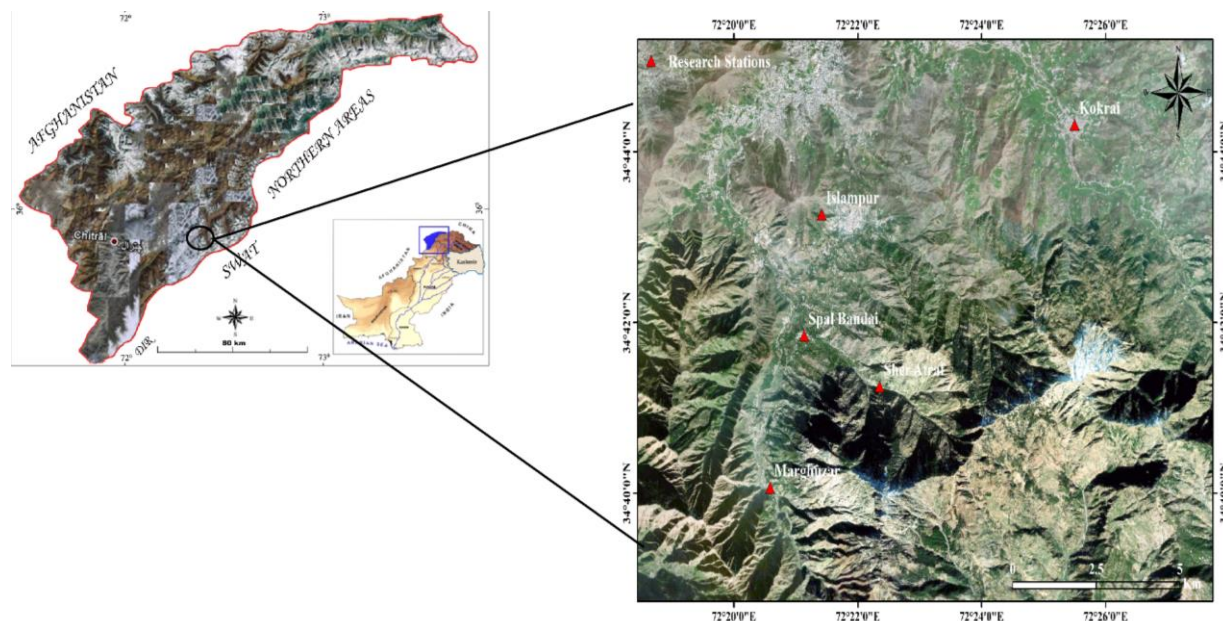


Figure 1. Geo reference map of the study area (Spal Bandai, Kokrai, Marghar, Sher Athraf and Islampur)



Figure 2. Scenic view of the study area

Plant preservation and identification

Collected and preserved plant samples provide authentic information regarding diversity, classification, distribution and taxonomic identification. Therefore, it gives evidence for plant existence in a specific area and time. Hence plants were preserved in a suitable arrangement. The samples were collected from five different localities after being dried in a proper way in a newspaper (roots, stems, leaves), preserved and pressed all the collected samples, regarding blotting papers in between the adjacent samples. Polythene bags, newspapers and blotting papers were changed after a week to avoid fungus attack, free moisture and rotting. The specimens were treated with HgCl_2 solution in Ethylene to protect them from insect and fungal attacks. The specimens were mounted on (standard) herbarium sheets about (37.05 cm x 31.05 cm). Tools and materials used in data collection in the field included a compass, GPS, ruler, plastic bottles, polythene bag, newspaper, pencil, tags, eraser, highlighter, scissor, small knife, digital camera, permanent marker, surgical gloves, field dairy, glue and remover. During collection, localities of each specimen were written in newspapers and field diaries as well. Photographs of each

and every species were taken by digital camera. Certain parameters like habit, life cycle, life form and leaf size were observed during field works.

Specimens (flowering plants) were identified with the help of native flora (flora of Pakistan) and other available literature (Ali and Nasir 1989-1991; Ali and Nasir 1991-1993; Ali and Qaiser 1986; Ali and Qaiser 1993-2017; Ali and Qaiser 2000-2012; Ali 1978; Ali 1980; Ali et al. 2001; Cronquist 1968; Nasir 1981; Stewart 1967; Stewart 1972), grasses identified with the manual of (Cope 1982; Ahmad et al. 1958). Fern and their allies (Pteridophytes) was identified from (Gul et al. 2017; Lellinger 2002; Nakaike and Malik 1992; Nakaike and Malik 1993; Nayar 1964; Stewart 1957), flora of China (Zhang et al. 2013) and other available literature (Beddome 1866; Beddome 1873; Clarke 1973; Fraser-Jenkins 2014; Hope 1899-1902; Shah et al. 2020, 2021). Plant samples were also confirmed from snapshots existing on the international herbaria website. Certain unidentified specimens were identified from various Taxonomists, Herbarium botanists, curators from the department of Botany, University of Peshawar and Government degree college Matta, Swat for his valuable information and knowledge. After identification and observation of taxonomic data, ecological data were successfully noted. For taxonomic classification, genera and taxon ranked first after family fern and their allies (Pteridophytes) were placed first, according to the standard classification of Ching and Christenhusz then placed non-flowering plants (Gymnosperm) second while flowering plants (Angiosperms) were placed at last using a standard phylogenetic scheme of classification associated with Angiosperm Phylogeny Group (APG) by Judd et al. 1999. All taxon voucher numbers will be given and then arranged alphabetically after being submitted to the Herbarium of the Department of Botany, Bacha Khan University, Charsadda (HBKU) for strengthening and further research.

Biological spectrum

Biological spectra are important in comparing geographically, habitually, and widely separated plants and are considered an indicator of prevailing environmental conditions. These changes are due to biotic impacts like agricultural practices, grazing, deforestation, trampling and climatic changes (Badshah et al. 2013). Therefore, Raunkiaerian biological spectrum was used for life form and leaf size class and plants were identified according to the method of Raunkiaer (1934) which was followed by Hussain (1989) and Badshah et al. (2013) as follow.

Life form classes

Life form class's concept backs to Von Humboldt (1806) that was initially created for comparisons of non-taxonomical vegetation of different districts of the globe (Abbas et al. 2017). It gives proper climatic information. Plant species adaptation to its surrounding climate is revealed by the life form of an ecosystem (Bano et al. 2017). Life form based on Raunkiaer (1934) classification is much dependable, which is based on the perennating bud protection amid the adverse and unfavorable condition.

(Th) Therophytes: The annual plant that possesses seeds completes its life cycle in a year and survives the harsh seasons through spores and seeds. These plant species are broadly distributed in dry and hot deserts.

(G) Geophytes / (Cr) Cryptophytes: They are basically perennating buds found below the soil surface or submerged in water. These are also known as Earth plants. The plants included in this class are deep rhizomes, tubers, bulbs, emergent, corm, submerged, or floating hydrophytes rooted in the muddy substratum.

(H) Hemicryptophytes: These are perennials herbaceous plants of which aerial portion of plant demolished at the end of growing season parting shooting buds on or just below the soil surface i.e. grasses, biennial plants and rosette.

(Ch) Chamaephytes: These parenting buds lie close to the ground level and reach up to 25 cm. They are also called Surface plants. They may be low woody, low stem succulent, trailing, herbaceous and cushion plants.

(Ph) Phanerophytes: This group includes trees and shrubby species that borne perennating buds on the aerials surface of plants and gain height more than 25 cm above soil surface.

Life form spectra can be determined as follow:

Life form spectrum =

$$\frac{\text{Number of species falling in a particular life form class}}{\text{Total number of all the species for that community or area}} \times 100$$

Leaf size classes

According to leaf size spectra plant specimen were classified into different classes (Raunkiaer 1934) as follows: (L) Leptophyll: leaf area up to 25mm² (i), (N) Nanophyll: leaf area from 25 to 225 mm² (ii), (Mic) Microphyll: leaf area from 225 to 2025mm² (iii), (Mes) Mesophyll: leaf area from 2025 to 18225mm² (iv), (Mac) Macrophyll: leaf area from 18225 to 164025mm² (v), (Meg) Megaphyll: leaf area large then class V (vi).

Raunkarian spectrum was determined as follows:

Leaf size spectrum =

$$\frac{\text{Number of species falling in a particular leaf size class}}{\text{Total number of all the species for that community or area}} \times 100$$

RESULTS AND DISCUSSION

Taxonomic studies

Marghazar Valley is a lush green part of the Hindukush Range with a greater diversity of plant resources. A comprehensive survey was carried out during April 2019-June 2020 to explore, identify and observe ecological aspects of plants of Marghazar Valley, Hindukush Range, Swat, Pakistan. Geo-climatically and ecologically, this valley is characterized by the vegetation of moist temperate and subtropical zone having snowfall with heavy rain and lies within Sino-Japanese type of vegetation.

The explorations revealed a total of 307 plant taxa belonging to 236 genera under 94 families. Among them, 14 taxa within 9 genera and 7 families were recognized as Pteridophytes, 5 taxa were segregated under 4 genera and 2 families as Gymnosperms and the remaining 288 taxa were classified under 223 genera and 85 families were Angiosperms in which 57 taxa, 50 genera and 13 families were recorded as Monocots while 231 taxa distributed over 173 genera and 72 families were recorded as Dicots (Table 1-2).

Dryopteridaceae and Pteridaceae shared 3 taxa and 2 genera each and are considered as dominant families in Pteridophytes, followed by Aspleniaceae with 3 taxa and 1 genera, Athyriaceae with 1 genera and 2 species, Equisetaceae, Dennstaedtiaceae and Marsileaceae with 1 genera and 1 specie each. The number of taxa within families in Pteridophytes ranged from 1 to 14 (Tables 1 and 2).

Pinaceae, with a total of 2 genera and 3 species is the largest family in Gymnosperms, followed by Cupressaceae which contributed 2 genera and 2 species. The number of taxa within families in Gymnosperms ranged from 1 to 5.

Poaceae shared 33 genera and 38 species and was the largest family in Monocots, followed by Araceae (3 genera, 3 species), Cyperaceae (2 genera, 3 species) and Alliaceae (1 genera, 2 species), Asphodelaceae and Liliaceae (2 genera and 2 species) while Amaryllidaceae, Asclepiadaceae, Asparagaceae, Commelinaceae, Convallariaceae, Musaceae and Smilacaceae comprised of only 1 genera and 1 species each. The number of taxa within families in Monocots ranged from 1 to 57.

Asteraceae/Compositae shared the highest number of genera (22) and species (29) and observed as dominant family in Dicots followed by rose family Rosaceae with 11 genera and 22 species, Brassicaceae with 10 genera and 13 species, Lamiaceae with 10 genera and 11 species, Papilionaceae with 8 genera and 10 species while rest of families had less than 10 species and the remaining 29 families were monogeneric and monospecific that consisted of only single genera and single specie each, i.e., Aceraceae, Aquifoliaceae, Araliaceae, Berberidaceae, Betulaceae, Buddlejaceae, Buxaceae, Campanulaceae, Cannabaceae, Caprifoliaceae, Casuarinaceae, Crassulaceae, Cuscutaceae, Elaeagnaceae, Fumariaceae, Guttiferae, Hippocastanaceae, Juglandaceae, Meliaceae, Myrsinaceae, Oleaceae, Onagraceae, Paeoniaceae, Platanaceae, Polygalaceae, Sapindaceae, Saxifragaceae, Simaroubaceae and Zygophyllaceae. The number of taxa within families in Dicots ranged from 1 to 231 (Table 1).

Table 1. Floristic list, ecological attributes and biological spectrum of plants of Marghazar Valley, Hindukush Range, Swat, Pakistan

Division/family/taxa	Voucher no.	Habit	Life cycle	Biological spectra		Locality
				Life form	Leaf size	
PTERIDOPHYTES						
Athyriaceae						
<i>Athyrium attenuatum</i> (Clarke) Tagawa.	HBKU-748	H	Perennial	G	Mic	Marghazar
<i>Athyrium oxyphyllum</i> (Wall. ex Hook.) T. Moore ex Bedd.	HBKU-597	H	Perennial	G	Mic	Marghazar
Aspleniaceae						
<i>Asplenium adiantum-nigrum</i> L.	HBKU-808	S	Perennial	G	Nan	Sher Athraf
<i>Asplenium dalhousiae</i> Hook.	HBKU-633	S	Perennial	G	Lep	Marghazar
<i>Asplenium trichomanes</i> L.	HBKU-584	S	Perennial	G	Lep	Marghazar
Equisetaceae						
<i>Equisetum arvense</i> L.	HBKU-706	H	Perennial	G	Aph	Spal Bandai
Dennstaedtiaceae						
<i>Pteridium aquilinum</i> (L.) Kuhn.	HBKU-739	H	Perennial	G	Mic	Marghazar
Dryopteridaceae						
<i>Cyrtomium caryotideum</i> (Wall. ex Hook. & Grev.) C. Presl.	HBKU-728	H	Perennial	G	Mic	Marghazar
<i>Dryopteris juxtaposita</i> Christ.	HBKU-726	H	Perennial	G	Mic	Marghazar
<i>Dryopteris ramosa</i> (C. Hope) C. Chr.	HBKU-725	H	Perennial	G	Lep	Marghazar, Spal Bandai
Marsileaceae						
<i>Marsilea minuta</i> L.	HBKU-745	H	Perennial	Hyd	Nan	Kukrai
Pteridaceae						
<i>Adiantum capillus-veneris</i> L.	HBKU-577	H	Perennial	G	Nan	Marghazar
<i>Pteris cretica</i> L.	HBKU-721	H	Perennial	G	Mic	Spal Bandai, Marghazar
<i>Pteris vittata</i> L.	HBKU-720	H	Perennial	G	Mic	Spal Bandai, Marghazar
GYMNOSPERMS						
Cupressaceae						
<i>Cupressus sempervirens</i> L.	HBKU-583	T	Perennial	Megp	Lep	Marghazar
<i>Thuja orientalis</i> L.	HBKU-541	S	Perennial	NP	Lep	Islampur
Pinaceae						
<i>Cedrus deodara</i> (Roxb. ex D. Don).	HBKU-793	T	Perennial	Megp	Nan	Marghazar, Sher Athraf
<i>Pinus wallichiana</i> A. B. Jackson.	HBKU-773	T	Perennial	Megp	Nan	Islampur
<i>Pinus roxburghii</i> Sargent.	HBKU-628	T	Perennial	Megp	Nan	Marghazar
ANGIOSPERMS						
MONOCOTS						
Alliaceae						
<i>Allium cepa</i> L.	HBKU-776	H	Annual	G	Lep	Sher Athraf, Islampur, Marghazar
<i>Allium sativum</i> L.	HBKU-775	H	Annual	G	Lep	Sher Athraf, Islampur, Marghazar
Amaryllidaceae						
<i>Narcissus tazetta</i> L.	HBKU-746	H	Annual	G	Lep	Sher Athraf, Islampur, Marghazar, Kukrai
Araceae						
<i>Acorus calamus</i> L.	HBKU-778	H	Annual	G	Mic	Sher Athraf
<i>Arisaema jacquemontii</i> Blume.	HBKU-779	H	Annual	G	Mac	Sher Athraf
<i>Colocasia esculenta</i> (Linn.) Schott.	HBKU-545	H	Annual	G	Mac	Spal Bandai
Asclepiadaceae						
<i>Calotropis procera</i> (Ait.) Ait. f.	HBKU-819	S	Perennial	Np	Mac	Sher Athraf, Islampur, Marghazar, Kukrai, Spal Bandai
Asparagaceae						
<i>Asparagus adscendens</i> Roxb.	HBKU-780	SS	Perennial	HC	Nan	Sher Athraf
Asphodelaceae						
<i>Aloe vera</i> (L.) Burm. F.	HBKU-811	H	Perennial	HC	Mac	Sher Athraf
<i>Asphodelus tenuifolius</i> Cav.	HBKU-727	H	Annual	Th	Nan	Marghazar
Commelinaceae						
<i>Commelina benghalensis</i> L.	HBKU-694	H	Annual	Th	Mic	Spal Bandai
Convallariaceae						
<i>Polygonatum verticillatum</i> (L.) All.	HBKU-791	H	Annual	G	Mic	Sher Athraf
Cyperaceae						
<i>Bolboschoenus glaucus</i> (Lam.) S.G. Smith.	HBKU-724	H	Perennial	HC	Mic	Marghazar
<i>Cyperus eleusinoides</i> Kunth.	HBKU-709	H	Perennial	HC	Lep	Spal Bandai
<i>Cyperus niveus</i> Retz.	HBKU-649	H	Perennial	HC	Lep	Kukrai

Liliaceae							
<i>Notholirion thomsonianum</i> (D. Don) Stapf.	HBKU-568	H	Annual	G	Mic	Marghazar	
<i>Tulipa clusiana</i> DC.	HBKU-567	H	Annual	G	Mic	Marghazar, Islampur	
Musaceae							
<i>Musa paradisiaca</i> L.	HBKU-762	TH	Perennial	HC	Meg	Kukrai	
Smilacaceae							
<i>Smilax glaucophylla</i> Klotzch.	HBKU-576	C	Perennial	Np	Mic	Spal Bandai, Marghazar	
Poaceae							
<i>Acrachne racemosa</i> (Heyne ex Roem. & Schult.) Ohwi	HBKU-645	G	Perennial	HC	Lep	Kukrai	
<i>Agrostis</i> sp.	HBKU-729	G	Perennial	HC	Lep	Marghazar	
<i>Agrostis viridis</i> Gouan.	HBKU-600	G	Perennial	HC	Lep	Marghazar	
<i>Apluda mutica</i> L.	HBKU-651	G	Perennial	HC	Lep	Spal Bandai	
<i>Aristida cyanantha</i> Nees ex Steud.	HBKU-672	G	Perennial	HC	Nan	Kukrai	
<i>Arundo donax</i> L.	HBKU-815	G	Perennial	HC	Lep	Sher Athraf	
<i>Avena fatua</i> L.	HBKU-599	G	Annual	Th	Lep	Marghazar	
<i>Bothriochloa pertusa</i> (L.) A. Camus	HBKU-659	G	Perennial	HC	Nan	Kukrai	
<i>Bromus japonicus</i> Thunb. ex Murr.	HBKU-794	G	Perennial	HC	Lep	Sher Athraf	
<i>Bromus pectinatus</i> Thunb.	HBKU-552	G	Perennial	HC	Nan	Marghazar	
<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv.	HBKU-685	G	Perennial	HC	Lep	Kukrai, Spal Bandai	
<i>Chrysopogon serrulatus</i> Trin.	HBKU-719	G	Perennial	HC	Lep	Spal Bandai	
<i>Cymbopogon jwarancusa</i> (Jones) Schult.	HBKU-640	G	Perennial	HC	Lep	Kukrai	
<i>Cynodon dactylon</i> (L.) Pers.	HBKU-534	G	Perennial	HC	Lep	Spal Bandai, Kukrai, Marghazar, Islampur	
<i>Dactylis glomerata</i> L.	HBKU-635	G	Perennial	HC	Lep	Spal Bandai, Marghazar	
<i>Dendrocalamus strictus</i> (Roxb.) Nees.	HBKU-767	HTT	Perennial	HC	Nan	Spal Bandai	
<i>Dichanthium annulatum</i> (Forssk.) Stapf.	HBKU-683	G	Annual	Th	Mic	Kukrai, Spal Bandai	
<i>Digitaria ciliaris</i> (Retz.) Koel.	HBKU-684	G	Annual	Th	Mic	Kukrai, Spal Bandai	
<i>Echinochloa colona</i> (L.) Link	HBKU-658	G	Perennial	HC	Nan	Kukrai, Spal Bandai	
<i>Eleusine indica</i> (L.) Gaertn.	HBKU-689	G	Perennial	HC	Lep	Spal Bandai	
<i>Enneapogon persicus</i> Boiss.	HBKU-741	G	Annual	Th	Mic	Marghazar	
<i>Hemarthria sibirica</i> (Gandog.) Ohwi	HBKU-696	G	Perennial	HC	Lep	Kukrai, Spal Bandai	
<i>Heteropogon contortus</i> (L.) P. Beauv. ex Roem. & Schult.	HBKU-671	G	Perennial	HC	Lep	Kukrai	
<i>Lolium temulentum</i> L.	HBKU-598	G	Annual	Th	Mic	Marghazar	
<i>Paspalum paspalodes</i> (Michx.) Scribner.	HBKU-711	G	Perennial	HC	Lep	Spal Bandai, Kukrai	
<i>Pennisetum glaucum</i> (L.) R. Br.	HBKU-525	G	Perennial	HC	Lep	Islampur	
<i>Pennisetum orientale</i> L.C. Rich.	HBKU-718	G	Perennial	HC	Lep	Kukrai	
<i>Phleum paniculatum</i> Huds.	HBKU-589	G	Annual	Th	Mic	Marghazar	
<i>Piptatherum laterale</i> (Munro ex Regel) Rozhev.	HBKU-653	G	Annual	Th	Mic	Kukrai, Spal Bandai	
<i>Poa bulbosa</i> L.	HBKU-581	G	Annual	Th	Mic	Marghazar	
<i>Polypogon fugax</i> Ness ex Steud.	HBKU-810	G	Annual	Th	Mic	Sher Athraf	
<i>Polypogon monspeliensis</i> (L.) Desf.	HBKU-812	G	Perennial	HC	Lep	Sher Athraf	
<i>Saccharum filifolium</i> Nees ex Steud.	HBKU-702	G	Perennial	HC	Lep	Kukrai, Spal Bandai	
<i>Setaria pumila</i> (Poir.) Roem. & Schult.	HBKU-655	G	Perennial	HC	Lep	Kukrai, Spal Bandai	
<i>Sorghum bicolor</i> (L.) Moench.	HBKU-533	G	Perennial	HC	Nan	Islampur	
<i>Sorghum halepense</i> (L.) Pers.	HBKU-670	G	Perennial	HC	Lep	Kukrai	
<i>Triticum aestivum</i> L.	HBKU-754	G	Perennial	Th	Lep	Kukrai	
<i>Zea mays</i> L.	HBKU-523	G	Annual	Th	Mac	Islampur	
DICOTS							
Acanthaceae							
<i>Dicliptera bupleuroides</i> Nees in Wall.	HBKU-638	H	Annual	Th	Mic	Kukrai	
<i>Justicia adhatoda</i> L.	HBKU-774	S	Perennial	NP	Mes	Sher Athraf	
Aceraceae							
<i>Acer cappadocicum</i> Gleditsch.	HBKU-707	T	Perennial	MegP	Mes	Spal Bandai	
Aizoaceae							
<i>Portulaca oleracea</i> L.	HBKU-763	H	Annual	Th	Mic	Kukrai	
<i>Trianthema portulacastrum</i> L.	HBKU-515	H	Annual	Th	Mic	Islampur, Kukrai	
Amaranthaceae							
<i>Achyranthes aspera</i> L.	HBKU-710	H	Annual	Th	Mic	Spal Bandai	
<i>Alternanthera pungens</i> Kunth.	HBKU-717	H	Annual	Th	Mic	Spal Bandai	
<i>Amaranthus caudatus</i> L.	HBKU-639	H	Annual	Th	Mic	Kukrai	
<i>Amaranthus retroflexus</i> L.	HBKU-698	H	Annual	Th	Mic	Kukrai, Spal Bandai	
<i>Celosia argentea</i> L.	HBKU-695	H	Annual	Th	Mic	Spal Bandai	
Anacardiaceae							
<i>Cotinus coggyria</i> Scop.	HBKU-686	S	Perennial	NP	Mic	Spal Bandai	
<i>Mangifera indica</i> L.	HBKU-521	T	Perennial	MegP	Mes	Islampur	

<i>Pistacia chinensis</i> Bunge.	HBKU-605	T	Perennial	MesP	Mes	Kukrai, Islampur, Marghazar
Apocynaceae						
<i>Nerium oleander</i> L.	HBKU-818	S	Perennial	NP	Mes	Sher Athraf
<i>Vinca major</i> L.	HBKU-569	H	Annual	Th	Mic	Marghazar
Aquifoliaceae						
<i>Ilex dipyrrena</i> Wall.	HBKU-740	T	Perennial	MegP	Mes	Marghazar
Araliaceae						
<i>Hedera nepalensis</i> K. Koch.	HBKU-571	C	Perennial	NP	Mes	Marghazar, Kukrai
Asteraceae						
<i>Achillea millefolium</i> L.	HBKU-770	H	Perennial	HC	Mes	Marghazar
<i>Artemisia absinthium</i> L.	HBKU-626	H	Perennial	HC	Mes	Marghazar
<i>Artemisia brevifolia</i> Wall. ex DC.	HBKU-781	H	Perennial	HC	Mes	Sher Athraf
<i>Artemisia santolinifolia</i> Turcz. Ex Krasch.	HBKU-624	H	Perennial	HC	Mes	Marghazar
<i>Artemisia scoparia</i> Waldst. & Kit.	HBKU-625	H	Perennial	HC	Mes	Marghazar
<i>Artemisia vulgaris</i> L.	HBKU-627	S	Perennial	HC	Mes	Kukrai, Marghazar
<i>Aster subulatus</i> Michaux	HBKU-715	H	Perennial	HC	Mes	Spal Bandai
<i>Bidens tripartita</i> L.	HBKU-666	H	Perennial	HC	Mes	Spal Bandai, Kukrai
<i>Calendula arvensis</i> L.	HBKU-575	H	Perennial	HC	Mes	Marghazar
<i>Carpesium abrotanoides</i> L.	HBKU-674	H	Perennial	HC	Mic	Kukrai
<i>Erigeron bonariensis</i> L.	HBKU-765	H	Perennial	HC	Mes	Spal Bandai
<i>Erigeron canadensis</i> L.	HBKU-643	H	Perennial	HC	Mes	Kukrai
<i>Cousinia bupthalmoides</i> Regel.	HBKU-766	H	Annual	HC	Mes	Spal Bandai
<i>Cichorium intybus</i> L.	HBKU-699	H	Perennial	HC	Mic	Spal Bandai
<i>Cirsium vulgare</i> (Savi) Ten.	HBKU-691	H	Annual	Th	Mic	Spal Bandai
<i>Eclipta alba</i> (L.) Hassk.	HBKU-681	H	Annual	Th	Lep	Spal Bandai
<i>Helianthus annuus</i> L.	HBKU-769	H	Annual	Th	Mac	Kukrai
<i>Lactuca tatarica</i> (L.) C. A. Mey.	HBKU-673	H	Annual	Th	Mes	Kukrai
<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajagopal.	HBKU-579	H	Perennial	HC	Lep	Marghazar
<i>Parthenium hysterophorus</i> L.	HBKU-527	H	Perennial	HC	Lep	Islampur
<i>Phagnalon niveum</i> Edgew.	HBKU-661	H	Perennial	HC	Mes	Kukrai
<i>Silybum marianum</i> (L.) Gaertn.	HBKU-758	H	Perennial	HC	Mes	Kukrai
<i>Solidago virgaurea</i> L.	HBKU-665	H	Perennial	HC	Mic	Kukrai
<i>Sonchus arvensis</i> L.	HBKU-704	H	Annual	Th	Mic	Marghazar, Spal Bandai
<i>Sonchus asper</i> (L.) Hill	HBKU-735	H	Annual	Th	Mic	Kukrai, Spal Bandai
<i>Sonchus oleraceus</i> L.	HBKU-713	H	Annual	Th	Mic	Spal Bandai
<i>Tagetes minuta</i> L.	HBKU-822	H	Perennial	HC	Mic	Sher Athraf
<i>Taraxacum officinale</i> Webb.	HBKU-761	H	Annual	Th	Mic	Kukrai
<i>Xanthium strumarium</i> L.	HBKU-703	H	Annual	Th	Mac	Marghazar, Spal Bandai
Berberidaceae						
<i>Berberis lycium</i> Royle.	HBKU-561	S	Perennial	NP	Mic	Marghazar
Betulaceae						
<i>Alnus nitida</i> (Spach) Endl.Gen.	HBKU-692	T	Perennial	MegP	Mic	Spal Bandai
Boraginaceae						
<i>Cynoglossum lanceolatum</i> Forssk.	HBKU-697	H	Annual	Th	Mic	Spal Bandai
<i>Onosma dichroantha</i> Boiss.	HBKU-650	H	Annual	Th	Mic	Kukrai
Brassicaceae						
<i>Arabis pterosperma</i> Edgew.	HBKU-733	H	Annual	Th	Mic	Marghazar
<i>Brassica rapa</i> subsp. <i>campestris</i> (L.) Clapham.	HBKU-782	H	Annual	Th	Mes	Sher Athraf
<i>Brassica rapa</i> subsp. <i>rapa</i>	HBKU-744	H	Annual	Th	Mic	Sher Athraf
<i>Capsella bursa-pastoris</i> (L.) Medik.	HBKU-634	H	Annual	Th	Mic	Marghazar
<i>Coronopus didymus</i> (L.) Smith.	HBKU-813	H	Perennial	HC	Mic	Sher Athraf
<i>Eruca sativa</i> Mill.	HBKU-612	H	Annual	Th	Mic	Marghazar
<i>Lepidium sativum</i> L.	HBKU-783	H	Annual	Th	Mic	Sher Athraf
<i>Nasturtium officinale</i> R. Br.	HBKU-555	H	Annual	Th	Mes	Spal Bandai , Marghazar
<i>Neslia apiculata</i> Fisch.	HBKU-609	H	Annual	Th	Lep	Marghazar
<i>Raphanus raphanistrum</i> L.	HBKU-652	H	Annual	Th	Mic	Kukrai
<i>Raphanus sativus</i> var. <i>sativus</i>	HBKU-738	H	Annual	Th	Mic	Sher Athraf
<i>Sisymbrium irio</i> L.	HBKU-554	H	Annual	Th	Mic	Marghazar
<i>Sisymbrium orientale</i> L.	HBKU-582	H	Annual	Th	Mic	Marghazar
Buddlejaceae						
<i>Buddleja crispa</i> Benth.	HBKU-587	S	Perennial	NP	Mes	Marghazar
Buxaceae						
<i>Sarcococca saligna</i> (D. Don) Muell.-Arg.	HBKU-814	S	Perennial	NP	Mes	Sher Athraf
Campanulaceae						
<i>Campanula pallida</i> Wall.	HBKU-602	H	Annual	Th	Mic	Kukrai, Marghazar

Cannabaceae						
<i>Cannabis sativa</i> L.	HBKU-806	H	Annual	Th	Nan	Kukrai, Sher Athraf, Marghazar
Caprifoliaceae						
<i>Lonicera japonica</i> Thunb.	HBKU-768	CS	Perennial	NP	Mes	Spal Bandai
Casuarinaceae						
<i>Casuarina equisetifolia</i> L.	HBKU-620	T	Perennial	MegP	Nan	White Palace Marghazar
Caryophyllaceae						
<i>Cerastium glomeratum</i> Thuill.	HBKU-560	H	Annual	Th	Mic	Marghazar
<i>Silene conoidea</i> L.	HBKU-613	H	Annual	Th	Mes	Marghazar
<i>Stellaria media</i> (L.) Vill.	HBKU-784	H	Annual	Th	Mes	Sher Athraf
Chenopodiaceae						
<i>Chenopodium ambrosioides</i> L.	HBKU-687	H	Annual	Th	Mic	Spal Bandai
<i>Chenopodium botrys</i> L.	HBKU-700	H	Annual	Th	Mic	Spal Bandai
<i>Chenopodium murale</i> L.	HBKU-785	H	Annual	Th	Mic	Sher Athraf
Convolvulaceae						
<i>Convolvulus arvensis</i> L.	HBKU-546	C	Annual	Th	Mic	Kukrai
<i>Ipomoea eriocarpa</i> R. Br.	HBKU-662	C	Annual	Th	Mic	Kukrai
<i>Ipomoea hederacea</i> Jacq.	HBKU-731	C	Annual	Th	Mes	Marghazar
<i>Ipomoea purpurea</i> (L.) Roth.	HBKU-678	C	Annual	Th	Mic	Spal Bandai
Crassulaceae						
<i>Sedum hispanicum</i> L.	HBKU-749	H	Annual	Th	Lep	Marghazar
Cucurbitaceae						
<i>Cucumis melo</i> subsp. <i>agrestis</i> (Naud.) Grebensch.	HBKU-646	C	Annual	Th	Mac	Kukrai
<i>Luffa cylindrica</i> (L.) Roem.	HBKU-539	C	Annual	Th	Mes	Islampur
Cuscutaceae						
<i>Cuscuta reflexa</i> Roxb.	HBKU-526	PH	Perennial	Th	Aph	Islampur
Ebenaceae						
<i>Diospyros kaki</i> L.	HBKU-750	T	Perennial	MegP	Mac	Islampur
<i>Diospyros lotus</i> L.	HBKU-616	T	Perennial	MegP	Mes	Marghazar
Elaeagnaceae						
<i>Elaeagnus angustifolia</i> L.	HBKU-617	S	Perennial	NP	Mes	Marghazar
Euphorbiaceae						
<i>Andrachne cordifolia</i> (Wall. Ex Decne.) Muell.	HBKU-714	S	Perennial	NP	Mes	Spal Bandai
<i>Euphorbia helioscopia</i> L.	HBKU-742	H	Annual	Th	Mic	Sher Athraf
<i>Euphorbia heterophylla</i> L.	HBKU-721	H	Annual	Th	Mic	Spal Bandai
<i>Euphorbia hirta</i> L.	HBKU-807	H	Annual	Th	Mic	Sher Athraf
<i>Euphorbia prostrata</i> Ait.	HBKU-743	H	Annual	Th	Mic	Sher Athraf
<i>Mallotus philippensis</i> (Lam.) Muell.	HBKU-786	S	Perennial	NP	Mes	Sher Athraf
<i>Ricinus communis</i> L.	HBKU-772	SH	Perennial	NP	Mac	Kukrai
Fagaceae						
<i>Quercus baloot</i> Griff.	HBKU-630	S	Perennial	NP	Mic	Marghazar
<i>Quercus dilatata</i> Royle.	HBKU-787	T	Perennial	MicP	Mic	Sher Athraf
<i>Quercus incana</i> Roxb.	HBKU-592	T	Perennial	MicP	Mes	Marghazar
Fumariaceae						
<i>Fumaria indica</i> (Hausskn.) Pugsley.	HBKU-755	H	Annual	Th	Lep	Kukrai
Geraniaceae						
<i>Geranium collinum</i> Steph. Ex Willd	HBKU-636	H	Annual	Th	Lep	Marghazar
<i>Geranium ocellatum</i> Camb.	HBKU-637	H	Annual	Th	Mic	Marghazar
<i>Geranium wallichianum</i> D. Don ex Sweet.	HBKU-604	H	Annual	Th	Mic	Marghazar
Guttiferae						
<i>Hypericum perforatum</i> L.	HBKU-789	H	Annual	Th	Lep	Sher Athraf
Hippocastanaceae						
<i>Aesculus indica</i> (Wall.ex Camb.) Hook.f.	HBKU-788	T	Perennial	MegP	Mes	Sher Athraf
Juglandaceae						
<i>Juglans regia</i> L.	HBKU-802	T	Perennial	MegP	Mes	Spal Bandai, Kukrai, Marghazar, Sher Athraf, Islampur
Lamiaceae						
<i>Ajuga bracteosa</i> Wall.ex Benth.	HBKU-578	H	Annual	Th	Mes	Marghazar
<i>Clinopodium umbrosum</i> (M. Bieb.) C. Koch.	HBKU-644	H	Annual	Th	Mic	Spal Bandai, Kukrai
<i>Isodon rugosus</i> (Wall. Ex Benth.).	HBKU-557	S	Perennial	Ch	Mes	Marghazar
<i>Lamium amplexicaule</i> L.	HBKU-804	H	Annual	Th	Mes	Islampur
<i>Mentha longifolia</i> (L.) Huds.	HBKU-594	H	Annual	G	Mic	Marghazar
<i>Micromeria biflora</i> (Buch.-Ham. Ex D. Don) Benth.	HBKU-570	H	Annual	Th	Mes	Marghazar
<i>Ocimum basilicum</i> L.	HBKU-809	H	Perennial	Ch	Mes	Sher Athraf
<i>Origanum vulgare</i> L.	HBKU-677	H	Perennial	HC	Mic	Kukrai, Marghazar

<i>Salvia lanata</i> Roxb.	HBKU-675	H	Perennial	HC	Mic	Kukrai
<i>Salvia mocroftiana</i> Wall. ex Benth.	HBKU-663	H	Annual	Th	Mes	Kukrai
<i>Thymus linearis</i> Benth.	HBKU-790	H	Annual	Th	Nan	Sher Athraf
Malvaceae						
<i>Abelmoschus esculentus</i> (L.) Moench.	HBKU-536	H	Annual	Th	Mes	Islampur
<i>Hibiscus syriacus</i> L.	HBKU-664	S	Perennial	NP	Mes	Kukrai
<i>Malvastrum coromandelianum</i> (L.) Garcke	HBKU-701	H	Annual	Th	Mes	Spal Bandai
<i>Malva neglecta</i> Wallr.	HBKU-760	H	Annual	Th	Mes	Kukrai
<i>Malva sylvestris</i> L.	HBKU-736	H	Annual	Th	Mes	Marghazar
Meliaceae						
<i>Melia azedarach</i> L.	HBKU-524	T	Perennial	MegP	Mic	Kukrai, Islampur
Moraceae						
<i>Broussonetia papyrifera</i> (L.) L'Herit. ex Vent.	HBKU-528	T	Perennial	MegP	Mes	Islampur
<i>Ficus carica</i> L.	HBKU-759	T	Perennial	MesP	Mac	Kukrai
<i>Ficus palmata</i> Forssk.	HBKU-550	T	Perennial	MegP	Mac	Kukrai
<i>Morus alba</i> L.	HBKU-535	T	Perennial	MegP	Mes	Islampur
<i>Morus nigra</i> L.	HBKU-530	T	Perennial	MegP	Mes	Islampur
Myrsinaceae						
<i>Myrsine africana</i> L.	HBKU-553	S	Perennial	NP	Lep	Marghazar
Myrtaceae						
<i>Callistemon lanceolatus</i> DC.	HBKU-544	T	Perennial	MesP	Lp	Spal Bandai
<i>Eucalyptus camaldulensis</i> Dehn.	HBKU-771	T	Perennial	MegP	Lep	Kukrai
<i>Psidium guajava</i> L.	HBKU-519	T	Perennial	MesP	Mes	Islampur
Nyctaginaceae						
<i>Boerhavia procumbens</i> Banks ex Roxb.	HBKU-716	H	Annual	Th	Nan	Spal Bandai
<i>Mirabilis jalapa</i> L.	HBKU-520	H	Annual	Th	Nan	Islampur
Oleaceae						
<i>Olea ferruginea</i> Wall. Ex Aitch.	HBKU-593	T	Perennial	MegP	Mic	Marghazar
Onagraceae						
<i>Oenothera rosea</i> L' Her. Ex Ait.	HBKU-588	H	Annual	Th	Mes	Marghazar
Oxalidaceae						
<i>Oxalis corniculata</i> L.	HBKU-548	H	Annual	Th	Nan	Islampur
<i>Oxalis corymbosa</i> DC.	HBKU-563	H	Annual	Th	Nan	Marghazar
Paeoniaceae						
<i>Paeonia emodi</i> Wall. ex Royle.	HBKU-792	H	Perennial	Th	Mic	Sher Athraf
Papaveraceae						
<i>Papaver dubium</i> L.	HBKU-756	H	Annual	Th	Mic	Kukrai
<i>Papaver pavoninum</i> Schrenk.	HBKU-574	H	Annual	Th	Mic	Marghazar
Papilionaceae						
<i>Acacia nilotica</i> (L.) Delile.	HBKU-752	T	Perennial	MicP	Mic	Marghazar
<i>Desmodium elegans</i> DC.	HBKU-648	S	Perennial	MicP	Mic	Kukrai
<i>Indigofera heterantha</i> var. <i>gerardiana</i> (Wall. ex Baker) Ali	HBKU-622	S	Perennial	NP	Mes	Marghazar
<i>Indigofera heterantha</i> var. <i>heterantha</i>	HBKU-615	S	Perennial	NP	Mes	Marghazar
<i>Lathyrus aphaca</i> L.	HBKU-823	H	Annual	Th	Nan	Marghazar
<i>Medicago lupulina</i> L.	HBKU-590	H	Annual	Th	Lep	Marghazar
<i>Medicago polymorpha</i> L.	HBKU-611	H	Annual	Th	Lep	Marghazar
<i>Robinia pseudo-acacia</i> L.	HBKU-562	T	Perennial	MesP	Mes	Marghazar
<i>Trifolium repens</i> L.	HBKU-573	H	Annual	Th	Lep	Marghazar
<i>Vicia sativa</i> L.	HBKU-632	H	Annual	Th	Mic	Marghazar, Sher Athraf
Platanaceae						
<i>Platanus orientalis</i> L.	HBKU-757	T	Perennial	MegP	Mac	Kukrai
Polygalaceae						
<i>Polygala abyssinica</i> R.Br. ex Fresen	HBKU-708	H	Annual	Th	Mic	Spal Bandai
Polygonaceae						
<i>Bistorta amplexicaulis</i> (D. Don) Green.	HBKU-795	H	Perennial	HC	Mes	Sher Athraf
<i>Persicaria hydropiper</i> (L.) Spach.	HBKU-647	H	Perennial	HC	Mes	Spal Bandai, Kukrai
<i>Rumex dentatus</i> L.	HBKU-688	H	Annual	Th	Mic	Spal Bandai
<i>Rumex hastatus</i> D. Don.	HBKU-642	H	Annual	Th	Mic	Kukrai
Primulaceae						
<i>Androsace rotundifolia</i> Hardw.	HBKU-803	H	Annual	Th	Mes	Marghazar
<i>Primula denticulata</i> Smith.	HBKU-796	H	Annual	Th	Mic	Sher Athraf
Punicaceae						
<i>Punica granatum</i> L.	HBKU-529	T	Perennial	MesP	Mes	Islampur

Ranunculaceae						
<i>Clematis grata</i> Wall.	HBKU-618	C	Perennial	NP	Mes	Kukrai, Marghazar
<i>Clematis graveolens</i> Lindl.	HBKU-631	C	Perennial	NP	Mes	Marghazar
<i>Ranunculus laetus</i> Wall .ex Hook .f. & J.W. Thomson.	HBKU-586	H	Perennial	NP	Mic	Spal Bandai, Marghazar
Rhamnaceae						
<i>Sageretia thea</i> (Osbeck) M.C.	HBKU-621	S	Perennial	NP	Mic	Marghazar
<i>Ziziphus jujuba</i> Mill.	HBKU-690	T	Perennial	MesP	Mic	Spal Bandai
<i>Ziziphus nummularia</i> (Burm. f.) Wight & Arn.	HBKU-798	S	Perennial	MicP	Mes	Sher Athraf
<i>Ziziphus oxyphylla</i> Edgew.	HBKU-824	S	Perennial	NP	Mic	Sher Athraf
Rosaceae						
<i>Duchesnea indica</i> (Andrews).	HBKU-608	H	Annual	Th	Mic	Marghazar
<i>Eriobotrya japonica</i> (Thunb.) Lindl.	HBKU-522	T	Perennial	MesP	Mic	Islampur
<i>Fragaria nubicola</i> (Hook.f.) Lindl.	HBKU-623	H	Annual	Th	Mic	Marghazar
<i>Malus pumila</i> Mill.	HBKU-764	T	Perennial	MicP	Mic	Kukrai
<i>Potentilla supina</i> L.	HBKU-730	H	Annual	Th	Mic	Marghazar
<i>Prunus armeniaca</i> L.	HBKU-732	T	Perennial	MesP	Mic	Marghazar
<i>Prunus domestica</i> L.	HBKU-751	T	Perennial	MicP	Mic	Marghazar
<i>Pyrus communis</i> L.	HBKU-656	T	Perennial	MesP	Mic	Kukrai
<i>Pyrus pashia</i> Buch.-Ham. ex D. Don.	HBKU-641	T	Perennial	MesP	Mes	Kukrai
<i>Pyrus pseudopashia</i> T. T. Yu	HBKU-657	T	Perennial	MesP	Mes	Kukrai
<i>Rosa alba</i> L.	HBKU-543	S	Perennial	NP	Mic	Islampur
<i>Rosa banksiae</i> W. T. Aiton.	HBKU-734	S	Perennial	NP	Mic	Marghazar
<i>Rosa brunonii</i> Lindl.	HBKU-591	S	Perennial	NP	Mes	Marghazar
<i>Rosa chinensis</i> Jacq.	HBKU-542	S	Perennial	NP	Mic	Islampur
<i>Rubus ellipticus</i> Smith.	HBKU-667	S	Perennial	NP	Mic	Kukrai
<i>Rubus fruticosus</i> L.	HBKU-668	S	Perennial	NP	Mic	Kukrai
<i>Rubus irritans</i> Focke.	HBKU-595	S	Perennial	NP	Mes	Marghazar
<i>Rubus macilentus</i> Camb.	HBKU-654	S	Perennial	NP	Mes	Kukrai
<i>Rubus niveus</i> Thunb.	HBKU-682	S	Perennial	NP	Mic	Spal Bandai
<i>Rubus ulmifolius</i> Schott.	HBKU-669	S	Perennial	NP	Mes	Spal Bandai, Kukrai
<i>Sibbaldia procumbens</i> L.	HBKU-596	H	Annual	Th	Mes	Marghazar
<i>Spiraea corymbosa</i> Rafinesque.	HBKU-737	S	Perennial	NP	Mes	Marghazar
Rubiaceae						
<i>Galium aparine</i> L.	HBKU-601	H	Annual	Th	Lep	Marghazar
<i>Rubia cordifolia</i> L.	HBKU-564	H	Annual	Th	Lep	Marghazar
Rutaceae						
<i>Citrus limon</i> (L.) Burm. f.	HBKU-537	S	Perennial	NP	Mes	Islampur
<i>Citrus medica</i> L.	HBKU-538	T	Perennial	MicP	Mes	Islampur
<i>Citrus sinensis</i> (L.) Osbeck.	HBKU-540	T	Perennial	MesP	Mes	Islampur
<i>Zanthoxylum armatum</i> DC.	HBKU-629	S	Perennial	NP	Mes	Marghazar
Salicaceae						
<i>Populus alba</i> L.	HBKU-517	T	Perennial	MegP	Mes	Islampur
<i>Populus nigra</i> L.	HBKU-518	T	Perennial	MegP	Mes	Islampur
<i>Salix acmophylla</i> Boiss.	HBKU- 610	T	Perennial	MegP	Mes	Marghazar
Sambucaceae						
<i>Sambucus nigra</i> L.	HBKU-603	T	Perennial	MegP	Mes	Marghazar
<i>Sambucus wightiana</i> Wall. Ex Wight & Arn.	HBKU-723	SH	Perennial	NP	Mes	Marghazar
Sapindaceae						
<i>Dodonaea viscosa</i> (L.) Jacq.	HBKU-753	S	Perennial	NP	Mes	Kukrai
Saxifragaceae						
<i>Bergenia ciliata</i> (Haw.) Sternb.	HBKU-799	H	Annual	Th	Mac	Sher Athraf
Scrophulariaceae						
<i>Mazus japonicus</i> (Thunb.) O. Kuntze.	HBKU-722	H	Annual	Th	Mic	Sher Athraf
<i>Verbascum thapsus</i> L.	HBKU-565	H	Annual	Th	Mic	Marghazar
<i>Veronica anagallis-aquatica</i> L.	HBKU-705	H	Annual	Th	Mes	Marghazar
<i>Veronica polita</i> Fr.	HBKU-614	H	Annual	Th	Mic	Marghazar
Simaroubaceae						
<i>Ailanthus altissimus</i> (Mill.) Swingle.	HBKU-532	T	Perennial	MegP	Mic	Spal Bandai, Islampur
Solanaceae						
<i>Capsicum annuum</i> L.	HBKU-551	H	Annual	Th	Mic	Kukrai
<i>Hyoscyamus niger</i> L.	HBKU-800	H	Annual	Th	Mic	Sher Athraf
<i>Lycopersicon esculentum</i> Mill.	HBKU-820	H	Annual	Th	Mic	Sher Athraf
<i>Solanum nigrum</i> L.	HBKU-559	H	Annual	Th	Mes	Marghazar
<i>Solanum surattense</i> Burm. F.	HBKU-516	H	Annual	Th	Mes	Islampur, Kukrai
<i>Solanum tuberosum</i> L.	HBKU-821	H	Annual	Th	Mes	Sher Athraf
<i>Withania somnifera</i> (L.) Dunal.	HBKU-801	S	Perennial	NP	Mes	Sher Athraf

Thymelaeaceae						
<i>Daphne mucronata</i> Royle.	HBKU-556	S	Perennial	NP	Mes	Sher Athraf, Marghazar
<i>Wikstroemia canescens</i> Meisn.	HBKU-660	S	Perennial	NP	Mes	Kukrai
Ulmaceae						
<i>Celtis caucasica</i> Willd.	HBKU-607	T	Perennial	MesP	Mes	Spal Bandai, Marghazar
<i>Celtis eriocarpa</i> Decne.	HBKU-619	T	Perennial	MesP	Mic	Marghazar
<i>Celtis tetrandra</i> Roxb.	HBKU-712	T	Perennial	MicP	Mes	Spal Bandai
Umbelliferae						
<i>Bunium persicum</i> (Boiss.) Fedtsch.	HBKU-777	H	Annual	Th	Mic	Sher Athraf
<i>Foeniculum vulgare</i> Mill.	HBKU-558	H	Annual	Th	Mic	Kukrai, Marghazar
<i>Pimpinella stewartii</i> (Dunn) E. Nasir.	HBKU-679	H	Annual	Th	Lep	Spal Bandai
<i>Torilis leptophylla</i> (L.) Reichb. f.	HBKU-606	H	Annual	Th	Mic	Marghazar
Urticaceae						
<i>Debregeasia salicifolia</i> (D.Don).	HBKU-572	S	Perennial	NP	Mic	Marghazar
<i>Pilea umbrosa</i> Blume.	HBKU-676	H	Annual	Th	Mes	Spal Bandai
<i>Urtica dioica</i> L.	HBKU-580	H	Annual	Th	Mic	Marghazar
<i>Urtica pilulifera</i> L.	HBKU-566	H	Annual	Th	Mes	Marghazar
Verbenaceae						
<i>Verbena officinalis</i> L.	HBKU-680	H	Annual	Th	Mic	Spal Bandai
<i>Vitex negundo</i> L.	HBKU-693	S	Perennial	NP	Mes	Spal Bandai
Violaceae						
<i>Viola canescens</i> Wall. ex Roxb.	HBKU-817	H	Annual	Th	Mic	Sher Athraf
<i>Viola pilosa</i> Blume.	HBKU-816	H	Annual	Th	Mic	Sher Athraf
Vitaceae						
<i>Vitis jacquemontii</i> Parker.	HBKU-805	WC	Perennial	NP	Mac	Sher Athraf
<i>Vitis vinifera</i> L.	HBKU-531	S	Perennial	NP	Mac	Islampur
Zygophyllaceae						
<i>Tribulus terrestris</i> L.	HBKU-549	H	Annual	Th	Mic	Kukrai

Note: Habit: C: Climbers; CS: Climbing shrub; G: Grasses; H: herbs; HTT: Hollow tufted tree; PH: Parasitic herb; SH: Shrubby herbs; S: Shrubs; SS: Subshrub; TH: Tree-like herbs; T: Trees; WC: Woody climber. Life form classes: Ch: Chaemophytes; G: Geophytes; HC: Hemicryptophytes; Hyd: Hydrophytes; MegP: Megaphanerophytes; MesP: Mesophanerophytes; MicP: Microphanerophytes; NP: Nanophanerophytes; Th: Therophytes. Leaf size classes: Aphy: Aphyllus; Lep: Leptophylls; Mac: Macrophylls; MegP: Megaphylls; Mes: Mesophylls; Mic: Microphylls; Nan: Nanophylls

Table 2. Taxonomic classification of plants of Marghazar Valley, Swat, Pakistan

Taxonomic classification	Species	Genera	Families	Percentage
Pteridophytes	14	9	7	4.56%
Gymnosperms	5	4	2	1.62%
Monocots	57	50	13	18.56%
Dicots	231	173	72	75.24%
Total	307	236	94	99.99%

Important and dominant taxonomic groups with the highest number of genera and species are Dicots (75.24%) followed by Monocots (18.56%), Pteridophytes (4.56%) and Gymnosperms (1.62%) as shown in Table 2. *Cousinia bupthalmoides* was recorded as new to Swat and Pakistan because no such information is available to our native flora, other floras and published literature.

Herbaceous plants were the highest growth form with 161 species, followed by trees with 46 species, shrubs (45 species), grasses (37), climbers (10 species), shrubby herbs (2 species), subshrubs (1 species), tree-like herb (1 species), hollow tufted tree (1 species), climbing shrub (1 species), parasitic herb (1 species) and 1 species of a woody climber in decreasing order (Table 3. The

phenology of vegetation revealed that 174 taxa (56.35%) were perennial, followed by 134 annuals (43.50%), as shown in Table 4.

Floristic attributes and ecological studies

Bio-spectrum class represented by life form and leaf size classes as 126 species are therophytes (40.90%) as the leading class in life form followed by hemicryptophytes with 58 species (18.83%), nanophanerophytes with 47 species (15.25%), 26 species observed as megaphanerophytes (8.44%), geophytes 23 species (7.46%), mesophanerophytes 15 species (4.88%), microphanerophytes 9 species (2.92%), chaemophytes 2 species (0.64%) and 1 specie recorded as hydrophytes and share 0.32% adaptation (Table 5A). The life form is the indicator of micro and macroclimate and it is described by plant adaptation to certain environmental situations. Leaf size class (Table 5B). observed that microphylls dominated by a total of 122 species (39.61%), followed by mesophylls 94 species (30.61%), leptophylls 50 species (16.23%), nanophylls 22 species (7.41%), macrophylls 16 species (5.19%), megaphyll 1 species (0.32%) and remaining 2 species (*Cuscuta reflexa* and *Equisetum arvense*) are aphyllus species which possesses no leaves. The leaf size information helps in appreciative physical processes of flora.

Table 3. Composition of habit/growth form of the flora of Marghazar Valley, Swat, Pakistan

Habit classes	No. of species	Percentage
Herbs	161	52.27%
Trees	46	14.98%
Shrubs	45	14.61%
Grasses	37	12.01%
Climbers	10	3.24%
Shrubby herb	2	0.649%
Subshrub	1	0.324%
Tree like herb	1	0.324%
Hollow tufted tree	1	0.324%
Climbing shrub	1	0.324%
Parasitic herb	1	0.324%
Woody climber	1	0.324%
Total	307	99.99%

Table 4. Composition of type of life cycle of plants of Marghazar Valley, Swat, Pakistan

Life cycle	No. of species	Percentage
Annual	134	43.50%
Perennial	173	56.35%
Total	307	99.99%

Table 5. A biological spectrum of the flora of Marghazar Valley, Swat, Pakistan

Biological spectra	Number of species	Percentage
Life form class		
Therophytes	126	40.90%
Hemicryptophytes	58	18.83%
Nanophanerophytes	47	15.25%
Megaphanerophytes	26	8.44%
Geophytes	23	7.46%
Mesophanerophytes	15	4.88%
Microphanerophytes	9	2.92%
Chaemophytes	2	0.64%
Hydrophytes	1	0.32%
Total	307	99.99%
Leaf size class		
Microphylls	122	39.61%
Mesophylls	94	30.61%
Leptophylls	50	16.23%
Nanophylls	22	7.41%
Macrophylls	16	5.19%
Aphyllus	2	0.64%
Megaphylls	1	0.32%
Total	307	99.99%

Discussions

Our study results agree with that of (Cope 1982) reported a total of 492 grasses with 26 tribes and 158 genera to Pakistan, while (Phillips and Shouliang 2005) described 1795 grass species with 226 genera reported to China. Nobis et al. (2014) described 20 taxa from 10 countries (8 Asian and 2 European). Badshah et al. (2013) documented vegetation of Tank, KP, which recorded 205

taxa and 56 families. Among them, Poaceae with 34 taxa was the topmost dominating, followed by Papilionaceae with a total of 19 taxa. *Capparis decidua* and *Periploca aphylla* were recorded aphyllous taxa. Wariss et al. (2014) reported dicots (41 families), monocots (5 families), Pteridophytes (3 families). Ilyas et al. (2015) recognized a vegetation study of Kabal valley, Swat, Pakistan and documented 136 families including 31 ferns and their allies, 8 taxa of Gymnosperm, while the remaining 781 taxa were Angiospermic and share 597 taxa Dicotyledons and 184 Monocotyledons. Important and new species were *Vernoca hederifolia* and *Geranium swatense* was reported for first time in Pakistan. Razzaq et al. 2018 explored 476 taxa of vascular plants from Malam Jabba Valley, Swat, Pakistan during 2013-17. A total of 112 flowering families were recorded with 334 genera, including Pteridophytes (26 species, 14 genera and 10 families), Gymnosperms with (11 taxa, 9 genera and 4 families), Angiosperm with 353 Dicots and 86 Monocots species. Athyraceae (Pteridophytes), Pinaceae (Gymnosperm) and Poaceae (Monocots), Asteraceae (Dicots) were the most important families within-species diversity and abundance. Herbs were also the highest in their study, followed by shrubs and trees and climbers.

Floristic study of any given area helps to evaluate the plant wealth and its potential values (Shaheen et al. 2016). The main source of botanical materials of a specific region is its floristic checklists (Safidkon et al. 2003). The life form is the indicator of micro and macroclimate and it is described by plant adaptation to certain environmental situations (Shimwell 1971). However, floristic studies from Pakistan and Swat region have been reported by many workers, but no such information of floristic study in Marghazar is available, therefore this study will fulfill the current gap. Our present studies also agree with that of Khan et al. (2017) collected and identified a total of 90 known families and two hundred two genera from Ranizai Valley, Swat and highlighted family Poaceae as a dominant, while Khan et al. (2019) also agree with our results and reported 34 weedy species with Poaceae as a dominant family from Charbagh Valley, Swat. However, some attempts were also made by workers from other regions of KP. Khan et al. (2019) reported 51 grasses with 34 genera from district Charsadda, Pakistan, while Ibrahim et al. (2019) found Asteraceae and Poaceae as the dominant families in their study. Khan et al. (2019) also showed that Poaceae was the leading family in terms of a number of genera and species with 36 genera (19.04%) and 56 species (22.13%) followed by Asteraceae with 15 genera (7.936%) and 17 species (6.719%) from district Charsadda, Pakistan. Rahman et al. (2019) explored the comprehensive floristic checklist of Mahnoor Valley during 2015-2018 and classified a total of three hundred and fifty-four taxa with ninety-three families in which herbaceous cover was dominant followed by a shrubby layer with an important family of Asteraceae. Further they also identified therophytic (life form) and nanophylls (leaf size) as dominant. Our results also agree with Shaheen et al. (2019) reported one hundred thirty-two species from Deosai Plateau in North Pakistan.

To conclude, the study regarding plant resources of Marghazar Valley, Hindukush Range, Swat, Pakistan, revealed that the flora of Marghazar Valley comprised of 307 taxa belonging to 236 genera and 94 families. Based on the number of species, Asteraceae, Rosaceae, Brassicaceae, Lamiaceae, Papilionaceae were the most prevalent families. Phytoclimatic spectra of the area are Therophytic and Microphyllous type and the climatic conditions of the valley are influenced by grazing, snow sliding, excessive rain, unpleasant weather, land use, agriculture expansion, natural disaster and other anthropogenic activities which support short-lived species. This study offers baseline information on the flora, and further research is recommended for exploring quantitative vegetation attributes.

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