BIOLOGICAL SPECTRUM, LEAF SIZE SPECTRA AND PHENOLOGY OF FLORA OF BAJAUR DISTRICT, KHYBER PAKHTUNKHWA

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Abstract- The present study explored plant biodiversity, life form, leaf size spectra, and phenology of the Bajaur Agency, KP, Pakistan flora during 2020-2021. A total of 122 plants were collected belonging to 48 families. There were two flowering seasons: 107 plant species (87.70 %) flowers from March to August and 15 plant species (12.29 %) from August to onwards. The dominant families were Asteraceae with 16 spp. (13.3 %), followed by Lamiaceae with 10 spp. (8.1 %), Fabaceae 8 spp. (6.55 %). Brassicaceae, Euphorbiaceae, and Plantaginaceae 6 spp. (4.91 %) each. Solanaceae 5 spp. (4.09 %), Amaranthaceae, Moraceae, and Poaceae with 04 spp. (3.27 %) each. Polygonaceae with 03 spp. (2.46 %) each. The remaining 38 families have either 2 spp. or less than that. Life form was dominated by therophytes with 65 spp. (53.27 %), followed by megaphanerophytes 13 spp. (10.65 %), mesophenerophytes 05 spp. (4.09 %), hemicryptophytes, chamaephytes and nanophanerophytes 10 spp. each (8.19 %). Phanerophytes, geophytes and cryptophytes 03 spp. (2.14%) each. Leaf spectra of the region were dominated by microphylls with 53 spp. (43.44 %) followed by nanophylls with 31 spp. (25.40 %). leptophylls 20 spp. (16.39 %), mesophylls 15 spp. (12.29 %) and macrophylls 03 (2.45 %). The main aim of this study was to document the biological spectrum, leaf size spectra, and phonological behavior of species in the study area which will be helpful for further researchers such as conservationists, ecologists, and foresters, etc.

Index terms- Plant biodiversity, biological spectra, leaf size spectra, phenology, Bajaur district Pakistan

INTRODUCTION

Examining the floral makeup and related ecological factors is crucial for preserving biodiversity. This establishes an optimal habitat for wildlife and plays a pivotal role in sustainably managing distinctive, region-specific natural resources (Haq et al., 2021). Phenology, the investigation into the timing of recurring biological events in the plant kingdom, explores the interconnectedness among stages within the same or different species and the factors influencing their timing, encompassing both biotic and abiotic forces. Understanding the phenology of individual species is instrumental in shaping the organization and functioning of biomes (Zeb et al., 2020).

Bajaur, a district located at 34.7313° N latitude and 71.5130° E longitude, nearly half of Bajaur's total hilly terrain, covering 1290 km², constitutes a mere 0.015% of Pakistan's overall landmass (Haq and Badshah, 2021). Bajaur's landscape is characterized by a combination of hills and valleys (Abdullah et al., 2021). The plant life on these hills displays considerable diversity influenced by climate shifts and contingent upon precipitation and other geographical elements. It encompasses a wide array of species, particularly resilient grasses that can withstand grazing. Additionally, various flowering herbs, shrubs, wild roses, and thorny vegetation contribute to the dense plant cover. The non-thorny plants seem to thrive in the company of their thorny counterparts. Exploring the valleys of these hills reveals expanses of fragrant hay meadows, featuring sweet vernal grass (Ullah et al., 2019).

The floristic makeup of Tehsil Utmankhel Bajaur comprises a comprehensive total of 238 plant species categorized into 208 genera and 89 families (Ali et al., 2022). The floral arrangement in Pashat Valley, in district Bajaur, encompasses a collective count of 385 plant species distributed among 291 genera, with documentation across 102 families (Haq and Badshah, 2021). In Tehsil Utman Khel, located in the Bajaur district of Khyber Pakhtunkhwa, Pakistan, an inventory was compiled documenting 76 plant species from 47 families. These species, encompassing herbs, shrubs, mushrooms, trees, and vegetables, were systematically recorded for their medicinal applications (Shah et al., 2020). The botanical inventory of Swat Ranizai, district Malakand, encompasses a total of 264 plant species, distributed among 90 families and 202 genera (Khan et al., 2017). The Himalayan region within Azad Jammu and Kashmir has cataloged a collective of 127 plant and fungal species, categorized into 113 genera across 64 families (Haq et al., 2022). The floral makeup of Rabat Dara, district Lower Dir, is characterized by a diverse array of species distributed across various families. In the floristic assessment of Rabat, a total of 282 taxa were identified, representing 22 genera amid 95 families (Zamir et al., 2023).

This study was aimed to examine the plant life in Tehsil Salarzai, District Bajaur, with a specific emphasis on recording the types of species, leaf sizes, and the timing of plant life cycles (phenology). This study represents the first exploration of its kind in the area.

MATERIALS AND METHODS

Study area

The research was carried out at Tehsil Salarzai, District Bajaur. Research areas included Bar amadak and Lar amadak of Tehsil Salarazai, Bajaur having a mark difference in their altitudes. Lar amadak includes Pashat area and Bar Amadak includes Batwar, Gulo derai, Barji, Lakyano, Tandatok, Ambar Khana, Kadoka, Bar Dandokai, and Lar Dandokai. It is located at 1128 m asl with E 71°290′ latitude and N 34°510 longitude (Fig. 1). Fieldwork was carried out during the summer of 2020 and spring of 2021. During the winter, the season spans from November to March, occasionally bringing temperatures below 0 °C. Spring unfolds from mid-March to the end of April. The summer season, extending from May to October witnesses average temperatures ranging from 23 to 40 °C. The annual average rainfall stands at 800 mm (Abdullah et al., 2021).

Collection and preservation of plants

The plants were collected from the study area and were taken to the Department of Botany, University of Peshawar. All the plants were identified with the help of Flora of Pakistan (Nasir and Ali, 1970-1989; Ali and Nasir, 1989-1991; Ali and Qaiser, 1993-2022) and deposited in the herbarium of the Botany Department, University of Peshawar for future reference. Taxonomic and nomenclatural update was completed using the web site (World Flora Online (WFO) (2023-onwards)

Biological spectrum

Life form spectrum

Being an important ecological characteristic life form of a species adopted according to the prevailing climatic conditions of the area. The plants were assigned into different life form classes based on perennating buds during unfavorable conditions following the methodology of Raunkiaer (1934) and Hussain (1989). The recorded life forms were as follows: **Therophytes (Th)** are annual plants that complete their life cycle within one growing season. **Geophytes (G),** are the flora that have more or less tuberous subterranean organs filled with food and can make a quick growth when favorable conditions return. Perennating buds of geophytes were bulbs, corms, rhizomes, and tubers. **Hemicryptophytes (H)** were perennial plants with perennating buds and shoots near the soil surface, covered with litter. **Chameophytes (Ch),** were perennial plants in which the perennating buds lay up to 25 cm on an upright stem from the ground. **Phanerophytes (Ph),** Shrubs, and trees bearing perennating buds at least 25 cm from above the soil surface were recognized. These were further classified into the following classes: a) **Nanophanerophytes (Np)** were the plants whose perennating buds were located on aerial shoots about 0.25 to 2 m over the surface of the ground. **Microphanerophytes (MicP)** were shrubby plants with perennating buds located 1.8 to 7.6 m above the ground. **Mesophanerophytes (MesP),** plants in this group were small trees whose perennating buds were situated at 7.5 to 30 m above the surface of the ground. **Megaphanerophytes (MegP),** all trees having perennating buds located at a height of 30 m above the ground surface.

Life form spectrum was calculated by following the formula:

$$\text{Life form spectrum} = \frac{\text{No of species falling in a particular life form class}}{\text{Total number of all species for that ommuity}} \text{ X } 100$$

Leaf size spectra

Plants were classified into various Raunkiaerian (Raunkiaer 1934) and quantitative leaf sizes as follows: **Leptophyllous (L),** Leaf area up to 25 mm^2 **Nanophyllous (N),** Leaf area from 25 to 225 mm^2 **Microphyllous (Mic),** Leaf area from 225 to 2025 mm^2 **4) Mesophyllous (Mes),** Leaf area from 2025 to 18225 mm^2 **Macrophyllous (Mac),** Leaf area from 18225 to 164025 mm^2

RESULTS AND DISCUSSION

Floristic Composition

Floristic means the phytogeographical study of plants and plant groups' composition refers to the contribution of each plant species to the vegetation. Floristic diversity refers to the variety, and variability of plants in a given region. It refers to the number of taxa in a given region. As recorded in the current study, the flora of Bajaur district consisted of 122 taxa of 50 families. Asteraceae was the dominant family having 16 species (13.11 %) followed by Lamiaceae with 10 taxa (8.19 %), Lamiaceae followed by Fabaceae with 8 taxa (6.55 %). Similarly, Brassicaceae, Euphorbiaceae and Plantaginaceae with 6 taxa (4.91 %) each. Solanaceae with 5 taxa (4.09 %). Amaranthaceae, Moraceae, and Poaceae with 4 species (3.27 %) each, while Polygonaceae with 3 species (2.45

%). 10 families of Acanthaceae, Boraginaceae, Charyophyllaceae, Cannabeaceae, Geraniaceae, Oleaceae, Rununculaceae, Scrophalariaceae, Salicaceae, and Thymelaceae had 02 species (1.63 %) each. Family Apiaceae, Asclepiadaceae, Berberidaceae, Convolvulaceae, Crassulaceae, Dryopteridaceae, Equisetaceae, Hypericaceae, Juglandaceae, Linaceae, Meliaceae, Onagraceae, Plumbaginaceae, Platanaceae, Pinaceae, Primulaceae, Rubiaceae, Rutacaee, Rhamnaceae, Salicaceae, Sapindaceae, Simaroubaceae, Tamaricaceae, Urticaceae, Verbenaceae, Violaceae and Zygophyllaceae comprised on only 1 species (0.8 %) each (Table 1; Fig. 2).

In the current investigation, 13 plant species (*Circhorium endivia*, *Brassica rapa*, *Juglans regia*, *Mentha arvensis*, *Ficus carica*, *Morus alba*, *Plantago major*, *Medicago minima*, *Rubus persicus*, *Ziziphus jujuba*, *Physalis minima*, *Solanum nigrum*, and *Verbascum thapsus*), accounting for 10.6 % of the total, belong to 13 genera (10.6 %) and 11 families (22.91 %), are utilized as food or vegetables by the local population. Notably, certain wild vegetables such as *Chenopodium album*, *Rumex stenophyllus*, *Brassica rapa* (referred to as "gedai" by locals), *Malva parviflora* were used commercially in local markets. Additionally, cultivated vegetables like *Mentha arvensis* is traditionally important and has different uses by locals. It's worth mentioning that the remaining taxa are not cultivated within the study areas, and residents transport these vegetables to local markets as a source of income.

From the findings of the present research, it is observed that *Juglans regia*, locally referred to as 'Ghoz,' is identified as a threatened species. The significance of this species lies in its versatile applications, where the wood is extensively utilized in furniture production and as a fuel source, while the bark finds use in crafting traditional toothbrushes and in the formulation of traditional cosmetics and *Olea europaea subsp. cupsidata* locally referred to as 'Zaitoon,' primarily attributed to its widespread use as fuelwood and its slow regeneration capacity.

Many previous researchers including; Ullah et al. (2019) reported the floristic compositions of Bajaur KP, Pakistan, and showed that Asteraceae was the leading family followed by Lamiaceae. Shah et al. (2020) reported the floral composition of Tehsil Utman Khel, District Bajaur KP, Pakistan, and mentioned that Asteraceae was the dominant family; Ali et al. (2016) reported floristic composition and ecological characteristics of plants of Chail Valley, District Swat, Pakistan and stated that Asteraceae was the dominant family with 42 (9.07 %) species; Khan et al. (2013) explored the flora Sheikh Maltoon, District Mardan, Pakistan and stated that Asteraceae was the dominant family; Khan et al. (2014) studied the floristic composition of Mardan, Pakistan and showed that Asteraceae was the dominant family; Nasir and Sultan (2002) reported the floristic biological and leaf size spectra of weeds in District Chakwal, Pakistan and found that the leading family was Asteraceae and Poaceae, all these reported findings of researchers are similar and agreed with the present findings.

Life Form

The life form and leaf size spectra are important physiognomic attributes that have been widely used in vegetation studies. The life form spectra are said to be the indicators of micro and macroclimate (Shimwell, 1971). According to Raunkiaer (1934), the climate of a region is characterized by life forms, while the biological spectrum of the region exceeds the percentage of the same life form (Ullah et al., 2019).

Life form of the region is dominated by therophytes with 65 taxa (53.27 %) followed by megaphenerophytes with 10 taxa (10.65 %), mesophenerophytes with 5 taxa (4.09 %), hemecryptophytes, chamaephytes and nanophenerophytes with 10 taxa each (8.19 %). phenerophytes, geophytes, and cryptophytes have 3 taxa each (2.14 %) (Table 2; Fig. 3).

The dominance of therophytes (65 spp., 53.27 %) in the study area indicated that the investigated area was under heavy biotic pressure due to deforestation and overgrazing. Therophytes survive under adverse conditions through seed production. The predominance of therophytes in variable conditions such as dry, hot, or cold met for low to higher elevation might be the reason for their higher percentage in the present study (Ullah et al., 2019). The regeneration process of weeds and woody plants has been prevented in the absence of proper management. Most of the important weeds are uprooted by the local people as used for forage (Zeb et al., 2020). According to life form classification Ullah et al. (2020) reported the biological spectrum of the flora of Lajbouk, Dir Lower, and described that therophytes were dominant with 42 species supporting the present study.

Many workers explored different floras including; Zeb et al. (2020) reported the species diversity in Biha Valley, Swat, and revealed that the dominant life form is therophytes. Ibrahim et al. (2019) explored the flora of Takht Bhai, District Mardan, and reported that therophytes were the leading class. Khan et al. (2017) reported the flora of Sathan Gali, Mansehra, Pakistan, and stated that therophytes were the leading life forms. Asim et al. (2016) reported the vegetation of Kokarai Valley, District Swat, Pakistan described that therophytes were the dominant life form, all these results supported and strengthened the current study.

Leaf Size Spectra

Leaf size classes are very useful for plant associations. According to Oosting (1956), leaf size knowledge may help in the understanding of the physiological processes of plants and plant communities. In the present study of leaf spectra, the region is dominated by microphylls with 53 species (43.44 %) followed by nanophylls with 31 species (25.40 %), leptophylls with 20 species (16.39 %), mesophylls with 15 species (12.29 %), and macrophylls 03 (2.45 %) (Table 3; Fig. 4).

Ibrahim et al. (2018) studied the flora of Takht Bhai and listed that microphylls were the dominant leaf size class followed by nanophylls which strongly agrees with the present study. Khan *et al*. (2017) worked on the floristic diversity of vegetation in Swat Ranizai and reported that the microphylls class was the dominant leaf size class which also strengthens the current findings. Khan et al. (2017) studied the biological spectra of Sathan Gali Mansehra and mentioned that microphylls were the dominant leaf size class which further strengthens the present study. Khan *et al*. (2018) studied the biological features of Thandiani Forest Abbottabad and found that the dominant leaf size class of the area was microphylls with 88 (34.92 %) species and nanophylls with 60 (23.8 %) spp. which agrees with the present findings. Nasir et al. (2016) recorded the flora Muzaffarabad and reported that leaf size was dominated by microphylls supporting the present findings.

Phenology

Every living organism encounter defined physical thresholds beyond which its performance declines or it faces the risk of perishing. Additionally, organisms grapple with the challenge of allocating limited resources among various structures and functions, presenting inherent trade-offs. The evolutionary pathways adopted for tasks like establishment, survival, growth, and reproduction are intricately molded by these fundamental constraints and trade-offs (Albert et al., 2019). Phenology involves the examination of cyclic patterns in the growth and development of plants and the behavioral patterns of animals throughout the year (Piao et al., 2019).

Contemporary phenology explores the progression of recurrent biological occurrences in plants, investigating the underlying reasons for their temporal evolution, the interconnectedness among these phases, and the influences of both biotic and abiotic factors. Examples of phenological events encompass budding, flowering, fruit ripening, color changes, and autumnal leaf fall. Beyond its application in plant cultivation, phenology as a scientific discipline extends its relevance to diverse domains such as climatology, population health, tourism, and nature conservation (Cosmulescu, 2023). Within temperate regions, the initiation of budbursts in woody plants is primarily dictated by temperature. The current body of experimental evidence highlights the multifaceted impact of temperature on spring phenology across distinct developmental stages. Notably, temperature cues can be categorized into two phases: winter chilling and spring forcing (Wang et al., 2020).

The results of phenological studies on plants may contribute to the expansion of knowledge regarding their phenological responses as bio-indicators of changing environmental conditions. The flowering period of the study area was reviewed from the literature which ranged from March to August for 107 plant species (87.70 %) while from August to onward only 15 plant species (12.29 %) were reviewed (Fig. 5). The variability of the flowering season in the present study could be due to the various factors such as altitude, soil type, UV radiations and rainfall etc. Zeb et al. (2020) and Ullah et al. (2019) also support the present study.

Table 1: Life form diversity and leaf size spectra of recorded flora of Bajaur Agency, Khyber Pakhtunkhwa. LEAF SIZE; Mic (Microphyll); Mes (Mesophyll); Mac (Macrophyll); N (Nanophyll); L (Leptophyll). LIFE FORM; TH (Therophytes); MP (Megaphanerophytes); MesP (Mesophanerophytes); H (Hemicryptophytes); CH (Chamaephytes); NP (Nanophanerophytes); PH (Phanerophytes); G (Geophytes); Cr (Cryptophytes).

Family	Sp. No.	Plant species	Life form	Leaf size	Habit	**Sub-locality** (elevation by meter)	Flowering period
Asteraceae	1.	*Artemisia absinthium* Linn.	Ch	N	Herb	Derakai (870)	June-July
	2.	*Artemisia vulgaris* Linn.	TH	Mic	Herb	Gulo derai (1490)	Aug-Sep
	3.	*Aster altaicus* Willd.	H	Mic	Herb	Lara dandakoi (990)	June-Aug
	4.	*Cirsium vulgare* (Savi) Ten.	Ch	Mic	Herb	Lakyano (1310)	Dec-Jan
	5.	*Cichorium endivia* L.	TH	N	Herb	Kadok (1290)	Apr-July
	6.	*Centaurea iberica* Trevir. ex Spreng.	TH	N	Herb	Sango (890)	Apr-May
	7.	*Carduus edelbergii* Rech.f.	TH	Mic	Herb	Lakyano (1310)	June-Oct
	8.	*Helianthus annuus* L.	TH	Mes	Shrub	Lara dandakoi (990)	July-Sept
	9.	*Ixeris polycephala* Cass.	TH	Mic	Herb	Amber khana (1390)	Marc-Apr
	10.	*Lactuca serriola* L.	TH	Mes	Herb	Sango (890)	Aug-Sept
	11.	*Seriphidium maritimum* (L.) Poljak	Ph	Le	Shrub	Lakyano (1310)	Aug-Sep
	12.	*Sonchus oleraceus* L.	TH	Mic	Herb	Amber khana (1390)	Apr-May
	13.	*Steirodescus tagetes* (L.) Schltr.	TH	N	Herb	Lakyano (1310)	June-July
	14.	*Taraxacum erythrospermum* Andrz. ex Besser	H	Mic	Herb	Gulo derai (1490)	Apr-May
	15.	*Urospermum picroides* (L.) Scop. ex. F.W. Schmidt	TH	Mic	Herb	Lakyano (1310)	Apr-June
	16.	*Xanthium strumariumm* L.	TH	Mes	Herb	Sango (890)	May-June
Apiaceae	17.	*Scandix pecten-veneris* L.	TH	L	Herb	Tandatok (1400)	Marc-May
Acanthaceae	18.	*Dicliptera bupleuroides* Nees	TH	L	Herb	Tandatok (1400)	June-Aug
	19.	*Strobilanthes glutinosus* Nees in Wall.	Cr	Mic	Herb	Lakyano (1310)	Oct-Marc
Amaranthaceae	20.	*Alternanthera pungens* Kunth	TH	Mic	Herb	Tandatok (1400)	Apr-May
	21.	*Digera muricata* Mart.	TH	N	Herb	Tandatok (1400)	July-Sept
	22.	*Chenopodium botrys* (L.) Mosyakin & Clements	He	Mic	Herb	Barji (918)	June-July
	23.	*Chenopodium album* L.	TH	N	Herb	Barji (918)	June-July
Asclepiadaceae	24.	*Calotropis procera* (Aiton) Dryand	Ch	Mes	Shrub	Barji (918)	July-Aug
Berberidaceae	25.	*Berberis lycium* Royle	NP	Mic	Shrub	Gulo derai (1490)	May-June
Brassicaceae	26.	*Brassica rapa* L.	TH	N	Herb	Lakyano (1310)	June-July
	27.	*Capsella bursa-pastoris* Medik.	TH	L	Herb	Pashath area (972)	Apr-May
	28.	*Descurainia sophia* (L.) Webb Prantl	TH	L	Herb	Pashath area (972)	May-July
	29.	*Lepidium didymus* L.	TH	Mic	Herb	Amber khana (1390)	June
	30.	*Nasturtium officinale* R.Br	TH	N	Herb	Bar dandakoi (1150)	Apr-May
	31.	*Sisymbrium irio* Linn.	TH	N	Herb	Bar dandakoi (1150)	Apr-June
Boraginaceae	32.	*Heliotropium lasiocarpum* Fisch. & C.A. Mey.	TH	N	Herb	Pashath area (972)	June

	33.	*Trichodesma zeylanicum* (Burm.f.) R.Br.	Ch	Mic	Herb	Lakyano (1310)	March
Caryophyllaceae	34.	*Stellaria media* (L.) Vill	TH	L	Herb	Pashath area (972)	Apr-May
	35.	*Silene conoidea* L.	TH	N	Herb	Lara dandakoi (990)	Apr-May
Cannabaceae	36.	*Cannabis sativa* L.	TH	Mic	Herb	Tandatok (1400)	May-June
	37.	*Celtis caucasica* Willd.	MesP	Mic	Tree	Tandatok (1400)	Apr-July
Convolvulaceae	38.	*Ipomoea purpurea* (L.) Roth	TH	Mes	Herb	Kadoka (1290)	June-July
Crassulaceae	39.	*Rosularia adenotricha* (Wall. ex Edgew.) C.A.- Jansson	G	L	Herb	Amber khana (1390)	June-July
Dryopteridaceae	40.	*Polystichum munitum* (Kaulf.) C. Presl	TH	Mic	Fern	Tandatok (1400)	March
Euphorbiaceae	41.	*Chrozophora tinctoria* (L.) A. Juss.	TH	Mic	Herb	Amber khana (1390)	June-Aug
	42.	*Euphorbia hirta* L.	TH	Mic	Herb	Bar dandakoi (1150)	Aug-Sept
	43.	*Euphorbia balbissi* Boiss.	TH	L	Shrub	Batwar (1462)	June-July
	44.	*Euphorbia peplus* L.	TH	N	Shrub	Lakyano (1310)	June-Sept
	45.	*Euphorbia helioscopia* subsp. *helioscopoides* (Loscos & J. Pardo)	TH	N	Herb	Batwar (1462)	Aug-Sept
	46.	*Ricinus communis* L.	NP	Mes	Shrub	Barji (918)	June-Oct
Equisetaceae	47.	*Equisetum arvense* L.	Cr	L	Herb	Tandatok (1400)	March
Fabaceae	48.	*Indigofera aspalathoides* Vahl ex DC.	TH	L	Shrub	Amber khana (1390)	May-June
	49.	*Lathyrus articulates* L.	TH	N	Herb	Bar dandakoi (1150)	Mar-Apr
	50.	*Medicago minima* (L.) Bartl.	He	N	Tree	Bar dandakoi (1150)	June-July
	51.	*Robinia pseudacacia* L.	MesP	Mic	Tree	Lara dandakoi (990)	Apr-May
	52.	*Sesbania sesban* var. nubica Chiov.	Ph	N	Shrub	Lara dandakoi (990)	Aug-Sept
	53.	*Trifolium alexandrium* L.	TH	N	Herb	Bar dandakoi (1150)	April
	54.	*Vicia sativa* subsp. nigra Ehrh.	TH	N	Herb	Bar dandakoi (1150)	Apr-May
	55.	*Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.	MP	L	Tree	Barji (918)	March-Aug
Fagaceae	56.	*Quercus leucotrichophora* A. Camus	MesP	Mic	Tree	Tandatok (1400)	Apr-May
Geraniaceae	57.	*Erodium cicutarium* (L.) L'Hér.	TH	L	Herb	Batwar (1462)	Apr-June
	58.	*Geranium albicans* A.St.-Hil.	TH	Mic	Herb	Amber khana (1390)	June-July
Hypericaceae	59.	*Hypericum perforatum* subsp. *veronense* (Schrank) H. Lindb.	TH	L	Herb	Lakyano (1310)	June-Aug
Juglandaceae	60.	*Juglans regia* L.	MP	Mes	Tree	Gulo derai (1490)	Apr-May
Lamiaceae	61.	*Ajuga parviflora* Benth.	TH	Mic	Herb	Tandatok (1400)	May-June
	62.	*Lamium galeobdolon* subsp. *argentatum* (Smejkal) J. Duvign.	CH	Mic	Herb	Barji (918)	June
	63.	*Lamium amplexicaule* L.	TH	N	Herb	Amber khana (1390)	July-Oct
	64.	*Mentha arvensis* L.	MP	N	Herb	Barji (918)	July-Sept
	65.	*Micromeria biflora* var. *rhodesiaca* (Elly Walther and K.H. Walther)	CH	L	Herb	Tandatok (1400)	Aug-Sept
	66.	*Nepeta cataria* L.	H	N	Herb	Lakyano (1310)	July-Sept

	67.	*Salvia plebeia* R.Br.	TH	Mic	Herb	Bar dandakoi (1150)	All year
	68.	*Salvia moorcroftiana* Wall. ex Benth.	CH	Mes	Herb	Gulo derai (1490)	Apr-Aug
	69.	*Teucrium stocksianum* Boiss.	TH	L	Herb	Lakyano (1310)	Apr-May
	70.	*Vitex negundo* L.	NP	Mic	Shrub	Tandatok (1400)	Sept-Oct
Linaceae	71.	*Reinwardtia indica* Dumort.	NP	N	Shrub	Lakyano (1310)	October
Moraceae	72.	*Ficus carica* L.	MP	Mac	Tree	Tandatok (1400)	June-July
	73.	*Ficus sarmentosa* var. *landucca* (Roxb.) Corner	PH	Mic	Tree	Tandatok (1400)	March
	74.	*Morus nigra* L.	MesP	Mes	Tree	Bar dandakoi (1150)	Apr-May
	75.	*Morus alba* L.	MesP	Mes	Tree	Bar dandakoi (1150)	Apr-May
Meliaceae	76.	*Melia azedarach* Linn.	MP	Mic	Tree	Lakyano (1310)	Apr-May
Onagraceae	77.	*Oenothera rosea* Aiton	TH	N	Herb	Lakyano (1310)	Apr-May
Oleaceae	78.	*Chrysojasminum humile* (L.) Banfi	NP	Mic	Shrub	Barji (918)	Apr-June
	79.	*Olea europaea* subsp. *cupsidata* (Wall. G.Don) Cif	MP	Mic	Tree	Lara dandakoi (990)	Apr-May
Poaceae	80.	*Arundo donax* Linn.	H	Mac	Herb	Barji (918)	July-Sept
	81.	*Bromus japonicus* Houtt.	H	L	Herb	Lara dandakoi (990)	Apr-May
	82.	*Sorghum halepense* (L.) Pers.	H	Mic	Grass	Barji (918)	August
	83.	*Urochloa reptans* (L.) Stapf	TH	L	Grass	Lara dandakoi (990)	Apr- Aug
Plantaginaceae	84.	*Plantago ovata* Forssk.	TH	N	Herb	Barji (918)	March-July
	85.	*Plantago major* Linn.	TH	Mes	Herb	Tandatok (1400)	June-July
	86.	*Plantago altissima* L.	TH	Mic	Herb	Tandatok (1400)	June-July
	87.	*Veronica campylopoda* Boiss.	TH	Na	Herb	Batwar (1462)	Apr-may
	88.	*Veronica persica* Poir.	TH	Mic	Shrub	Batwar (1462)	June-Sept
	89.	*Veronica anagalloides* Guss.	MP	Mes	Herb	Batwar (1462)	June-July
Polygonaceae	90.	*Polygonum aviculare* L.	TH	Mic	Herb	Barji (918)	May-June
	91.	*Rumex stenophyllus* Ledeb.	TH	Mes	Herb	Barji (918)	August
	92.	*Rumex hastatus* D. Don.	CH	N	Herb	Lakyano (1310)	Apr-May
Plumbaginaceae	93.	*Plumbago zeylanica* L.	TH	Mic	Herb	Amber khana (1390)	All the year
Platanaceae	94.	*Platanus orientalis* Linn.	MP	Mac	Tree	Kadoka (1290)	Apr-June
Pinaceae	95.	*Pinus roxburghii* Sarg.	MP	L	Tree	Batwar (1462)	May-June
Primulaceae	96.	*Lysimachia arvensis* (L.) U.Manns & Anderb.	TH	N	Herb	Amber khana (1390)	March-Sept
Rosaceae	97.	*Cotoneaster ellipticus* Hort ex Loudon	NP	L	Shrub	Amber khana (1390)	Apr-May
	98.	*Rubus hakonesis* Franch. & Sav.		Mic	Shrub	Tandatok (1400)	July- Aug
	99.	*Rubus persicus* Boiss.	NP	Mic	Shrub	Tandatok (1400)	July-Sept
Ranunculaceae	100.	*Ranunculus scleratoides* Perf. ex Ovcz.	G	Mic	Herb	Amber khana (1390)	May-Sept
	101.	*Ranunculus arvensis* L.	TH	Na	Herb	Tandatok (1400)	Mar-Apr
Rubiaceae	102.	*Galium aparine* L.	TH	Mic	Weed	Pashath area (972)	July-Oct
Rutaceae	103.	*Zanthoxylum armatum* DC.	NP	Mic	Shrub	Gulo derai (1490)	Apr-May

Rhamnaceae	104.	*Ziziphus jujuba* Mill.	MP	Mac	Tree	Batwar (1462)	June-July
Scrophulariaceae	105.	*Buddleja crispa* Benth.	NP	MIC	Shrub	Tandatok (1400)	Apr-May
	106.	*Verbascum thapsus* Linnaeus.	TH	Mic	Herb	Lakyano (1310)	Apr-May
Solanaceae	107.	*Datura innoxia* Miller.	Ch	Mes	Shrub	Pashath area (972)	Marc-May
	108.	*Nolana leptophylla* (Miers.) I.M.Johnst	TH	Mic	Herb	Derakai (870 m)	Feb-May
	109.	*Physalis minima* L.	Ch	Mic	Herb	Tandatok (1400)	August
	110.	*Solanum nigrum* Lesch. ex Dunal	TH	N	Herb	Barji (918)	Apr-Oct
	111.	*Withania somnifera* (L.) Dunal	Ch	Mic	Herb	Pashath area (972)	Apr-May
Salicaceae	112.	*Populus nigra* L.	MP	Mes	Tree	Bar dandakoi (1150)	April
	113.	*Salix tetrasperma* Roxb.	MP	Mic	Tree	Bar dandakoi (1150)	June-Oct
Sapindaceae	114.	*Dodonaea viscosa* Jacq.	NP	Mic	Shrub	Bar dandakoi (1150)	March-June
Simaroubaceae	115.	*Ailanthus altissima* (Mill.) Swingle	Mp	Mic	Tree	Kadoka (1290)	June-July
Thymelaeaceae	116.	*Daphne mucronata* Royle.	Np	Mic	Shrub	Gulo derai (1490)	Apr-Sept
	117.	*Thymelaea passerina* (L.) Coss. & Germ.	Ch	Na	Herb	Pashath area (972)	July-Sept
Tamaricaceae	118.	*Tamarix aphylla* (L.) Warb.	MP	L	Tree	Gulo derai (1490)	June-Oct
Urticaceae	119.	*Urtica dioica* L.	TH	Mic	Herb	Amber khana (1390)	Apr-May
Verbenaceae	120.	*Verbena officinalis* L.	H	Mic	Herb	Barji (918)	Apr-May
Violaceae	121.	*Viola canescens* Wall.	H	Mic	Herb	Kadoka (1290)	Apr-May
Zygophyllaceae	122.	*Tribulus terrestris* Muhl.	He	N	Herb	Bar dandakoi (1150)	Apr-Aug

Table 2: Life form of classes of flora of District Bajaur, Khyber Pakhtunkhwa.

Life form	No of species	Percentage (%)
Therophytes	65	53.27
Megaphenerophytes	13	10.65
Hemicryptophytes	10	8.19
Chamaephytes	10	8.19
Nanophenerophytes	10	8.19
Mesophenerophytes	5	4.09
Geophytes Phenerophytes	3	2.46
	3	2.46
Cryptophytes	3	2.46
Total	**122**	**100**

Table 3: Life form of classes of flora of District Bajaur, Khyber Pakhtunkhwa.

LEAF SIZE	NO OF SPECIES	PERCENTAGE (%)
Microphylls	53	43.45
Mesophylls	15	12.30
Nanophylls	31	25.40
Leptophylls	20	16.40
Macrophylls	3	2.45
Total	**122**	**100**

Table 4: Family wise distribution of plants of District Bajaur, Khyber Pakhtunkhwa.

FAMILY	NO OF SPECIES	PERCENTAGE (%)
Asteraceae	16	13.93
Lamiaceae	10	8.1
Fabaceae	8	6.55
Brassicaceae	6	4.91
Euphorbiaceae	6	4.91
Plantaginaceae	6	4.91

Solanaceae	5	4.09
Amaranthaceae	4	3.27
Moraceae	4	3.27
Poaceae	4	3.27
Polygonaceae	3	2.45
Acanthaceae	2	1.63
Boraginaceae	2	1.63
Caryophyllaceae	2	1.63
Cannabaceae	2	1.63
Geraniaceae	2	1.63
Oleaceae	2	1.63
Ranunculaceae	2	1.63
Scrophulariaceae	2	1.63
Salicaceae	2	1.63
Thymelaeaceae	2	1.63
Other 27 families	1 (each)	0.8
Total	**122**	**100**

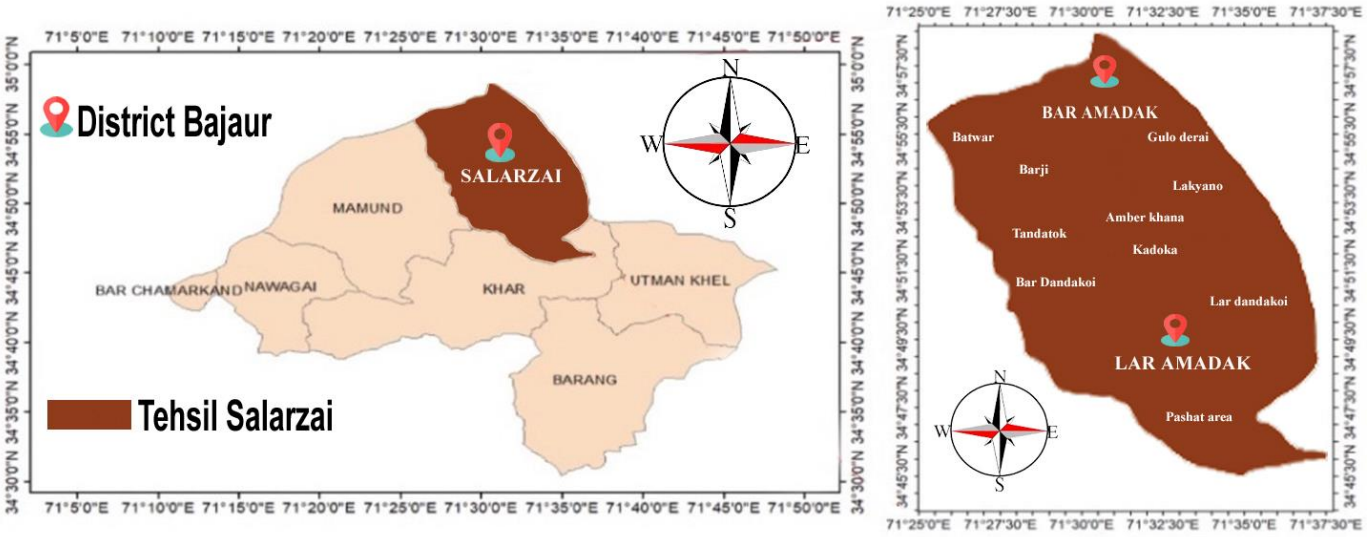

Fig. 1: Map of the study area shows different regions of Tehsil Salarzai, District Bajaur.

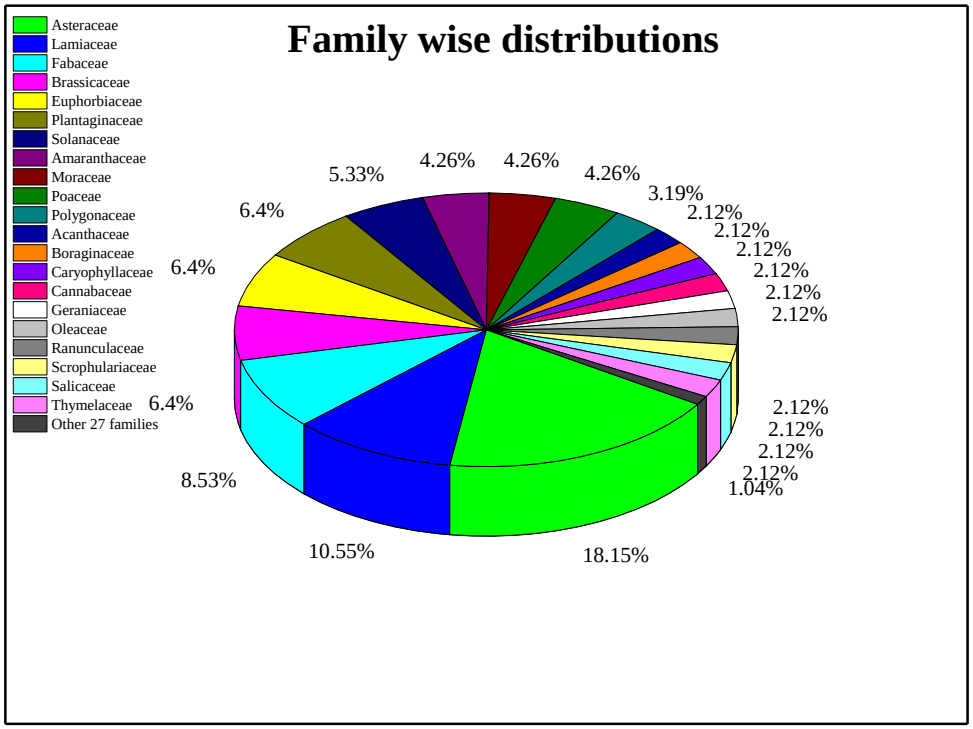

Fig. 2. Family wise distribution.

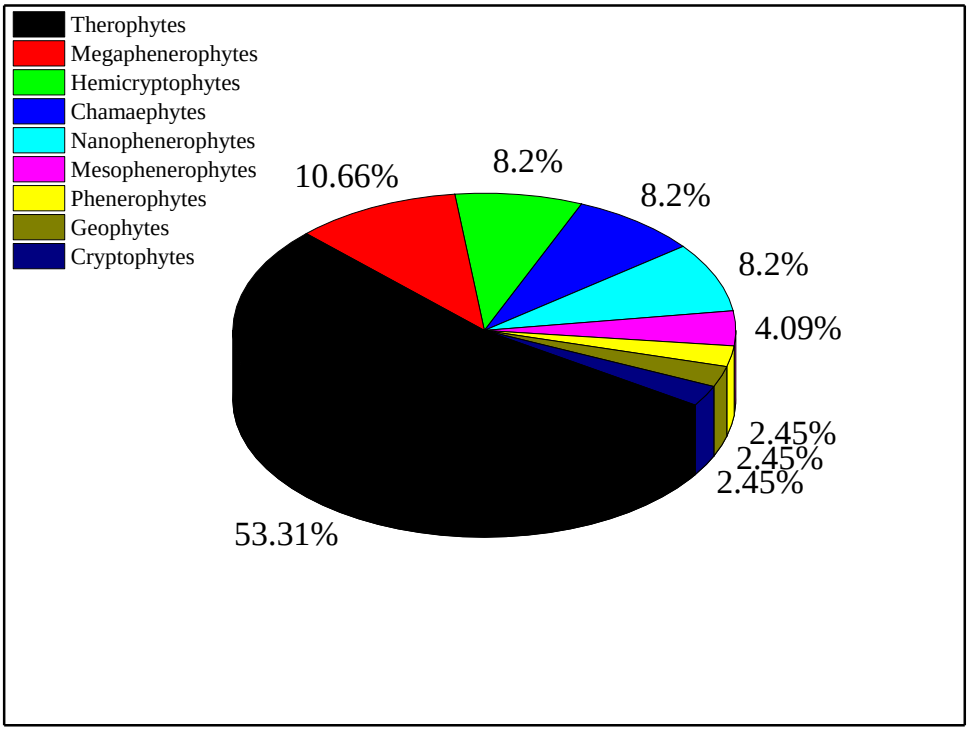

Fig. 3. Life form Classes

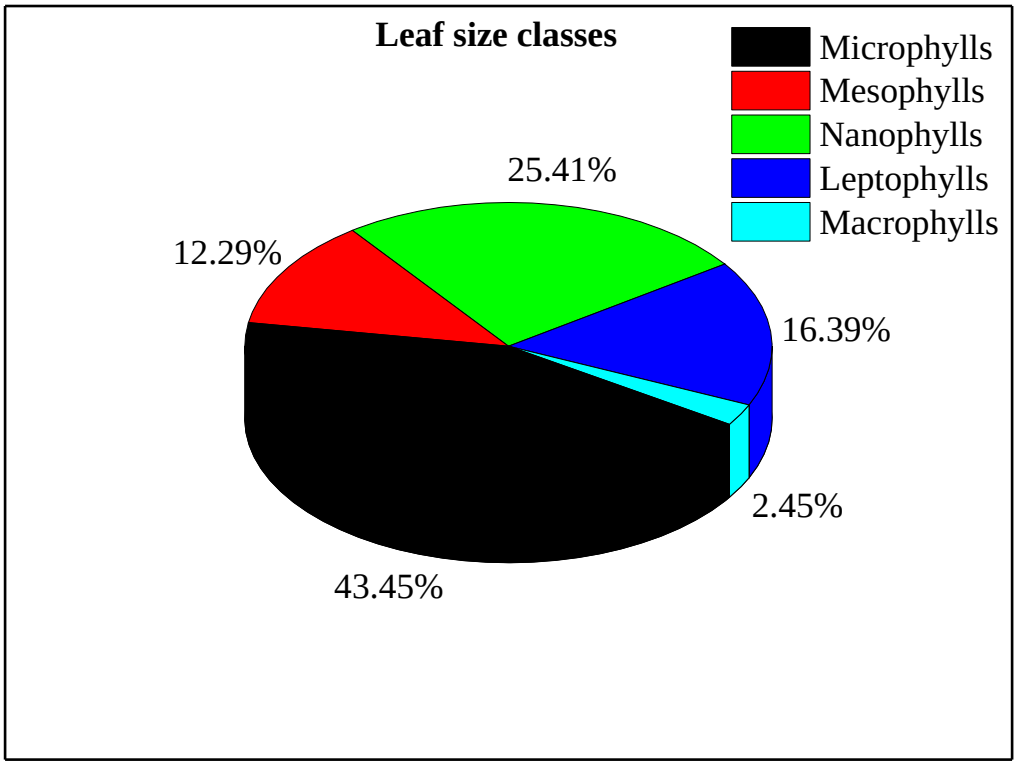

Fig. 4. Leaf size classes

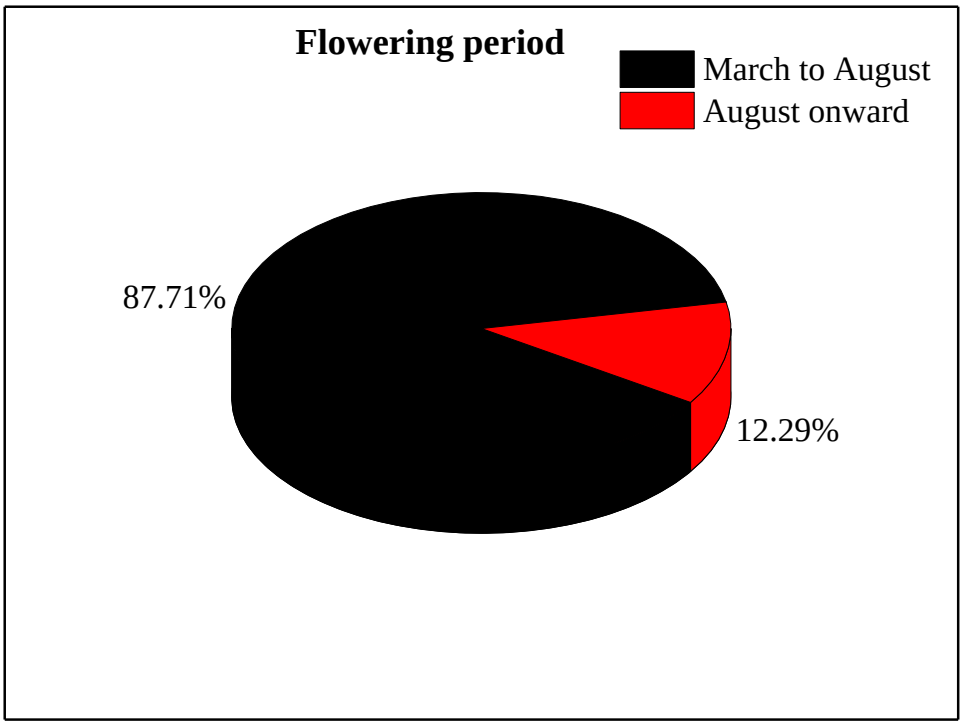

Fig. 5. Flowering period

CONCLUSION

Assessing the existing plant life offers an opportunity to study nutrient levels in the region, which boasts abundant phytodiversity. The prevalence of therophytes and microphylls signifies that the Bajaur District experiences a semi-arid, subtropical continental highland climate, as outlined in the Initial Environmental Examination Report (2020-2021). Due to a lack of proper management, the regeneration of woody plants has been impeded. The area holds significant potential for wildlife, floristic diversity, and rangeland utilization. The ecological traits, such as life form and leaf size spectra of the vegetation, are significantly linked to the existing environmental factors like altitude, slope, precipitation, and temperature. This correlation suggests that these ecological characteristics are influenced by and adapted to the specific environmental conditions prevailing in the area. The consumption of *Juglans regia* and *Olea europaea* subsp. *cupsidata* for fuel purposes, furniture and other purposes are outpacing its natural ability to replenish and regenerate, contributing to a decrease in its overall population which need proper attention to conserve biodiversity.

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